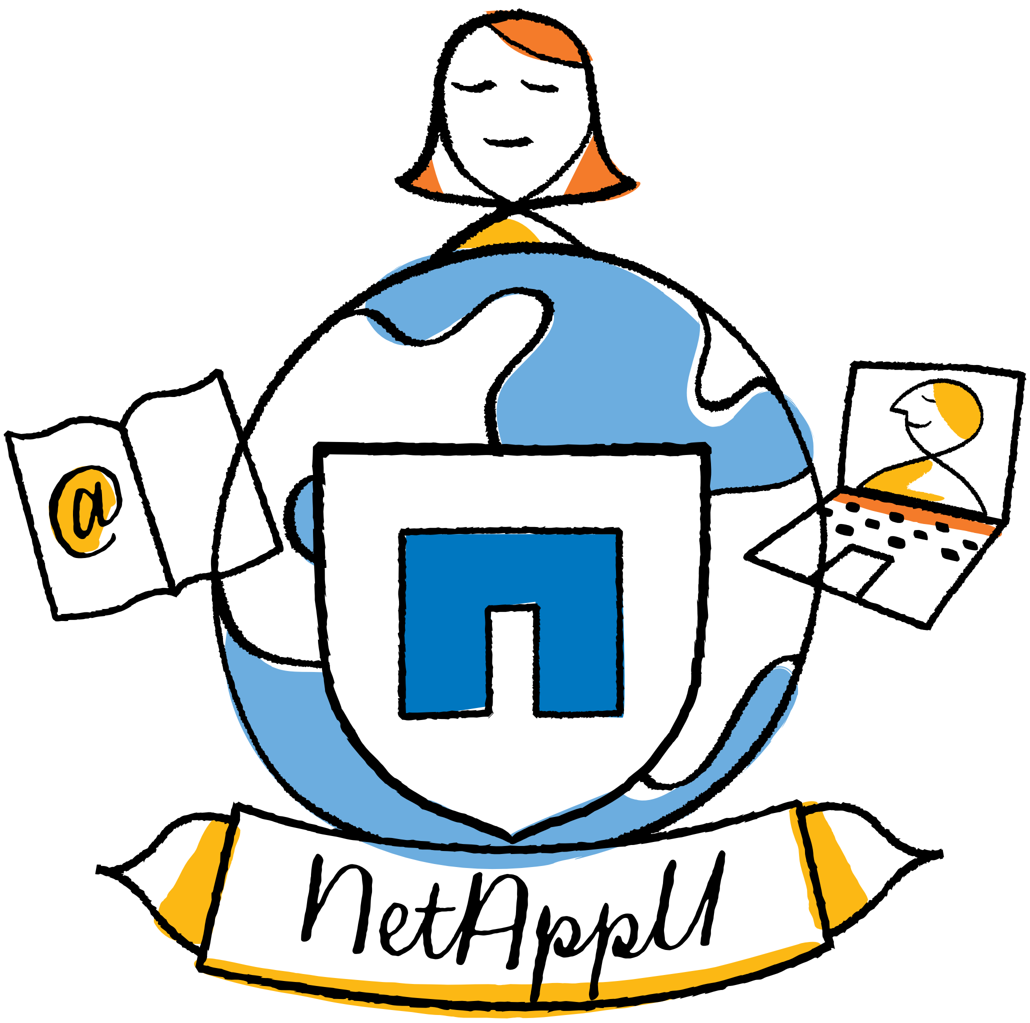
NetApp®

Go further, faster®

NetApp University

Implementing Oracle on NetApp Storage Systems

Student Guide



NETAPP UNIVERSITY

Implementing Oracle on NetApp Storage Systems

Student Guide

Course ID: STRSW-ILT-ORONSS_REV01
Catalog Number: STRSW-ILT-ORONSS_REV01
Content Version: 1.0

ATTENTION

The information contained in this course is intended only for training. This course contains information and activities that, while beneficial for the purposes of training in a closed, non-production environment, can result in downtime or other severe consequences in a production environment. This course material is not a technical reference and should not, under any circumstances, be used in production environments. To obtain reference materials, refer to the NetApp product documentation that is located at http://now.netapp.com/.

COPYRIGHT

U.S. GOVERNMENT RIGHTS

Commercial Computer Software. Government users are subject to the NetApp, Inc. standard license agreement and applicable provisions of the FAR and its supplements.

TRADEMARK INFORMATION

NetApp, the NetApp logo, Go further, faster, AdminNODE, Akorri, ApplianceWatch, ASUP, AutoSupport, BalancePoint, BalancePoint Predictor, Bycast, Campaign Express, ChronoSpan, ComplianceClock, ControlNODE, Cryptainer, Data ONTAP, DataFabric, DataFort, Decru, Decru DataFort, DenseStak, Engenio, E-Stack, FAServer, FastStak, FilerView, FlexCache, FlexClone, FlexPod, FlexScale, FlexShare, FlexVol, FPolicy, GatewayNODE, gFiler, Imagine Virtually Anything, Infinivol, Lifetime Key Management, LockVault, Manage ONTAP, MetroCluster, MultiStore, NearStore, NetApp Select, NetCache, NetCache, NOW (NetApp on the Web), OnCommand, ONTAPI, PerformanceStak, RAID DP, SANscreen, SANshare, SANtricity, SecureAdmin, SecureShare, Securitis, Service Builder, Simplicity, Simulate ONTAP, SnapCopy, SnapDirector, SnapDrive, SnapLock, SnapManager, SnapMirror, SnapMover, SnapProtect, SnapRestore, Snapshot, SnapValidator, SnapVault, StorageGRID, StorageNODE, StoreVault, SyncMirror, Tech OnTap, VelocityStak, vFiler, VFM, Virtual File Manager, WAFL, and XBB are trademarks or registered trademarks of NetApp, Inc. in the United States and/or other countries.

All other brands or products are either trademarks or registered trademarks of their respective holders and should be treated as such.

TABLE OF CONTENTS

NetApp

Go further, faster®

Implementing Oracle on NetApp Storage Systems

Course ID:
STRSW-ILT-ORONSS_REV01

 NetApp Confidential 1

IMPLEMENTING ORACLE ON NETAPP STORAGE SYSTEMS

This course provides instruction and hands-on practice to help you to learn how to implement an Oracle database solution in a NetApp clustered Data ONTAP storage environment. In this class, you practice discovering, planning, designing, and provisioning an Oracle environment. In the hands-on exercises of this course, you install and configure an Oracle server, create an Oracle database, and use NetApp data management solutions to back up and restore your Oracle database.

Classroom Logistics

Schedule
- Start time
- Stop time
- Break times

Facilities
- Food and drinks
- Restrooms
- Phones

Safety
- Alarm signal
- Evacuation procedure
- Electrical safety guidelines

CLASSROOM LOGISTICS

Course Objectives

By the end of this course, you should be able to:

- Describe key issues that occur with Oracle database deployments
- Describe key architecture decisions for deploying Oracle on NetApp storage systems
- Provision storage on NetApp systems for Oracle databases
- Configure Oracle databases to use NetApp storage systems
- Use NetApp data management solutions to back up, recover, and clone Oracle databases

 NetApp Confidential 3

COURSE OBJECTIVES

Course Agenda: Day 1

- Morning
  - Module 1: Implementing Oracle on NetApp Storage Systems: Overview
  - Module 2: Designing and Planning an Oracle Implementation
- Afternoon
  - Module 3: Setting Up NetApp Storage Systems for Oracle Databases
  - Module 4: Installing an Oracle Server and Oracle Databases

 NetApp Confidential 4

COURSE AGENDA: DAY 1

Course Agenda: Day 2

- Morning
  - Module 5: Using Oracle dNFS with NetApp Storage
- Afternoon
  - Module 6: Using Oracle ASM with NetApp Storage

COURSE AGENDA: DAY 2

Course Agenda: Day 3

- Morning
  - Module 7: Backup and Recovery Methods for Oracle
- Afternoon
  - Module 8: Cloning Oracle Databases
  - Module 9: Disaster Recovery for Oracle Databases

COURSE AGENDA: DAY 3

NetApp University Information Sources

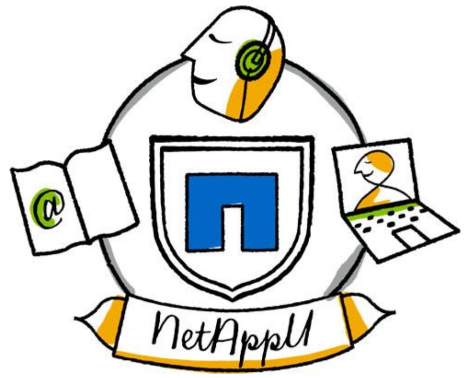
- NetApp Support Site
  http://support.netapp.com
- NetApp University
  http://www.netapp.com/us/services/university/
- NetApp University Support
  http://netappusupport.custhelp.com

NETAPP UNIVERSITY INFORMATION SOURCES

NetApp

Module 1

Implementing Oracle on NetApp Storage Systems: Overview



MODULE 1 – IMPLEMENTING ORACLE ON NETAPP STORAGE SYSTEMS: OVERVIEW

Module Objectives

After this module, you should be able to:

- Describe components of Oracle databases
- Describe key issues that are often experienced with Oracle deployments
- Describe the advantages of implementing Oracle solutions on NetApp technology

 NetApp Confidential

MODULE OBJECTIVES

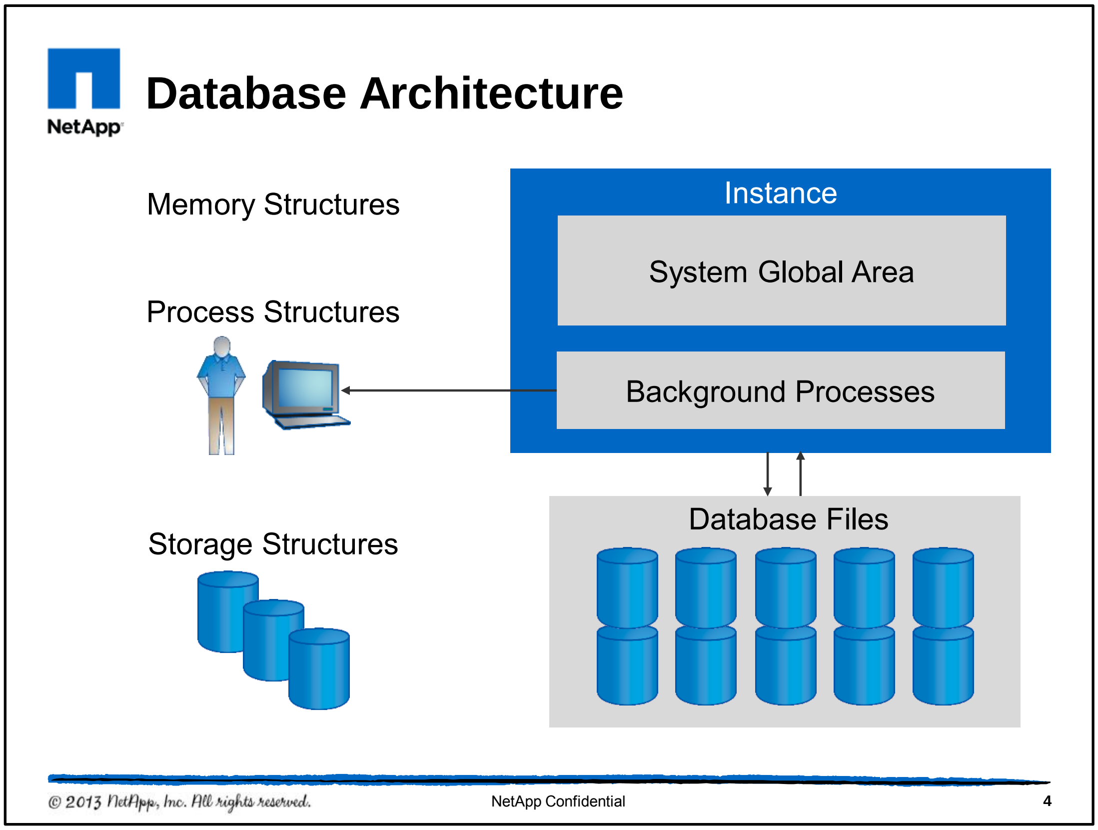
NetApp

Lesson 1

Oracle Database Components

 NetApp Confidential 3

LESSON 1: ORACLE DATABASE COMPONENTS

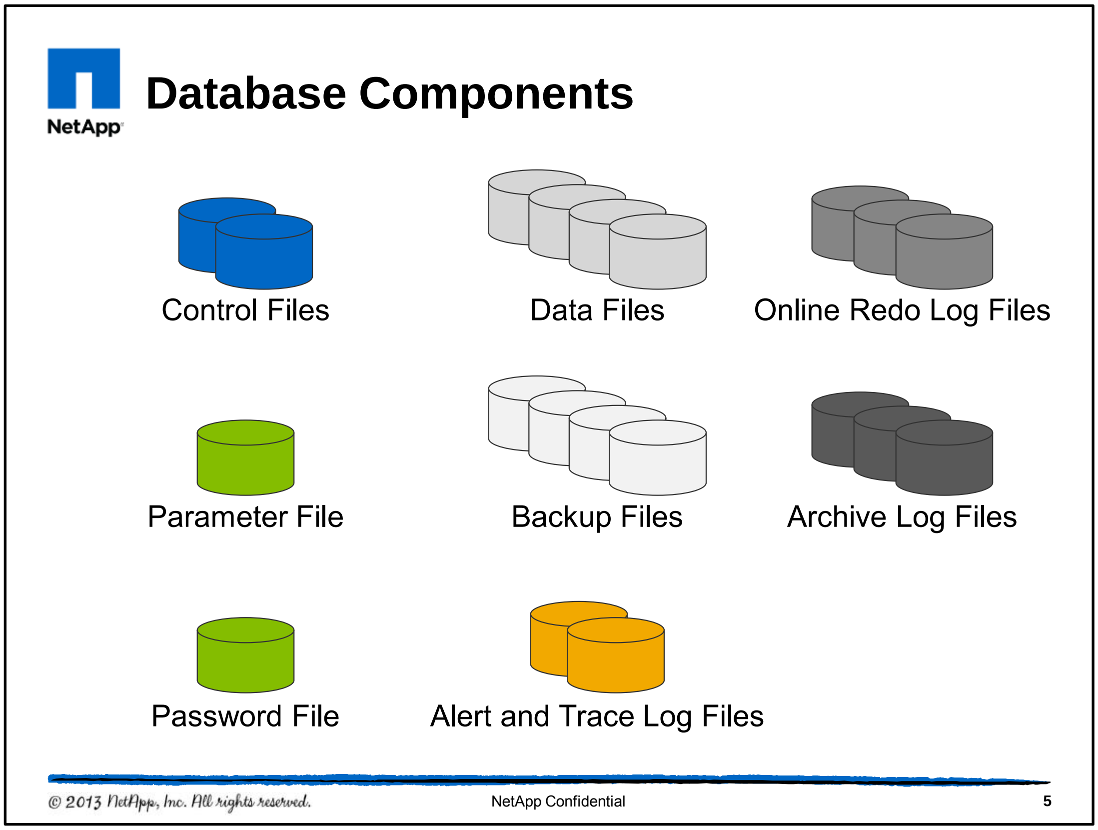


DATABASE ARCHITECTURE

You can install the Oracle relational database management system (RDBMS) on a variety of UNIX, Linux, and Windows operating systems.

An Oracle environment is typically called an "Oracle database" or an "Oracle instance." An instance consists of a set of OS process and memory structures that interact with storage. An instance contains more components than you see in this slide, which shows a high-level view of a database.

An Oracle database is a collection of data files that are treated as one unit. The Oracle server manages and writes to the data files, which are located in the physical storage.



DATABASE COMPONENTS

An Oracle database includes multiple components. The following components are the basic building blocks of an Oracle infrastructure:

Control files contain information about the Oracle logical database structure, restoration and recovery information, system change number (SCN), and checkpoint data.

Data files contain the physical data, which is organized by logical structures such as tablespaces and tables.

Online redo log files are where the database transactions are recorded:

- Archive log files
- Password file
- Alert and trace log files

- **The parameter file** is the Oracle initialization file. It contains the parameters that are necessary to configure the database.
- **Backup files** are part of the Oracle Recovery Manager (RMAN) utility. NetApp Snapshot copies provide an excellent alternative to the RMAN backup files.

Core Database Components

- Control files
- Data files
- Redo logs
- Archive log files

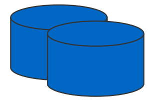
NOTE: All components, not only the core components, are required.

CORE DATABASE COMPONENTS

Each database component is important, but the core elements are control files, data files, redo logs, and archive log files.

Control Files

- The database cannot start without the control file.
- Control files can be re-created.



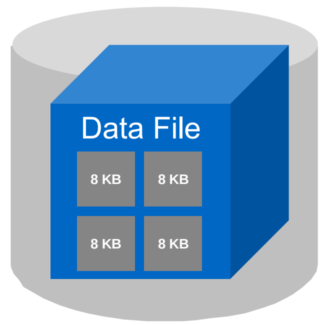
Caution: In some databases, the control files contain an RMAN catalog of backup data, which is lost if you lose the control files.

CONTROL FILES

The database control file contains information that is required by the instance to operate the database, including the status of the database's physical structure. Every Oracle database must have at least one control file. Usually more than one control file exists, for purposes of backup and recovery. In some databases, the control files contain an RMAN catalog of backup data, which is lost if you lose the control files.

Data Files

- A data file stores data on disk.
- A block contains data.
- A data file consists of blocks.
- There are two types of data files:
  – Regular
  – Temporary (tempfiles)

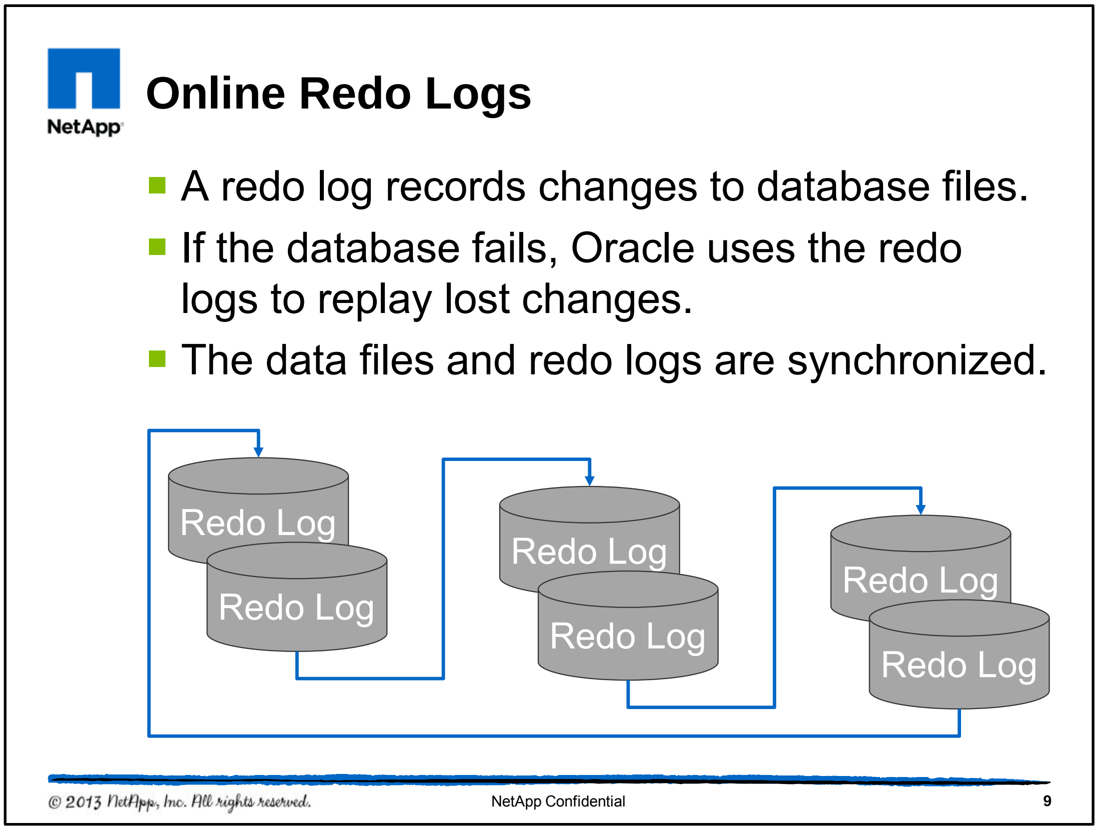


DATA FILES

The physical data files, which are stored on disk and contain the Oracle data, are written to only by the database write processes. These database data files are associated with Oracle tablespaces, which are logical containers for tables and indexes.

Data files store data on disk in blocks. In the context of this course, the NetApp controller presents blocks for storage to the Oracle host in either a LUN (where blocks are managed by the Oracle host file system) or an NFS share (where blocks are managed by the Data ONTAP operating system).

An Oracle database has both regular and temporary files (which are also called “tempfiles” or “temp tablespace”).



ONLINE REDO LOGS

Oracle records the changes in the appropriate online redo log when an item of data is changed in a data file. A redo log records the transactions that happen within the database. Individual redo logs are assigned to a redo log group, which contains multiple members. Oracle rotates to the next defined redo log group and begins recording transactions when the logs in the group are full.

When a database crashes, Oracle replays the redo logs instead of doing data file recovery. This action is called an "instance recovery," and it enables committed and uncommitted transactions to be redone, which guarantees data integrity and consistency.

For data consistency, Oracle does not issue any subsequent writes if a previous dependent write has yet to be completed or has an error. This method, called "subsequent dependent writes," guarantees data integrity and does not allow logical data corruption. (For example, imagine that your annual salary is increased to $1,000,000, but the Human Resources system does not complete the write to the database. Almost immediately, someone issues a transaction in error that changes your annual salary to $1. Due to the subsequent dependent write, Oracle does not allow the $1 salary update to be completed.)

If the database fails, Oracle uses the redo logs to replay lost changes.

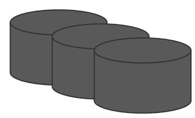
The synchronization of the data files with the redo logs must be perfect, so the information in the redo logs and the data files is equally important. The data files are corrupt without the information in the redo logs.

Oracle synchronously writes:

- Into the redo logs—the details of what Oracle is about to do with the normal data files
- To the data files
- Into the redo logs—that the write was successful

Archive Log Files

- Databases run in either of two modes:
  - ARCHIVELOG mode
  - NOARCHIVELOG mode
- Archive logs have these characteristics:
  - Are the archived online redo log data
  - Enable recovery of transactions
  - Are created by the Oracle ARCH process



ARCHIVE LOG FILES

The use of ARCHIVELOG mode requires database configuration:

- Put the database in ARCHIVELOG mode.
- Configure the ARCH process.
- Prepare the archived redo log destination directories.

ARCHIVELOG mode has some problems:

- Once an online redo log is filled, it cannot be reused until it is archived. If Oracle cannot archive the online redo log (if, for instance, the destination directory is full), it switches to the next online redo log and keeps working. At the same time, Oracle continues its attempt to archive the log file.
- Yet if the database runs out of available online redo logs, Oracle cannot write out the log files. It must overwrite them, losing the original data (which is not yet archived).
- However, Oracle protects the data; it does not overwrite data in an online redo log file until that log file has been archived. Instead, the database stops processing user requests until the log file is archived. This suspension frees the database, and processing proceeds as usual.

Temporary Data Files

- Temporary data files contain the following:
  - Volatile data
  - Data that is created during large queries
  - Data that cannot be accommodated in RAM
- Temporary data files are discarded when the database is shut down.

TEMPORARY DATA FILES

Temporary data files contain volatile data that Oracle uses:

- As part of a large query
- When not enough memory exists to manage large blocks of data

Consider a query to alphabetically sort one million email addresses. If insufficient memory is allocated to Oracle for that much data, Oracle uses temporary data files as scratch space. The contents of the temporary files are discarded when the logs in the group are full.

Without temporary data files, startup may be slow. You can add temporary files later.

Data File Storage

- A data file is fully allocated at creation.
- Oracle “walks the blocks” of a regular data file.
- Thin provisioning is not beneficial.
- Data is typically all you want to restore.
- Use a volume restore in your design.
- Storage design is key to a successful Oracle deployment.

DATA FILE STORAGE

When you allocate a data file to Oracle, Oracle “walks the blocks.” Imagine a whiteboard with a grid, and Oracle touches every block. As extents and segments are allocated, the Oracle blocks are updated. No matter whose storage is in use, the allocation of data files can be time-consuming.

Position yourself, when you build a database, in such a way that you can do a volume Snapshot restore. When a recovery is required, you should restore the data files through a volume Snapshot restore. These components are the largest components of your database.

When you design a solution for Oracle, create an overview of how the storage will be used and how much storage is required. Most customers use the storage controllers for more than one database, so a successful deployment requires collaboration.

Single-Instance Oracle Implementation

An Oracle single instance has these features:

- Has only one node
- Provides shared-nothing storage for the database data files
- Is a single database with a single instance on a single node:
  - An instance is a set of memory structures.
  - A series of processes manages each instance.

SINGLE-INSTANCE ORACLE IMPLEMENTATION

You can implement an Oracle database a single instance or as an Oracle Real Application Cluster (RAC). You implement a single-instance Oracle server on a shared-nothing (SN) distributed computing architecture, in which each node is independent and self-sufficient. An SN server does not share memory or disk storage with any other server.

NetApp

Oracle RAC Implementation

- RAC stands for Oracle Real Application Cluster.
- Many RDBMS systems use RAC to access a single database.
- RAC database data files use shared storage.
- RAC runs Oracle Cluster Ready Services (CRS).
- Use RAC to scale database workloads and add nodes to a cluster.
- When RAC is implemented, interinstance communication occurs between all instances of the clustered database.

 NetApp Confidential

ORACLE RAC IMPLEMENTATION

An Oracle RAC is an implementation of Oracle databases where multiple computers run Oracle RDBMS software while accessing a single database, providing clustering. An Oracle RAC has several nodes that are connected through an interconnect network that share storage for the database data files.

An Oracle RAC also:

- Runs Oracle Cluster Ready Services (CRS)
- Is used to scale database workloads and add nodes to a cluster
- Is a single database with an instance on each node
- Uses interinstance communication between all instances of the clustered database

NetApp

Lesson 2

Business Requirements
for Oracle Deployments

 NetApp Confidential 15

LESSON 2: BUSINESS REQUIREMENTS FOR ORACLE DEPLOYMENTS

Identifying Business Requirements

Ask questions about the following:

- Infrastructure
- Backup and recovery
- Disaster recovery
- High-availability (HA) requirements and SLAs
- Backup retention and archiving
- Development and testing requirements
- Database workload model

IDENTIFYING BUSINESS REQUIREMENTS

Ask questions about:

- **Infrastructure:** Understand and capture your host and Oracle database environments. Use the NetApp nSANity Data Collector to capture infrastructure detail (available for download from the NetApp Support site).
- **Backup and recovery:** Understand the current database backup solution (and its problems) and any backup and recovery requirements.
- **Disaster recovery:** Collect information about the disaster recovery strategy.
- **High availability and scalability:** Collect information about high-availability (HA) requirements and scalability needs.
- **Backup retention and archiving:** Understand what you need to do with your backups.
- **The test and development environment:** Collect information about the test and development storage infrastructure, including replication and cloning for testing and development purposes.
- **A workload model for the database:** Define the database workload and available tools.

The next eight slides list business requirement questions to ask in each area of discovery.

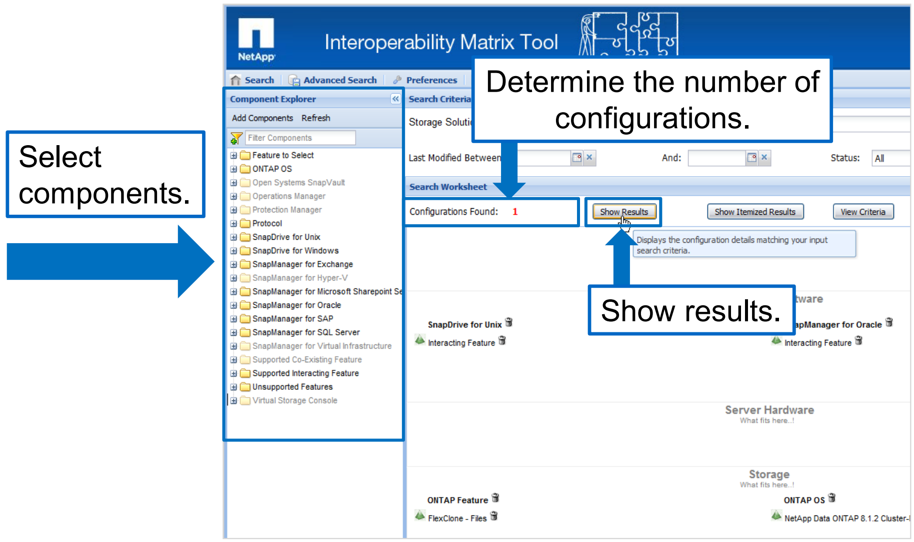
Business Requirement Questions
Infrastructure

- What version of the Data ONTAP operating system do you want to use?
- What is the host OS and version?
- Are you using NFS or SAN?
- If the performance can meet your requirements, do you want to use NFS?
- What are your network configurations?
- What components have been qualified as supportable in the NetApp Interoperability Matrix Tool (IMT)?

BUSINESS REQUIREMENT QUESTIONS: INFRASTRUCTURE

To ensure supportability, gather the infrastructure information, including the answers to the questions on this slide, and consult the NetApp Interoperability Matrix Tool (IMT) (http://support.netapp.com/matrix/) for the supported versions of each infrastructure component.

Business Requirement Questions
The NetApp IMT



 NetApp Confidential 18

BUSINESS REQUIREMENT QUESTIONS: THE NETAPP IMT

The NetApp IMT enables you to investigate test results for each component of any infrastructure. Use the selection tool on the left side of the page to open the IMT and select each component. This action narrows the scope of the criteria for the supportable configurations.

For example, you can use IMT to examine the components and determine if the infrastructure supports SnapManager software for Oracle and SnapDrive for UNIX. (Because SnapManager for Oracle depends on SnapDrive for UNIX to communicate between the Oracle server and the storage system, begin with SnapDrive for UNIX.)

1. Select SnapManager for Oracle.
2. Select the Data ONTAP operating system version, specifying Data ONTAP operating in 7-Mode or the clustered Data ONTAP operating system.
3. Select the NAS and SAN protocols that are part of the planned infrastructure.

Each time that you specify a component, and the scope is narrowed, fewer configurations are found, until only one or two possible configurations remain.

After all components have been specified in the IMT, click the **Show Results** button to read the detailed recommendations that are based on the testing of all of the components.

Generally, NetApp supports NFS without the use of the IMT. NetApp supports all NFS clients and client operating systems that conform to the following RFCs:

- RFC 1094 (NFSv2)
- RFC 1813 (NFSv3)
- RFC 2203 (RPCSEC_GSS)
- RFC 2623 (NFSv2 and NFSv3 security)
- RFC 3530 (NFSv4)

Business Requirement Questions
Backup and Recovery

- What are the recovery point objective (RPO) and recovery time objective (RTO) for this database?
- Do you know the typical amount of changed data per day?
- What is the current usage of your database? (For example, it is a 100-GB database that uses 80% of the space.)
- What is the current usage of the database file systems? (For example, it is a 250-GB file system that uses 100 GB that are allocated to the database.)
- How do you currently meet your recovery requirements?
- Can you create full backups as often as you want to?

BUSINESS REQUIREMENT QUESTIONS: BACKUP AND RECOVERY

Backup and recovery requirements are different for every environment and even every database. You must understand the needs of each database so that your storage design meets those needs.

Take full advantage of NetApp clustered Data ONTAP and NetApp data management solutions when you implement Oracle. This enables you to reach and exceed the requirements of the database environment.

Business Requirement Questions
Disaster Recovery

- What is your disaster recovery infrastructure?
- Do you have multiple locations for disaster recovery?
- What data do you need to transfer and maintain at the disaster recovery site?
- What are the requirements for the disaster recovery data center for your RTO and RPO?
- What are your replication and mirroring requirements? (How much data and how often?)
- How often do you perform a disaster recovery test?
- Do you have to break your disaster recovery solution to test disaster recovery?

BUSINESS REQUIREMENT QUESTIONS: DISASTER RECOVERY

Disaster recovery operates differently at different levels. Ask about the current disaster recovery infrastructure, process, and requirements. Do you need local recoverability, or only remote disaster recovery?

Business Requirement Questions
Backup, Retention, and Archiving

- What are your requirements for archiving backups?
- How many NetApp Snapshot copies must be available?
- How long should you keep the Snapshot copies?
- How many NetApp Snapshot copies does your archiving strategy require? (For example, you might require backups for 5 days but maintain 30 days of archive backups.)

BUSINESS REQUIREMENT QUESTIONS: BACKUP, RETENTION, AND ARCHIVING

Customers often have widely differing database backup and recovery requirements, anywhere from a few days to many weeks of backups. Understanding the critical needs in the current storage environment enables you to add storage capability for your customer in your design. The ability to take backups of large-scale databases within seconds allows storage and database administrators (DBAs) to meet and exceed SLAs.

Business Requirement Questions
Development and Testing Requirements

- Do you want to use backups to refresh a development and test environment?
- What is the retention of a development and test environment as compared to the retention of a NetApp Snapshot copy?
- Are you required to refresh your development and test environments regularly?
- If so, how often?
- How much storage do you use for development and test environments?

BUSINESS REQUIREMENT QUESTIONS: DEVELOPMENT AND TESTING REQUIREMENTS

DBAs and business teams find it useful to create new test environments, which they can easily do with NetApp technology. Reduced timelines for testing and qualifying new applications and upgrades allow customers and business units to get to market faster and more efficiently.

Business Requirement Questions

HA Requirements

- Do you want to improve availability through storage?
- Do you want to use the clustered Data ONTAP operating system?

BUSINESS REQUIREMENT QUESTIONS: HA REQUIREMENTS

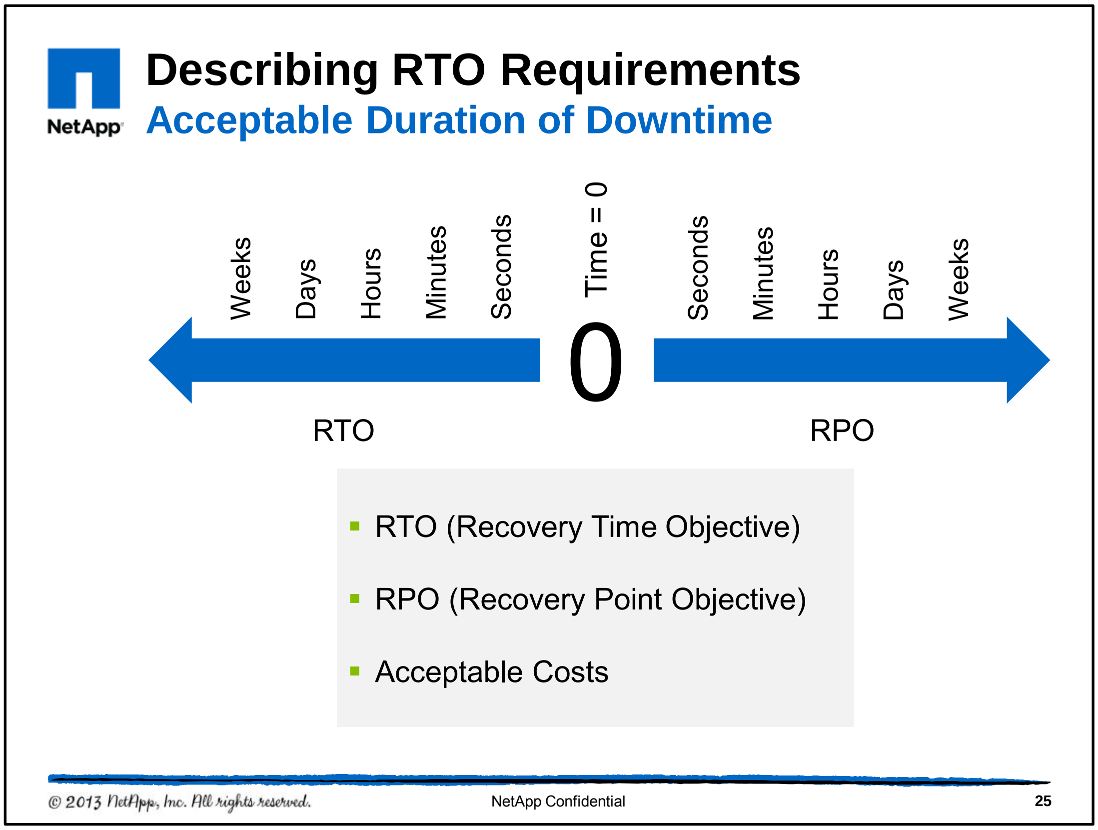
Business Requirement Questions
Workload

- What is the total throughput for the database?
- What is the ratio of reads to writes?
- What is the ratio of random to sequential reads?
- Is the workload type OLTP, decision support system (DSS), or data warehouse?
- At what times during the day does workload peak?
- What business events create peak workload?

 24

BUSINESS REQUIREMENT QUESTIONS: WORKLOAD

The type of workload that a database performs affects storage provisioning and the hardware that is required. The Oracle Automated Workflow Repository (AWR) Report enables you to identify the workload for existing databases. You can review the report in short increments (one hour or less) over a period of time, which greatly helps you understand the database environment.

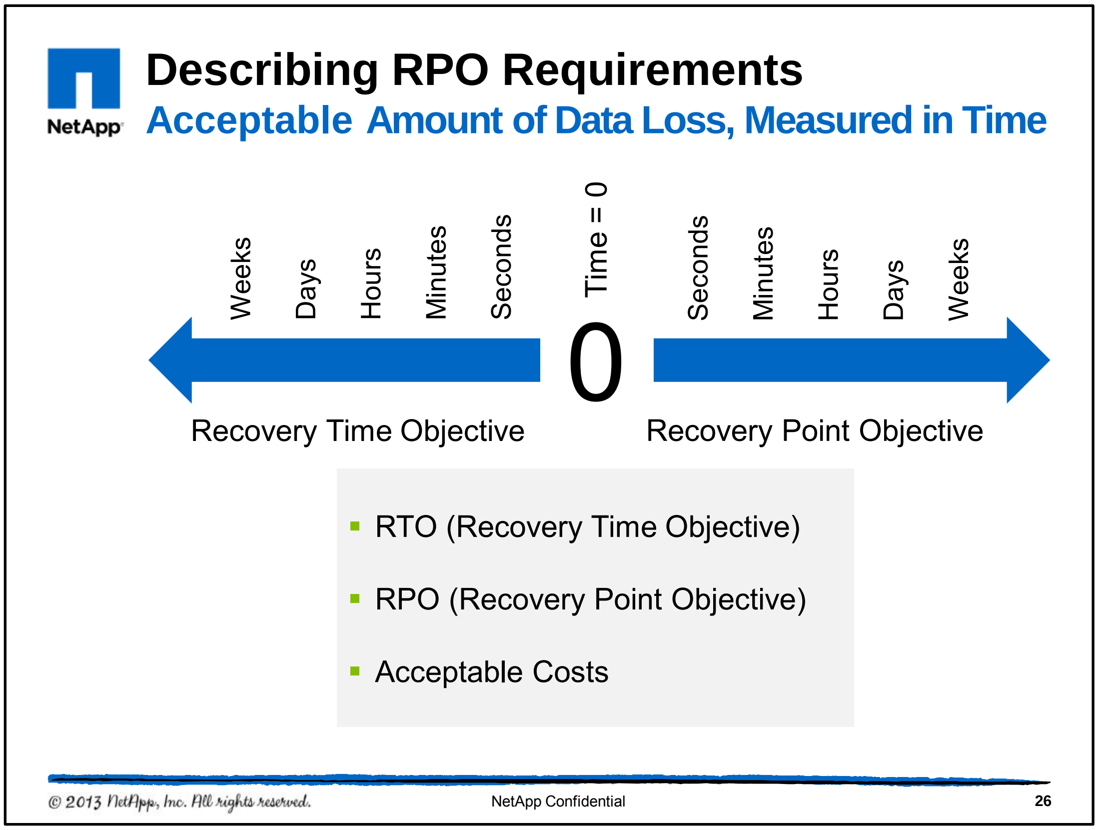


DESCRIBING RTO REQUIREMENTS: ACCEPTABLE DURATION OF DOWNTIME

These terms are key to determining customer requirements for meeting SLAs.

The recovery time objective (RTO) helps you identify storage space and application availability requirements. The RTO defines the acceptable duration of downtime for a specific data center application from the time that the outage occurs until the application is back up and available to clients. The RTO includes the time that it takes to restore the database.

It might take you hours, and possibly days, to restore a large database if you use traditional methods of restoration. Use NetApp technology to reduce the duration and cost of downtime.



DESCRIBING RPO REQUIREMENTS: ACCEPTABLE AMOUNT OF DATA LOSS, MEASURED IN TIME

The recovery point objective (RPO) defines, for a specific data center application, the acceptable amount of data loss that can be tolerated in the event of an outage. These values range from no data loss to a few minutes of lost transactions to hours of lost transactions. This time is usually equivalent to the time between backups for disaster recovery.

These measurements directly affect backup strategies, disaster recovery configuration, and backup retention and archiving, all of which can directly affect storage space use. To meet shorter RTOs, the most recent set of backups must be available immediately. Shorter RPOs require you to create frequent NetApp Snapshot copies, and to retain multiple versions of the copies, to guarantee that the most recent data is backed up.

NetApp

Lesson 3

Oracle Databases on the
Data ONTAP Operating System

 NetApp Confidential 27

LESSON 3: ORACLE DATABASES ON THE DATA ONTAP OPERATING SYSTEM

Challenges with Traditional Storage for Oracle

- Capacity is limited.
- You cannot scale out.
- Redistributing a workload disrupts database operations.
- Managing capacity and distributing workload require a disruption to service.
- You cannot tier data to reduce storage costs without downtime.

CHALLENGES WITH TRADITIONAL STORAGE FOR ORACLE

All vendors face challenges when they use a traditional database storage infrastructure, and these challenges almost always require downtime.

Capacity is limited within the storage controllers. Adding storage or moving to a different storage controller involves downtime.

A traditional storage infrastructure is unable to scale out, and scaling up also requires downtime.

Within enterprise data centers, rebalancing the workload on the storage controllers requires downtime, especially when the environment and applications demand increased processing power.

The Clustered Data ONTAP Operating System Solution

Enables you to do the following:

- Manage capacity requirements.
- Load-balance.
- Scale out.
- Manage application storage entities.
- Use tiered storage in NFS and SAN environments.

 NetApp Confidential 29

THE CLUSTERED DATA ONTAP OPERATING SYSTEM SOLUTION

The clustered Data ONTAP operating system enables you to:

Manage capacity requirements: Enables you to modify data infrastructures to meet Oracle database requirements with agility and without unnecessary downtime.

Load-balance: Enables you to balance network access loads across all nodes of a NetApp cluster.

Scale out: Enables you to seamlessly add NetApp nodes to your clusters and move data to other nodes within the NetApp cluster

Manage application storage entities: Enables you to match data storage requirements to the performance characteristics of different types of storage and meet SLAs while reducing costs. Different types of disks—including FC, SAS, and SATA—can co-exist.

Use tiered storage: The data mobility feature of the clustered Data ONTAP operating system allows this level of agility or NFS and SAN environments.

NetApp

Oracle on the Clustered Data ONTAP OS
Design Considerations

- Design the use of Oracle volumes and logical interfaces (LIFs) migrate, move, and manage environments as needed by:
  – Oracle environment
  – Oracle FlexVol volume
  – NFS client
- Consider using NFS failover groups for Oracle traffic.
- Maintain NFS mounts for Oracle FlexVol volumes that are local to NetApp nodes in the cluster.

ORACLE ON THE CLUSTERED DATA ONTAP OS: DESIGN CONSIDERATIONS

NOTE these design considerations when deploying Oracle on the clustered Data ONTAP OS.

Automatic Storage Management
Definition

What is Automatic Storage Management (ASM)?

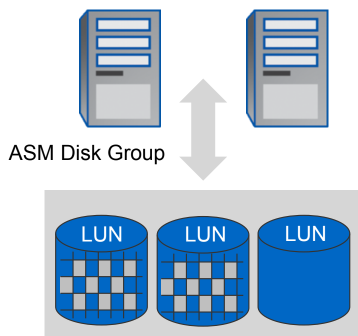
ASM is a storage manager that manages Oracle database files.

AUTOMATIC STORAGE MANAGEMENT: DEFINITION

NetApp

Automatic Storage Management
Primary Functions

- Combines LUNs or file systems into a single pool of storage
- Places control of the storage into a single file system



AUTOMATIC STORAGE MANAGEMENT: PRIMARY FUNCTIONS

ASM has two primary functions:

- It ties multiple disk groups (LUNs or file systems) together into a single, virtualized, load-balanced, high-performance pool of storage, similar to other logical volume managers (LVMs). ASM increases performance by striping data across multiple LUNs.
- It simplifies management of file system access by placing control of storage into a single Oracle-controlled ASM file system.

Automatic Storage Management
Striping

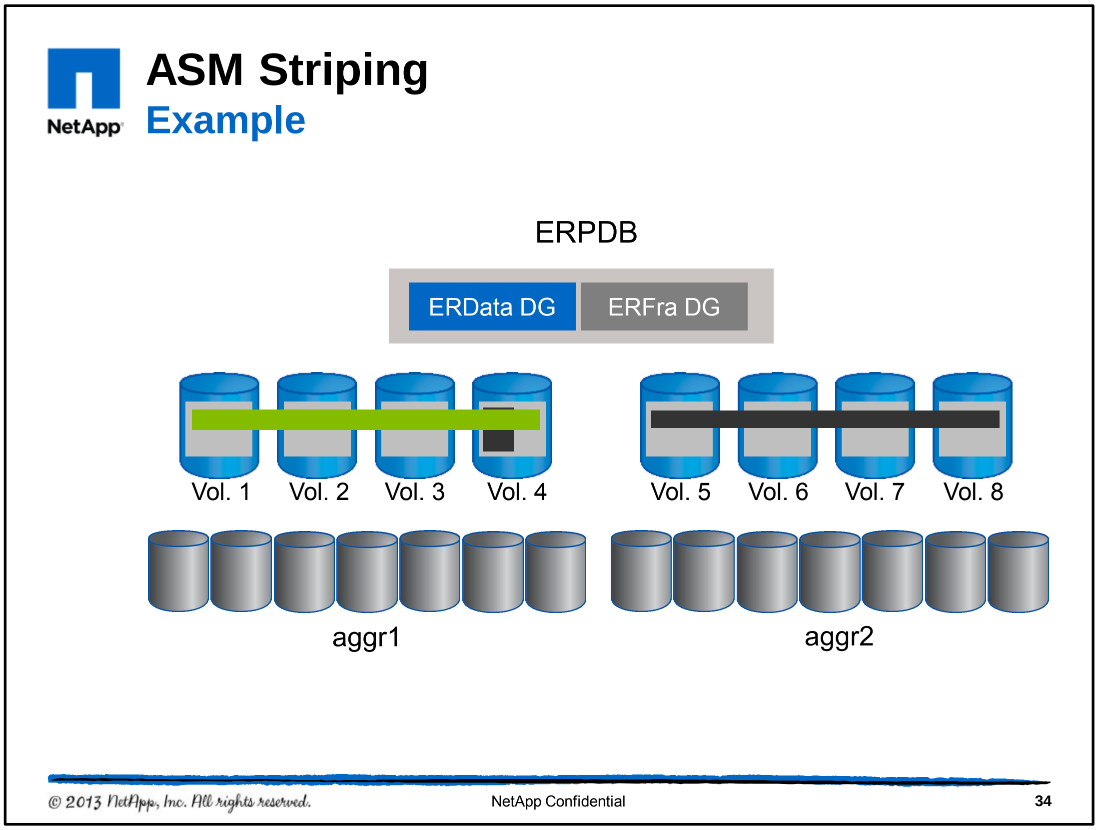
ASM stripes across Data ONTAP LUNs.

- Create disk groups from LUNs.
- Create multiple LUNs per FlexVol volume.

 33

AUTOMATIC STORAGE MANAGEMENT: STRIPING

Use ASM to stripe data across Data ONTAP LUNs. You can create disk groups from LUNs and multiple LUNs per FlexVol volume.



ASM STRIPING: EXAMPLE

The slide shows two NetApp aggregates, each containing four FlexVols and each FlexVol containing one LUN. The LUNs are presented to the host on which the Oracle ASM instance resides. The DBA can then add those devices to an ASM disk group.

In this example, you add four LUNs to the Disk Group named ERData and four LUNs to the ERFra disk group. Multiple LUNs on each FlexVol can be presented to the host and used for the ASM disk group.

Use volume-based SnapRestore technology to restore the database, which avoids situations where the SnapRestore technology might prevent database recovery.

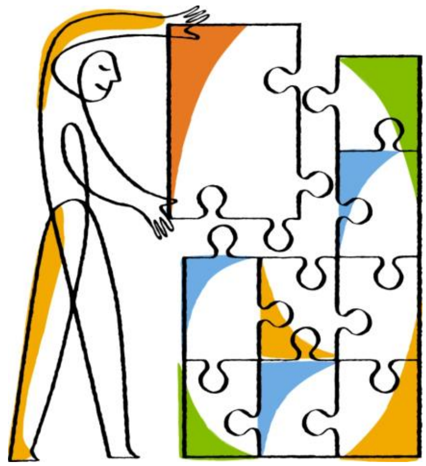
Module Summary

Now that you have completed this module, you should be able to:

- Describe components of Oracle databases
- Describe key issues that are often experienced with Oracle deployments
- Describe the advantages of implementing Oracle solutions on NetApp technology

MODULE SUMMARY

Learning Activity Questions



 NetApp Confidential 36

LEARNING ACTIVITY QUESTIONS

Learning Activity: Questions

1. What are the three core components of an Oracle database? (Choose three.)
   a. Control files
   b. Data files
   c. The parameter file
   d. Online redo log files

LEARNING ACTIVITY: QUESTIONS

Learning Activity: Questions

2. What are the key issues that you often experience with Oracle deployments? (Choose three.)
   a. Capacity is limited to the storage controllers, which requires downtime to solve.
   b. Oracle deployments are inexpensive but time-consuming.
   c. The storage infrastructure cannot scale out, which requires downtime to solve.
   d. You cannot tier the data to the cost of storage without downtime.

LEARNING ACTIVITY: QUESTIONS

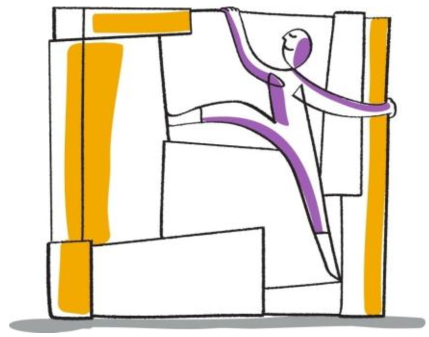
Learning Activity: Questions

3. Which three of these statements are true about implementing Oracle solutions on NetApp storage? (Choose three.)
   a. NetApp technology enables you to scale out by seamlessly adding NetApp nodes to your clusters.
   b. Security features prevent you from balancing network access loads across multiple nodes of a NetApp cluster.
   c. The data mobility feature of the Data ONTAP operating system provides agility through the use of tiered storage.
   d. With the Data ONTAP operating system, you can modify your data infrastructures to meet Oracle database requirements without downtime.

LEARNING ACTIVITY: QUESTIONS

Exercise

Time Estimate: 30 Minutes



 NetApp Confidential 40

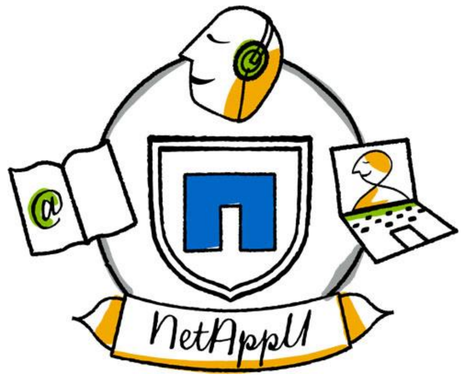
EXERCISE

Please refer to your exercise guide.

NetApp

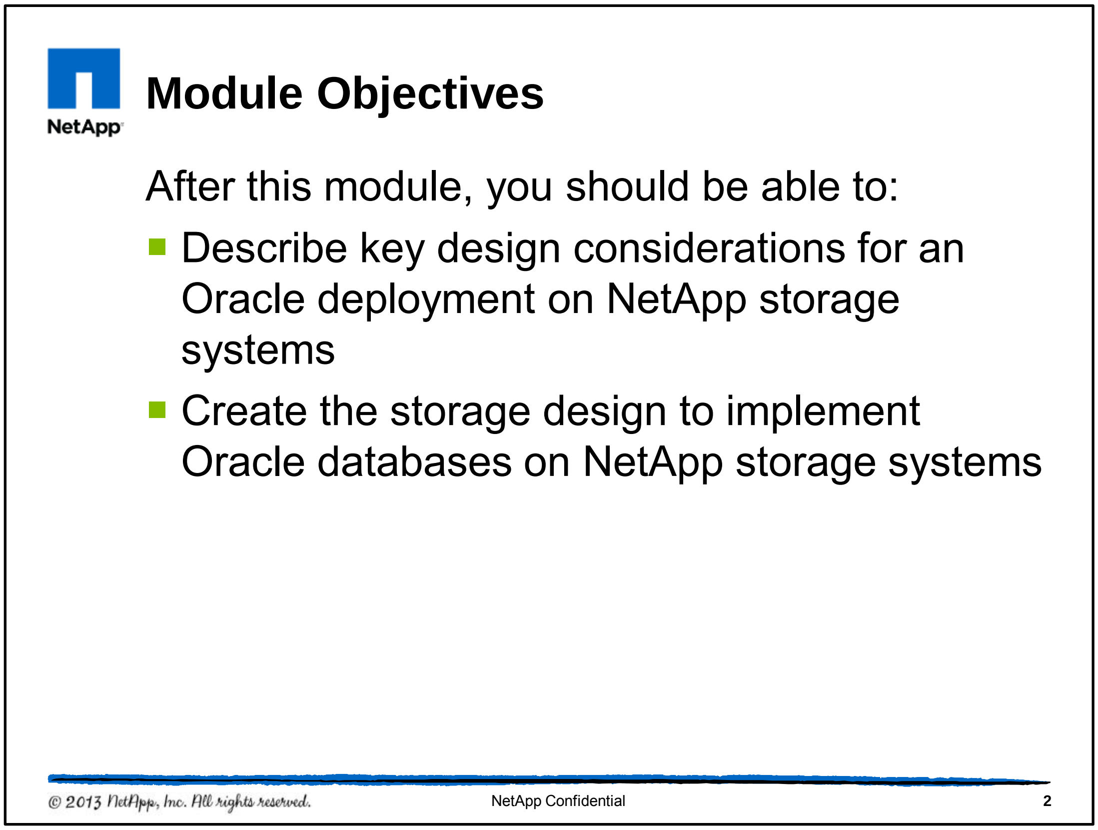
Module 2

Designing and Planning
an Oracle Implementation



 NetApp Confidential 1

MODULE 2: DESIGNING AND PLANNING AN ORACLE IMPLEMENTATION



MODULE OBJECTIVES

Lesson 1

Key Design Considerations

 NetApp Confidential 3

LESSON 1: KEY DESIGN CONSIDERATIONS

Design Considerations
The Data ONTAP Operating System

Consider these questions when you plan your design:

- What features of the clustered Data ONTAP operating system do you want to use?
- Is the Oracle server connected through NFS?
- Is the Oracle server in a SAN environment?

 NetApp Confidential 4

DESIGN CONSIDERATIONS: THE DATA ONTAP OPERATING SYSTEM

The Oracle solution for Data ONTAP operating in 7-Mode and the Oracle solution for the clustered Data ONTAP operating system are very similar. However, the new features of the clustered Data ONTAP operating system let you accomplish nondisruptive tasks that were not possible with earlier versions.

Consider these questions when planning your design:

- What features of the clustered Data ONTAP operating system do you want to use?

Consider how you want to use logical interfaces (LIFs), Vservers, and tools like SnapManager for Oracle (SMO).

- Does your storage design need to change?

No, the FlexVol storage design for the database may not require a change.

- Does the database layout need to change?

No change is required when you design the solution.

- Do you have to size differently when you use the clustered Data ONTAP operating system?

No. You use the same paradigm, but you must ensure that you size to the smaller controller high-availability (HA) pair when you use mixed environments.

The design should take advantage of clustered Data ONTAP technology so you can use the features of the clustered Data ONTAP operating system.

Design Considerations
The Storage OS

What factors should you consider for the storage OS?

- Storage design
- Database layout
- Sizing
- Unified environments
- Data ONTAP operating system features

DESIGN CONSIDERATIONS: THE STORAGE OS

Consider several factors when you choose your storage OS:

- Storage design
- Database layout
- Sizing
- Unified environments
- Data ONTAP operating system features

Choosing the Clustered Data ONTAP OS
Addressing Design Challenges

The clustered Data ONTAP operating system provides these solutions to design challenges:

- Load-balanced client access
- Tiered storage
- Data mobility to manage application storage
- Nondisruptive scale-out

CHOOSING THE CLUSTERED DATA ONTAP OS: ADDRESSING DESIGN CHALLENGES

Features of the clustered Data ONTAP operating system:

Load-balancing client access: Enables you to load-balance across the nodes of a NetApp cluster without disruption of service. For example, you can move a FlexVol volume that is part of an Oracle database to an alternate node. Depending on the protocol that you are using, you might need to migrate a data LIF.

Tiered storage: Multiple types of disks—FC, SAS, and SATA—can coexist, letting you match data to storage and performance requirements. You can move the data that needs to match the storage type without any disruption of service.

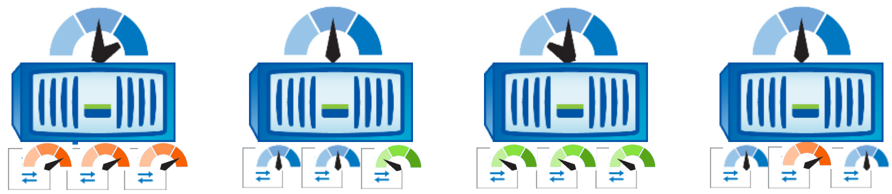
Data mobility: You can move the Oracle FlexVol volumes within the cluster without downtime.

Nondisruptive scale-out: You can add nodes to a NetApp cluster without interruption of your current environment, then use other features to scale the environment for more databases or for growth of current database environments, all without downtime (unlike a traditional infrastructure).

Choosing the Clustered Data ONTAP OS

Load-Balancing Client Network Access

- IP addresses are not tied to network ports.
- Network traffic can be load-balanced across storage controllers in the cluster.



 NetApp Confidential 7

CHOOSING THE CLUSTERED DATA ONTAP OS: LOAD-BALANCING CLIENT NETWORK ACCESS

The size and complexity of your Oracle environment might require you to manage your workloads and balance your IP traffic based on application use.

The clustered Data ONTAP operating system enables you to configure load balancing of your client network access to keep your network load balances across all nodes of the NetApp cluster.

IP addresses are not permanently tied to a single physical network port. Virtual data interfaces and interface groups are deployed. Interface groups let you:

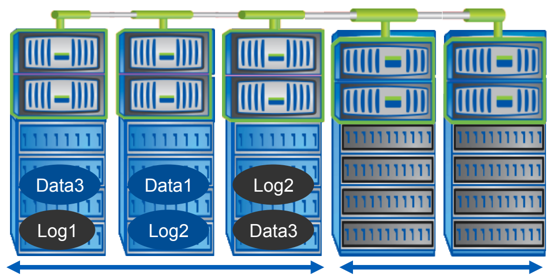
- Migrate the associated IP address to a different port and node
- Move FlexVol volumes that are associated to the NFS mounts where NFS clients want to use that IP address
- Balance the network traffic that traverses the interface groups across storage controllers in the cluster

You can also configure the Oracle utility, Direct NFS (dNFS), to load-balance network traffic across clustered Data ONTAP interface groups.

Choosing the Clustered Data ONTAP OS
Tiered Storage

The clustered Data ONTAP operating system enables you to do the following:

- Add nodes to the same namespace
- Add multiple types of disks (FC, SAS, and SATA)
- Move less frequently read data to slower, cheaper disks



Primary Storage (Highest Performance Across All Workloads)

Secondary Storage (Lower Cost per GB)

 NetApp Confidential 8

CHOOSING THE CLUSTERED DATA ONTAP OS: TIERED STORAGE

The clustered Data ONTAP operating system enables you to use tiered storage for your data. You can:

- Add nodes to the same namespace.
- Mix different types of disks (such as FC, SAS, and SATA) and connect them to the same controllers or to different controllers within the cluster.
- Match data to storage requirements, for instance, move data from high-performance disks to cheaper disks after it is no longer current (but has to be maintained).

So be aware of the business requirements of the Oracle databases when designing your storage.

Choosing the Clustered Data ONTAP OS

Managing Oracle Database Storage

The clustered Data ONTAP data mobility feature enables you to do the following:

- Manage capacity and performance
- Rebalance as needed
- Eliminate sizing headaches
- Maintain transparency for clients and applications
- Use capacity more efficiently
- Increase performance

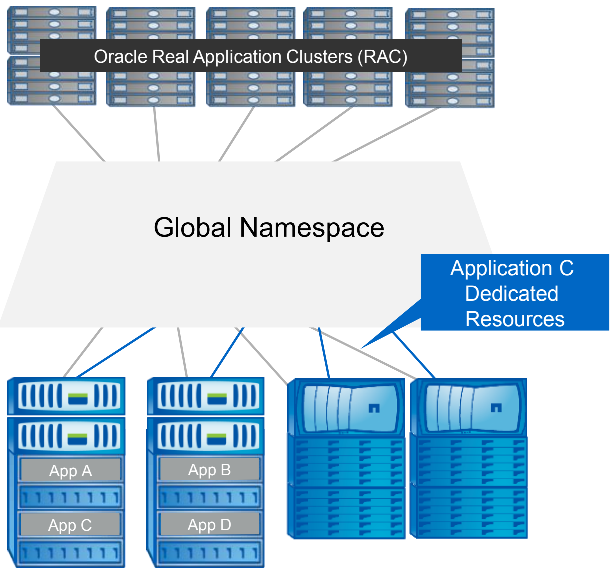
CHOOSING THE CLUSTERED DATA ONTAP OS: MANAGING ORACLE DATABASE STORAGE

The clustered Data ONTAP data mobility feature enables you to:

- Move volumes between nodes of the NetApp cluster and namespace to increase disk space utilization and rebalance capacity, which increases performance.
- Move volumes around without disruption to the accessibility of the Oracle database on the network, changing the client mount point, or causing downtime for the Oracle database server or any application server.

Eliminate sizing headaches, maintain transparency for clients and applications, use capacity more efficiently, and increase performance.

Choosing the Clustered Data ONTAP OS
Oracle Design Solution



 NetApp Confidential

CHOOSING THE CLUSTERED DATA ONTAP OS: ORACLE DESIGN SOLUTION

Choosing the Clustered Data ONTAP OS
Nondisruptive Scaling

The clustered Data ONTAP operating system enables you to nondisruptively scale out your storage capacity:

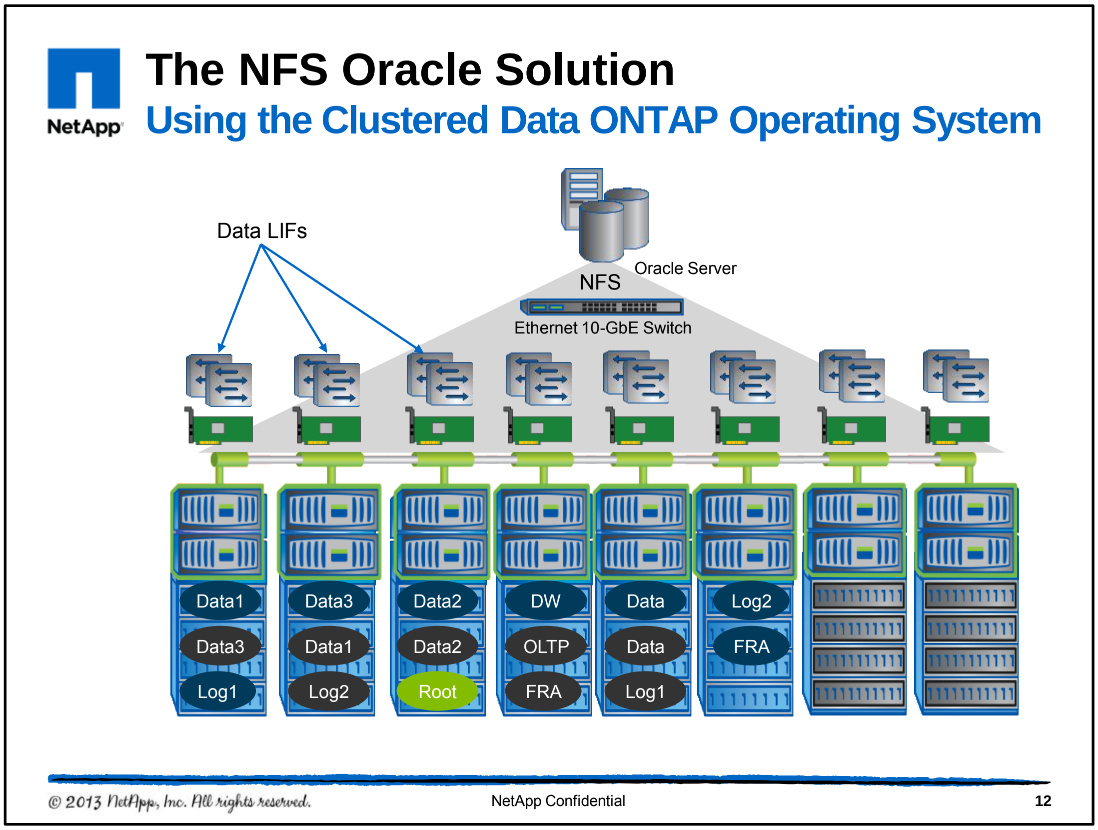
- To rapidly and seamlessly deploy new storage and applications
- To increase storage and computing capacity when required
- To scale out without downtime
- To scale out transparently to clients and applications

CHOOSING THE CLUSTERED DATA ONTAP OS: NONDISRUPTIVE SCALING

The clustered Data ONTAP operating system enables you to:

- Nondisruptively scale out your storage capacity and computing resources by adding HA pairs to your storage environment
- Redistribute the Oracle data across the additional controllers of a NetApp cluster

For example, if a specific controller is running with a higher CPU rate than the other controllers in the cluster, you can add two controllers with extra disk shelves and then rebalance the FlexVol volumes across the nodes of the NetApp cluster. As you scale out the system and balance the load to make more computing resources available for your Oracle database servers, your operations are transparent to the end user.



THE NFS ORACLE SOLUTION: USING THE CLUSTERED DATA ONTAP OPERATING SYSTEM

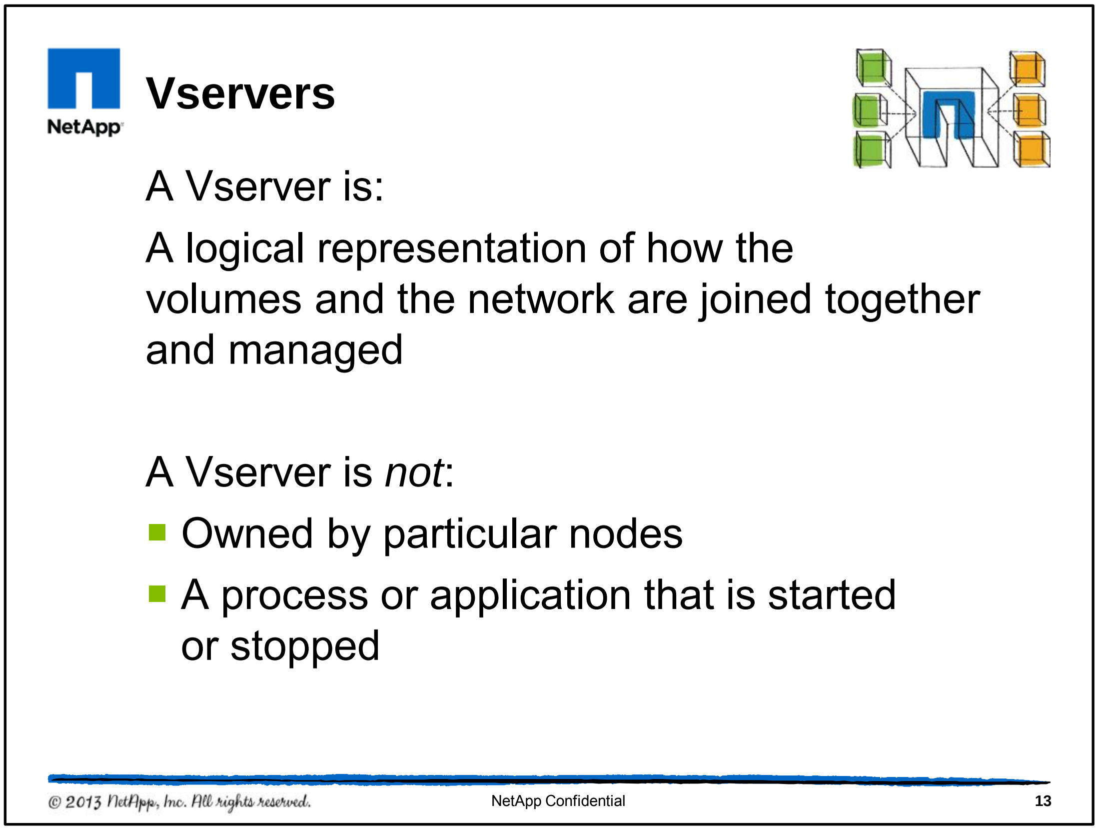
This example of an architecture that is used for NFS and an Oracle environment shows how you can:

- Move the FlexVol volumes to different controllers
- Move LIFs to different locations
- Migrate a LIF to different ports within the Vserver

When you design a solution, keep in mind that:

- You can use your LIFs for the traffic and avoid the use of remote access of the data by an NFS client.
- Migrating LIFs to the local node also enables your NFS client to maintain local access without traversing the cluster interconnect to obtain data through remote access.
- LIFs can be based on a database, an NFS client (host), or any combination you choose, letting you use data mobility within the NetApp cluster.

Be aware that Oracle does not yet support NFSv4 or parallel NFS (pNFS). Oracle want to provide support with later releases of its relational database management system (RDBMS) product for pNFS, NFSv4, and NFSv4.1.



VSERVERS

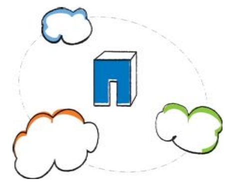
A Data ONTAP storage system contains volumes that are exported or shared on the network.

The Clustered Data ONTAP operating system introduces Vservers (similar to the Data ONTAP storage system hardware platform), which contain and share volumes on the network and are not owned by a particular storage controller.

Vservers for Oracle Implementations

Vservers provide the security and isolation that is required for Oracle databases. Examples:

- Four or five databases for your enterprise resource planning (ERP) solution: one Vserver
- Four or five databases for different teams: one Vserver per database
- A cloud environment for multiple tenants: one Vserver per tenant



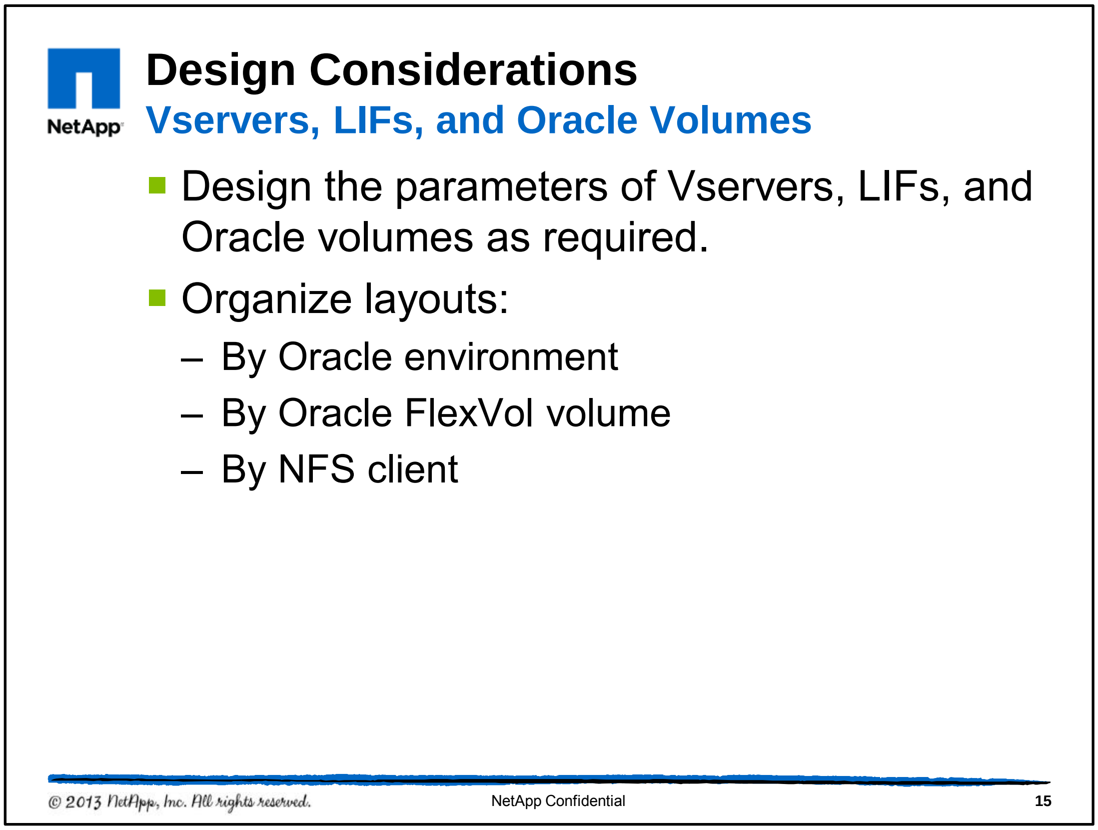
 NetApp Confidential 14

VSERVERS FOR ORACLE IMPLEMENTATIONS

How might you use Vservers?

- One Vserver for your Oracle environment
- One Vserver per database
- Multiple Vservers, to isolate environments and minimize interruptions

A Vserver is a required component of a clustered Data ONTAP deployment. Currently, Vservers are mostly used to provide security and isolation for storage entities that are used by multiple applications, databases, and business units within an organization.



DESIGN CONSIDERATIONS: VSERVERS, LIFS, AND ORACLE VOLUMES

- Design the parameters of Vservers, LIFs, and Oracle volumes as required.
- Migrate Oracle database and log content into dedicated Vservers, LIFs, and volumes that you create.
- Move volumes using the clustered Data ONTAP operating system.
- Use the latest version of OnCommand System Manager to manage clustered Data ONTAP environments.

NOTE that you can lay out databases on multiple Vservers that are organized by Oracle environment, Oracle FlexVol volume, or NFS client.

Design Considerations
Oracle Databases in an NFS Environment

Consider the following:

- The layout of Oracle volumes
- The layout of interface and failover groups
- Network configurations
- Export policies and NFS mount points

DESIGN CONSIDERATIONS: ORACLE DATABASES IN AN NFS ENVIRONMENT

In NFS environments, consider these key features of the clustered Data ONTAP operating system:

The layout of Oracle volumes: You can spread Oracle data FlexVol volumes across nodes, to increase performance and balance the workload across the cluster. (This is an advantage over using Data ONTAP operating in 7-Mode.)

The layout of interface and failover groups: Consider how you want to scale and to leverage load balancing, to determine how many LIFs you need. If you configure one LIF per nondata items and one LIF per data files, the result is two LIFs per database. This provides flexibility in migrating FlexVol volumes between nodes of the cluster without an excess of IP addresses or LIFs.

In some cases, having a LIF per database can be helpful:

- When a user has several databases
- When storage is provisioned within the NetApp cluster
- When you need a level of granularity to take advantage of clustered Data ONTAP features

Your LIF design should depend on your requirements and how you want to use the clustered Data ONTAP features.

Network configurations: When you spread Oracle volumes across nodes, you can:

- Create interface groups as needed
- Isolate database traffic on a different virtual LAN
- Use a 10-gigabit Ethernet (GbE) infrastructure
- Use jumbo frames for 10-GbE, kernel NFS (kNFS), and dNFS

Export policies and NFS mount points: Export policies are at the FlexVol volume level (and no longer at the qtree level) for the clustered Data ONTAP operating system.

Designing Interface and Failover Groups
In an NFS Environment

- When creating interface and failover groups in the clustered Data ONTAP operating system:
  - Maintain local access for the FlexVol volumes and nodes of the cluster for NFS clients
  - Create LIF failover groups for LIF availability
- Based on the Oracle environment, you can plan the number of LIFs:
  - One LIF per database
  - Multiple LIFs per database or NFS client

DESIGNING INTERFACE AND FAILOVER GROUPS: IN AN NFS ENVIRONMENT

Create interface and failover groups based on the Oracle environment. The design goals are:

- Maintain local access for the FlexVol volumes and nodes of the cluster for NFS clients
- Create interface groups as needed with the clustered Data ONTAP operating system
- Create LIF failover groups for LIF availability
- Ensure that your storage design addresses LIF requirements by determining if you need:
  - One LIF per database
  - Multiple LIFs per database or NFS client

Network Configurations
In an NFS Environment

These network configurations help you to avoid traffic issues:

- Use a 10-GbE infrastructure for NFS.
- Isolate your database traffic on a different subnet or virtual LAN (VLAN).
- Avoid running NFS traffic on the interconnect.
- Use jumbo frames for 10-GbE, kernel NFS (kNFS), and dNFS.

 NetApp Confidential 18

NETWORK CONFIGURATIONS: IN AN NFS ENVIRONMENT

What network configurations in NFS environments help you to avoid traffic issues?

- Use a 10-GbE infrastructure for NFS (depending on node, switch, and router compatibility).
- Isolate database traffic on a different subnet or VLAN (to minimize network latency and increase security).
- Avoid running NFS traffic on the clustered Data ONTAP interconnect LIF; use a dedicated LIF instead.
- Configure jumbo frames for 10-GbE, kNFS, and dNFS.

Export Policy Changes

In the clustered Data ONTAP operating system, policies are as follows:

- NFS export permissions are set at the volume (not qtree) level.
- All qtrees in a volume must be exported with the same permissions.
- An NFS mount that uses a qtree has the same export policy as the FlexVol volume.

EXPORT POLICY CHANGES

With Data ONTAP operating in 7-Mode, many customers use qtrees with different permissions.

Export policies in the clustered Data ONTAP operating system have changed. All export policies and rules are at the FlexVol volume level (though qtrees exist). You can still have the qtrees (some users have many qtrees within the FlexVol volume) and mount to different servers, but your export policies and rules for the FlexVol volume must be appropriate for all NFS clients that access that FlexVol volume. In other words, all qtrees in a volume must be exported with the same permissions.

For example, a single FlexVol volume might host the ORACLE_HOME directories for 10 servers. With the clustered Data ONTAP operating system, all 10 qtrees must be exported to all 10 servers with identical permissions.

Design Considerations
Oracle Databases in a SAN Environment

Consider the following:

- The layout of the Oracle volumes and consistency group Snapshot copies
- Interface groups for SAN protocols
- Multipath I/O (MPIO) and Asymmetric Logical Unit Access (ALUA)

 NetApp Confidential 20

DESIGN CONSIDERATIONS: ORACLE DATABASES IN A SAN ENVIRONMENT

In SAN environments that use the clustered Data ONTAP operating system, consider:

- Using multipath I/O (MPIO software such as Dev Mapper) to access LUNs is required.
- Using ALUA to determine the state of a path is required.

Using SAN with the Clustered Data ONTAP Operating System: Key Considerations

- Any SAN LIF can accept a SCSI command for the Vserver.
- Hosts are required to use MPIO to access LUNs.
- Hosts should use ALUA to determine the state of a path.

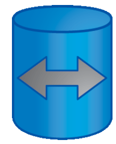
USING SAN WITH THE CLUSTERED DATA ONTAP OPERATING SYSTEM: KEY CONSIDERATIONS

In SAN environments, the following statements are true:

- Any SAN LIF can accept a SCSI command for the Vserver, regardless of where the LUN is provisioned.
- The LIF is configured on a port on a controller that “owns” the aggregate on which the LUN is provisioned.
- The LIF is configured on a port on a controller that does not “own” the aggregate on which the LUN is provisioned.

Consistency Group Snapshot Technology

Under the following conditions, consistency group Snapshot technology is required to guarantee that the database can be recovered:



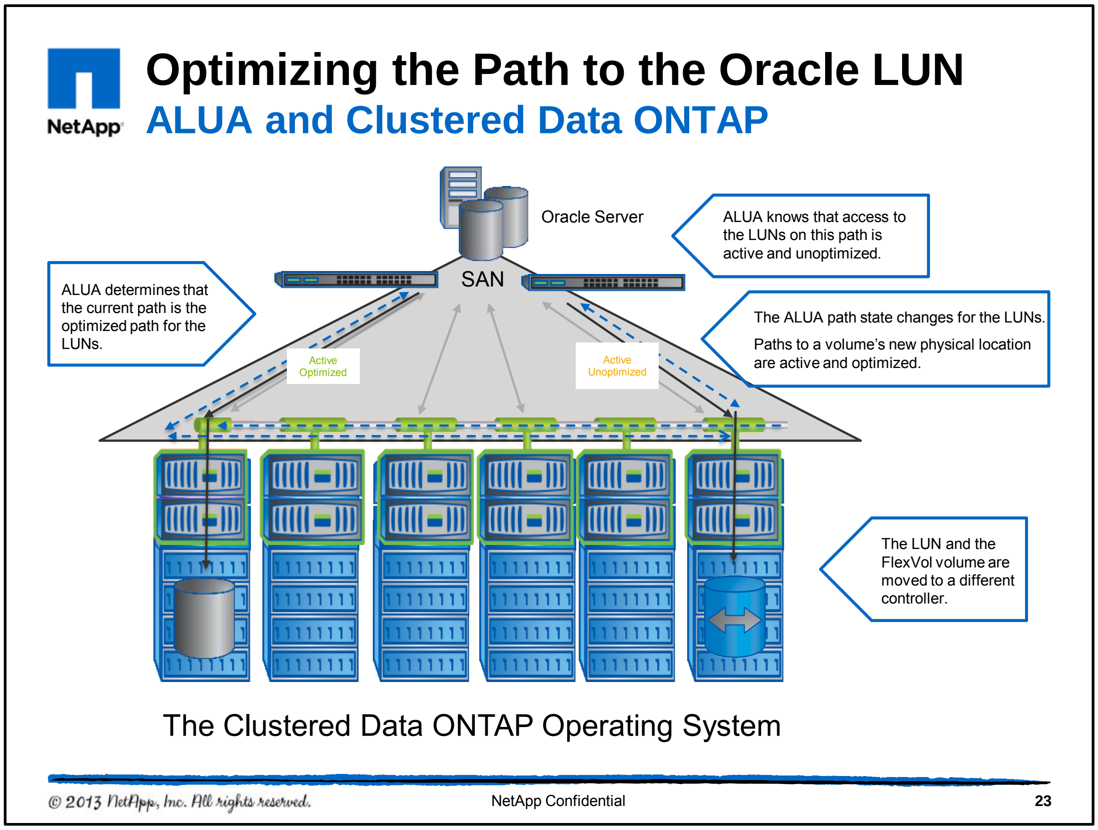
- In SAN environments
- When you use logical volume manager (LVM) or Automatic Storage Management (ASM)
- When you spread LUNs across multiple FlexVol volumes

 NetApp Confidential

CONSISTENCY GROUP SNAPSHOT TECHNOLOGY

For SAN environments that use an LVM or ASM:

If the LUNs within an LVM or ASM disk group are across multiple FlexVol volumes within the same Vserver, consistency group Snapshot technology is required to guarantee database recovery.



OPTIMIZING THE PATH TO THE ORACLE LUN: ALUA AND CLUSTERED DATA ONTAP

ALUA enables you to identify the following:

- The optimized path for host access of the NetApp LUN
- Paths that are active (thus they can be used in the event of failure) but are not the most efficient paths to the LUN

The clustered Data ONTAP 8.1 operating system enables you to seamlessly move LUNs to new locations within the NetApp cluster, as illustrated in the slide.

After the LUN is relocated, ALUA identifies a state change in the paths to the NetApp LUN, which provides the host with a new optimized path to the NetApp LUN.

Now the host can access the device through the appropriate path, because MPIO and ALUA are part of the infrastructure.

This configuration enables you to move LUNs to different nodes of the NetApp cluster, to mitigate resource and capacity issues without interruption to service.

Be careful when you move FlexVol volumes, and note the state of the infrastructure, because the move consumes resources within the NetApp cluster.

Caution

Avoid accessing a FlexVol volume on one node by using a LIF that is located on a different node.

- Most users do not observe any problem.
- If you have a latency-sensitive database, the additional millisecond in response time can be noticeable.

CAUTION

As a best practice, avoid access over the cluster interconnect. You may see some remote access traffic if you migrate FlexVol volumes across the nodes of a cluster without moving the LIF, but it is preferable to avoid remote access.

Lesson 2

Storage Design

 NetApp Confidential 25

LESSON2: STORAGE DESIGN

Storage Design
Requirements

Design your storage layout to optimize and balance requirements for:

- Performance
- Storage efficiency
- Recoverability

 NetApp Confidential 26

STORAGE DESIGN: REQUIREMENTS

Ask these questions:

- What is the size, scope, and growth factor of your Oracle database environment?
- What are the FlexVol and LIF limitations?
- What features of the clustered Data ONTAP operating system do you need now and in the future?

Storage Design
Performance

- Spread database components across the aggregates and nodes.
- Balance the workload.
- Rebalance as needed.
- Nondisruptively move FlexVol volumes as needed.

STORAGE DESIGN: PERFORMANCE

Balance the workload based on Oracle Automatic Workload Repository (AWR) reports with clustered Data ONTAP DataMotion software.

You are not required to lay out data files and archive logs in separate aggregates. If you cannot designate aggregates for specific I/O workloads, you can leverage clustered Data ONTAP options to rebalance data files as needed.

NetApp

Storage Design

Storage Efficiency with Oracle

Several Data ONTAP volume settings optimize storage efficiency for Oracle databases:

- Volume guarantee
- LUN reservation
- Fractional (space) reservation
- Snapshot copy reserve
- Automatic Snapshot deletion policies with the `try_first` option for space management
- Automatic volume sizing option

STORAGE DESIGN: STORAGE EFFICIENCY WITH ORACLE

Volume settings to implement include the following:

- Volume guarantee should be enabled.
- LUN reservation should be enabled.
- Fractional (space) reservation should be set to 0%.
- The Snapshot copy reserve should be set to 0%.
- Enable Automatic Snapshot deletion policies with the try_first option for space management set to grow the volume.
- While properly sizing volumes is the best way to preserve performance, you can turn on the volume autosize volume option to mitigate against unforeseeable circumstances.

Refer to the clustered Data ONTAP documentation for details on volume settings.

Storage Efficiency
Recommended Settings

Configuration	Default / SET Values
Guarantee	Volume
Snapshot copy reserve	0%
LUN reservation	On
Fractional reserve	0%
Automatic deletion	On
Volume autosize	On
try_first	volume_grow

STORAGE EFFICIENCY: RECOMMENDED SETTINGS

The table lists the parameters to set for Oracle volumes. (In other types of implementations, you typically set several parameters to save space for Snapshot copies, LUNs, and volumes.)

Recommendations for Oracle implementations:

- Because Oracle "walks the blocks" of each data file in non-ASM environments, you can set the space guarantee at the volume level for this configuration.
- Set the fractional reserve to 0% only if you know your database and the precise change rate of data (and you are using Snapshot copies for backups).
- Turn on automatic increase (the "autogrow" parameter) to enable the use of free space in the aggregate as needed and to prevent your volume from becoming full.
- The default automatic increase setting is usually sufficient, but you need to understand the characteristics of your database.

Self-management of FlexVol volumes with Snapshot copies requires the following:

- Allow the volume to grow before deleting the Snapshot copies.
- Delete the oldest copies first, and do not disrupt any pre-existing data-protection configuration.
- Do not delete or break the SnapMirror relationship.
- Monitor activity to determine when and why the volumes grow.

Storage Efficiency Commands
Page 1 of 2

Commands for Configuring the Clustered Data ONTAP Operating System for Storage Efficiency

- `volume create -vserver v_oraclass -volume v_oraclass_oradata -aggregate aggr_data_cluster1_01 -size 14G -space-guarantee volume -security-style unix -junction-path /v_oraclass_oradata -nvfail off`
- `volume modify -vserver v_oraclass -volume v_oraclass_oradata -percent-snapshot-space 0`
- `volume modify -vserver v_oraclass -volume v_oraclass_oradata -fractional-reserve 0`
- `volume modify -vserver v_oraclass -volume v_oraclass_oradata -snapshot-policy none`
- `volume snapshot autodelete modify -vserver v_oraclass -volume v_oraclass_oradata –commitment try`

STORAGE EFFICIENCY COMMANDS: PAGE 1 OF 2

The sample commands on this slide are used to provision a FlexVol volume and LUN.

Storage Efficiency Commands
Page 2 of 2

Commands for Configuring the Clustered Data ONTAP Operating System for Storage Efficiency

- `volume modify -vserver v_oraclass -volume v_oraclass_oradata –autosize true`
- `volume autosize –vserver v_oraclass –volume v_oraclass_oradata is-enabled on`
- `volume modify -vserver v_oraclass -volume v_oraclass_oradata –space-mgmt-try-first volume_grow`
- `volume snapshot autodelete modify -vserver v_oraclass –volume v_oraclass_oradata –enabled true`
- `volume snapshot autodelete modify -vserver v_oraclass -volume v_oraclass_oradata –commitment try`

STORAGE EFFICIENCY COMMANDS: PAGE 2 OF 2

Advantages of this sample configuration:

- Because there is only the volume and aggregate, you can easily monitor and understand space.
- The configuration does not sacrifice Snapshot copies unless it is required to.
- You can adjust the amount of thin provisioning and reservation per volume.
- The configuration uses shared free space from the aggregate.

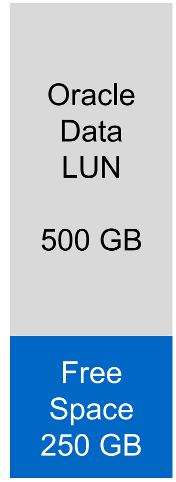
Disadvantages of this sample configuration:

- Volumes are not completely independent of each other.
- The growth of one volume can limit the growth of another.
- You must be able to monitor this activity.

Storage Efficiency Volume Sizing
Example

A volume is typically sized to hold LUNs and Snapshot copies. Consider the following example:

- A volume needs to accommodate:
  – One 500-gigabyte (GB) LUN
  – A 5% change rate per day
  – Snapshot copies that are retained for 7 days
- Size the volume as follows:
  – 500 GB + ((500 GB x 5%) x 7) = 710 GB
  – Round up the number to add buffer space.
  – The 750 GB includes buffer space and accommodates unanticipated Snapshot copy growth.



 NetApp Confidential 32

STORAGE EFFICIENCY VOLUME SIZING: EXAMPLE

The sizing formula is:

FlexVol volume size = A + ((A x Δ) x B), where A is the LUN size and B is the number of Snapshot copies to retain.

Storage Design
Backup and Recovery

Storage design options include the following:

- A single FlexVol volume
- Two FlexVol volumes
- Three FlexVol volumes
- Two copies of the online redo logs across two separate aggregates

 NetApp Confidential 33

STORAGE DESIGN: BACKUP AND RECOVERY

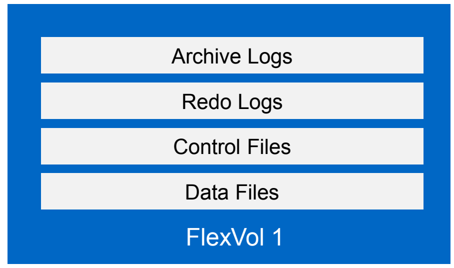
Several storage design options exist for the layout of redo, archive, control, and database files:

- A single FlexVol volume that contains all database files for simple Snapshot copies
- Two FlexVol volumes that separate redo and archive logs from database and control files
- Three FlexVol volumes that separate redo logs, archive logs, and database and control files
- Two copies of the online redo logs across two separate aggregates

Storage Designs
Option 1

Backup:
Create a Snapshot copy of FlexVol volume 1.

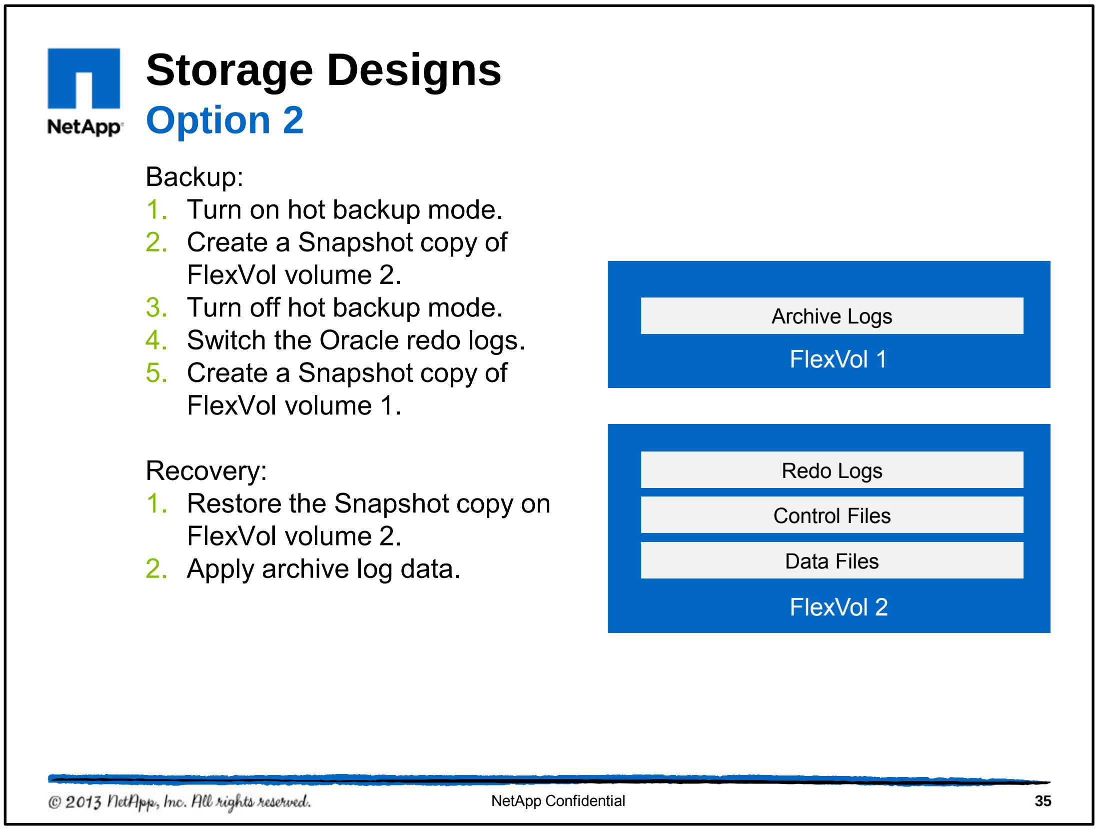
Recovery:
Use that Snapshot copy and recover the entire volume.



STORAGE DESIGNS: OPTION 1

For this method, you might not need to roll the database forward or retain the database in archive log mode. This option is for environments where the loss of data is irrelevant.

This method is easy, but you lose the archive logs and unarchived transactions in the redo logs, because online redo logs are restored with the data files. This approach prevents you from rolling the database forward.



STORAGE DESIGNS: OPTION 2

This method guarantees almost no data loss. The archive logs are stored in one FlexVol volume, and the redo logs, control files, and data files are stored in a separate FlexVol volume.

This method is also easy, but you lose unarchived transactions in the redo logs, because online redo logs are restored with the data files. In some environments, this method is acceptable data loss, because of one of the following:

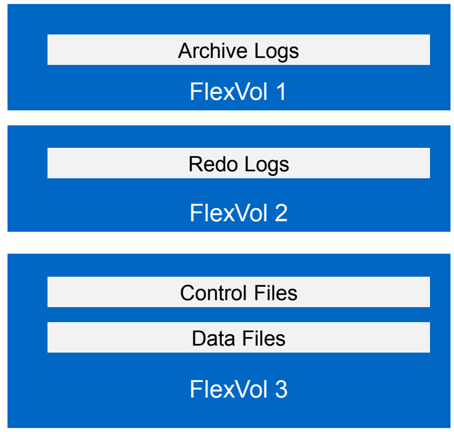
- The application can resynchronize itself.
- The environment is a development environment, and recoverability is needed.
- There is little change of data in the environment.

The redo logs are circular files. Therefore, Snapshot space of FlexVol volumes with redo logs can grow quickly, depending on the database workload.

Storage Designs
Option 3

Backup:
1. Turn on hot backup mode.
2. Create a Snapshot copy of FlexVol volume 2.
3. Turn off hot backup mode.
4. Switch the Oracle redo logs.
5. Create a Snapshot copy of FlexVol volume 1.

Recovery:
1. Restore the Snapshot copy on FlexVol volume 3.
2. Apply archive log data.
3. Apply redo log data.



 NetApp Confidential 36

STORAGE DESIGNS: OPTION 3

This method guarantees almost no data loss, unless a triple-disk failure occurs.

This design enables you to do the following:

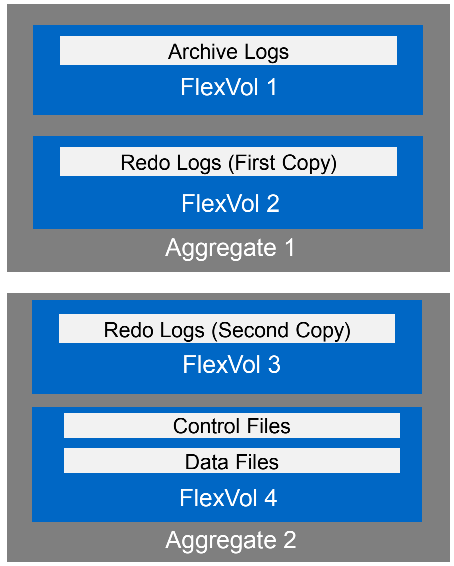
- Restore a volume from a Snapshot copy (in this case, FlexVol Volume 3).
- Recover the database to the time of the database crash.
- Back up data using SnapRestore technology.
- Roll forward the database using the archive logs, if they are undamaged.

The redo logs are in their original state at the time of the database crash. This means that the unarchived redo data that Oracle requires (to roll forward and roll back) is available. If you restore the archive log FlexVol volume, you have archive logs available only for the time when you created the Snapshot copy.

Storage Designs
Option 4

Backup:
1. Turn on hot backup mode.
2. Create a Snapshot copy of FlexVol volume 4.
3. Turn off hot backup mode.
4. Switch the Oracle redo logs.
5. Create a Snapshot copy of FlexVol volume 1.
6. Mirror data using the SnapMirror product family or SnapVault software.
7. Back up FlexVol volume 4.

Recovery:
1. Restore the Snapshot copy on FlexVol volume 4.
2. Apply archive log data.
3. Apply redo log data.



 37

STORAGE DESIGNS: OPTION 4

Although this method requires some extra work during recovery, you can confidently meet a strict recovery time objective (RTO) and recovery point objective (RPO) for the database.

This design enables you to do the following:

- Multiplex the online redo logs to a different aggregate and FlexVol volume.
  - This creates two copies of the online redo logs.
  - The Oracle control files and the data files are still together.

If you keep a copy of FlexVol volume 4, you never lose a committed transaction, even if an aggregate fails.

- If aggregate 1 fails, database integrity is unaffected, because you have the data files and a surviving copy of the redo logs in aggregate 2.
- If aggregate 2 fails, you must restore the data files, but you can subsequently replay archive logs and redo logs.

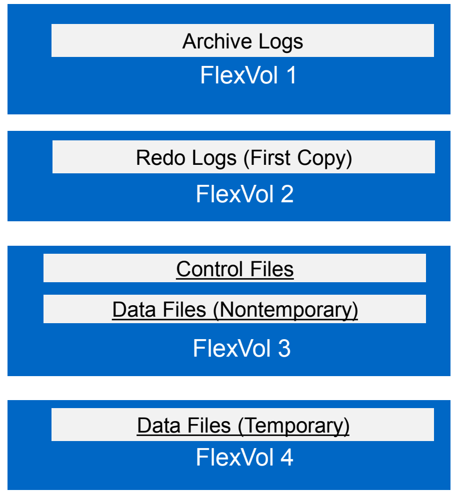
Although this design is resilient, use the SnapMirror solution or SnapVault software to mirror FlexVol volume 4 to another NetApp controller for fault tolerance.

Storage Designs
Option 5

Backup:
1. Turn on hot backup mode.
2. Create a Snapshot copy of FlexVol volume 3.
3. Turn off hot backup mode.
4. Switch the Oracle redo logs.
5. Create a Snapshot copy of FlexVol volume 1.

Recovery:
1. Restore the Snapshot copy on FlexVol volume 3.
2. Apply archive log data.
3. Apply redo log data.

NOTE: It is not necessary to create a Snapshot copy on the element that will not be recovered.

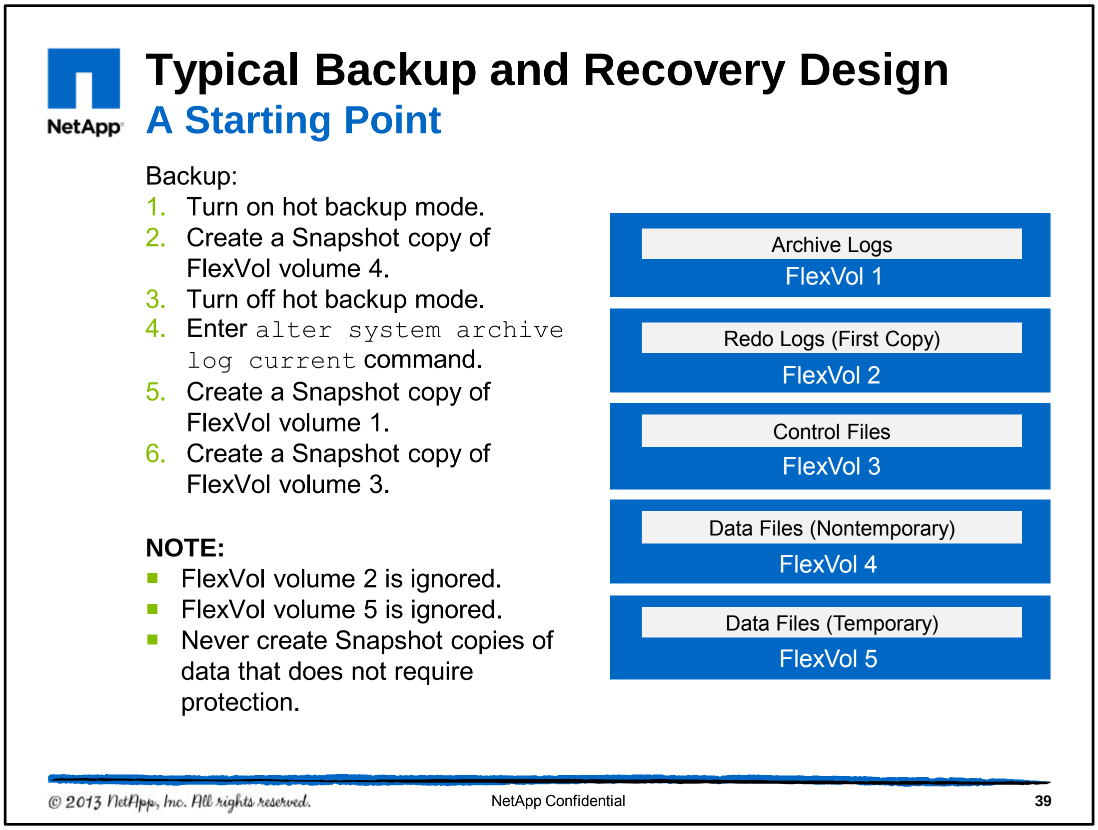


STORAGE DESIGNS: OPTION 5

With this design, do not back up the FlexVol volume that contains the temporary data files.

Why? Because temporary data files have these characteristics:

- Contain volatile data that can cause significant increases in Snapshot space
- Are not needed to start an Oracle database
- Do not require backup
- Can be easily created
- Never contain valuable data for a recovery
- Are like a “notepad” for work that is not performed in memory



TYPICAL BACKUP AND RECOVERY DESIGN: A STARTING POINT

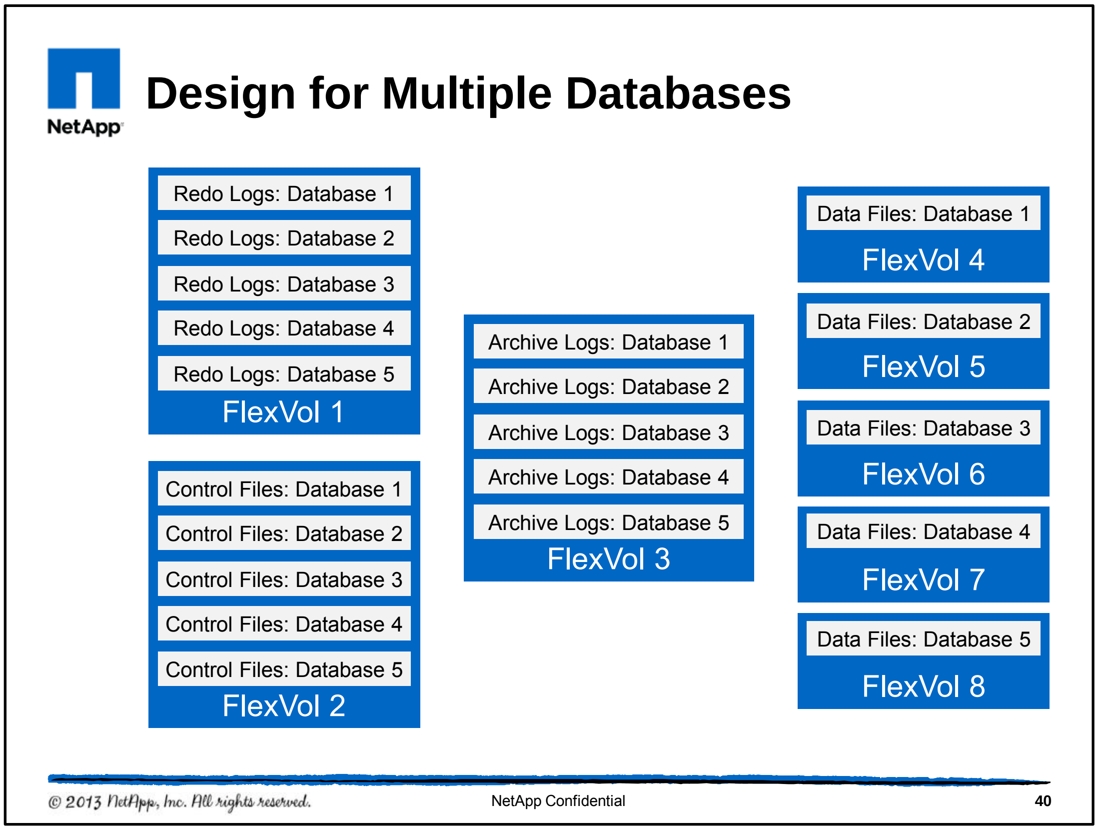
This option might be your primary reference point for designing storage for an Oracle database. You can adjust the design according to your requirements and environment. You can do the following with this design:

- Back up what you need to back up
- Restore what you need to restore
- Perform many recovery types that are available in Oracle

Using NetApp Snapshot technology for your backup design enables you to use the technology more efficiently:

- You do not back up FlexVol volume 2, Oracle online redo logs, or FlexVol volume 4 temporary data files.
- The major components of an Oracle database are separated, so that you avoid backing up unneeded items.

NOTE: The list of restoration designs in this module is not comprehensive; it includes only the most common designs.

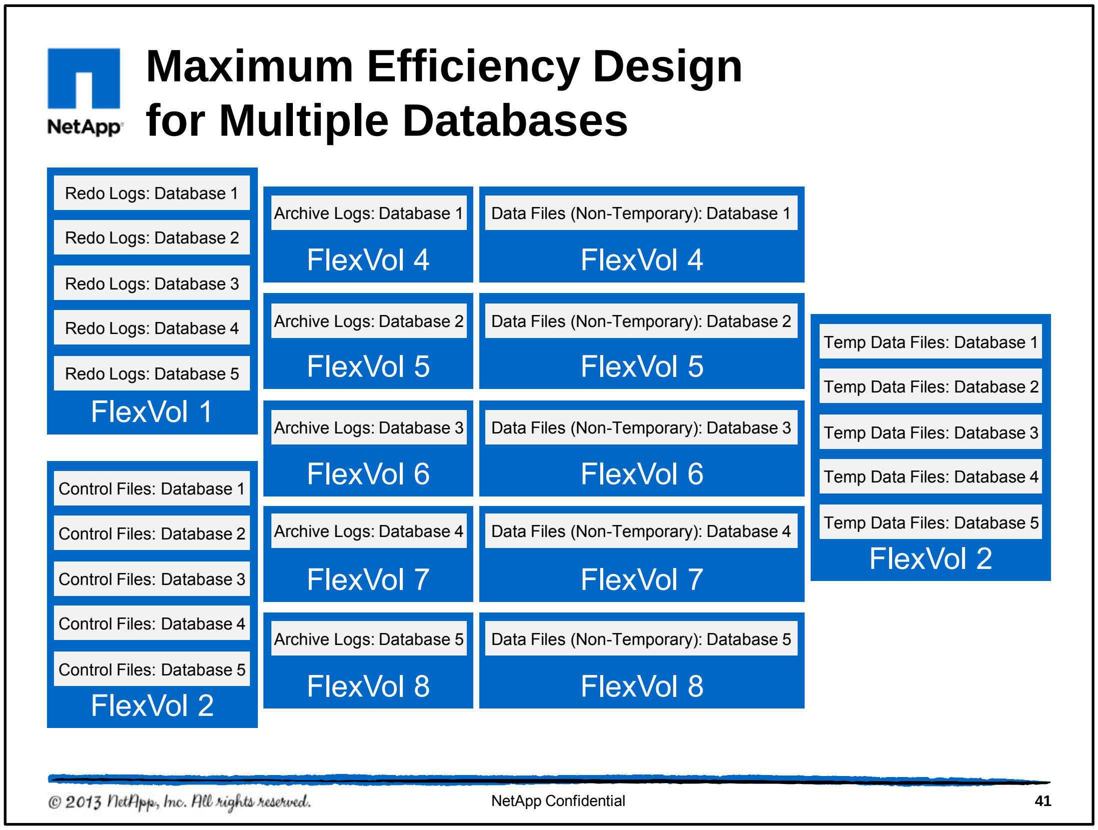


DESIGN FOR MULTIPLE DATABASES

The slide shows elements of an Oracle database that you do not need to replicate.

You may need to create Snapshot copies of these elements. For example, redo logs and control files are small enough to be efficiently restored with a file-based SnapRestore operation.

You do not need to restore certain elements of an Oracle database, such as temporary files. However, you might use some elements for cloning or archive recovery.



MAXIMUM EFFICIENCY DESIGN FOR MULTIPLE DATABASES

The archive logs in this design are separated by database:

- Reduces the number of Snapshot copies per volume
- Reduces the overall Snapshot copy space
- Provides granularity for managing Snapshot copies and FlexVol volumes

This design combines the database temporary data files:

- Avoids creating Snapshot copies of data that does not require backup
- Reduces Snapshot space consumption

This design offers several advantages:

- Separates the parts of the database that require backup
- Manages backups for individual databases more efficiently
- Reduces the number of FlexVol volumes when deploying multiple databases

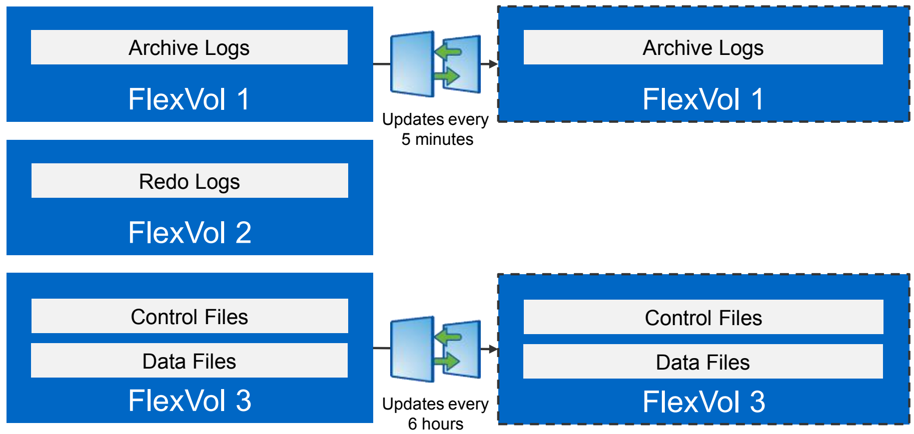
When you have many UNIX hosts that each run multiple databases:

- Use one FlexVol volume per UNIX host for the redo logs for all of the databases on the host.
- Or, use multiple FlexVol volumes for the redo logs for all of the databases within the infrastructure.
- Then, randomly place the redo logs of each database in the FlexVol volumes.
- This prevents a single FlexVol volume from taking down a series of databases during a catastrophic failure.

Because some customer environments do not run multiple databases on a single host, consider these factors:

- How are the databases deployed within your environment?
- Which strategy is the most effective for your infrastructure and requirements?
- Which strategy enables you to efficiently provide backup and recovery?

SnapMirror Design Options



 NetApp Confidential 42

SNAPMIRROR DESIGN OPTIONS

In this design:

- The SnapMirror solution is used to update the archive logs every five minutes.
- The database is mirrored every six hours.
- There is potentially a five-minute RPO for the Oracle archive logs.

You do not mirror the Oracle online redo logs, so you will lose any unarchived transactions within those logs.

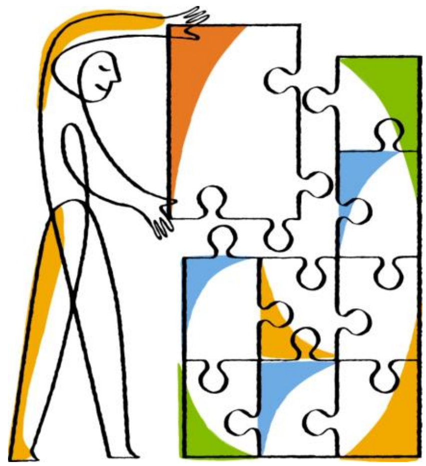
Module Summary

Now that you have completed this module, you should be able to:

- Describe key design considerations for an Oracle deployment on NetApp storage systems
- Create the storage design to implement Oracle databases on NetApp storage systems

MODULE SUMMARY

Learning Activity Questions



 NetApp Confidential 44

LEARNING ACTIVITY QUESTIONS

Learning Activity: Questions

1. Which two of these statements are true? (Choose two.)
   a. You should ensure that MPIO and ALUA are configured for an NFS environment.
   b. In a SAN environment, consistency group Snapshot copies are always optional.
   c. A LIF can be designated for both data and management.
   d. You should avoid accessing a FlexVol volume on one node by using a LIF that is located on a different node.

LEARNING ACTIVITY: QUESTIONS

Learning Activity: Questions

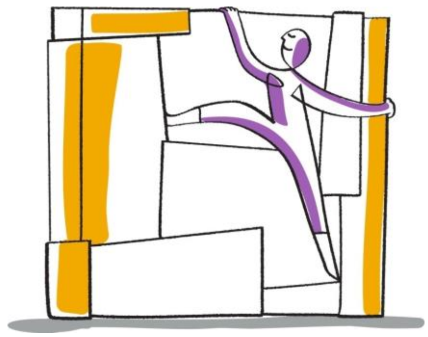
2. Which of the following design challenges are addressed by the clustered Data ONTAP operating system? (Choose three.)
   a. Load-balanced client access
   b. FlexVol volumes
   c. Data mobility to manage application storage
   d. Nondisruptive scale-out

LEARNING ACTIVITY: QUESTIONS

NetApp

Exercise

Time Estimate: 15 Minutes



 NetApp Confidential

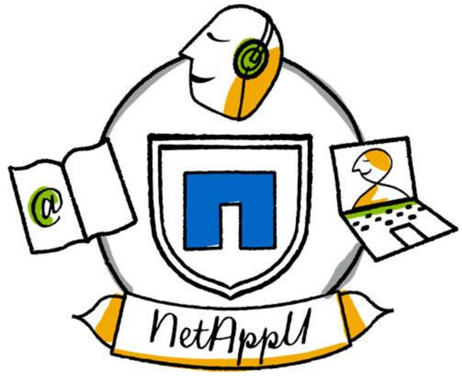
EXERCISE

Please refer to your exercise guide.

NetApp

Module 3

Setting Up NetApp Storage Systems for Oracle Databases



MODULE 3: SETTING UP NETAPP STORAGE SYSTEMS FOR ORACLE DATABASES

Module Objectives

After this module, you should be able to:

- Configure clustered Data ONTAP network interface groups, logical interfaces (LIFs), and interface failover
- Configure clustered Data ONTAP virtual storage servers (Vservers)
- Provision storage for a Vserver
- Access a Data ONTAP cluster
- Configure export policies
- Implement and validate a storage design on the clustered Data ONTAP operating system

MODULE OBJECTIVES

Lesson 1

Implementing Your Storage Design

 NetApp Confidential 3

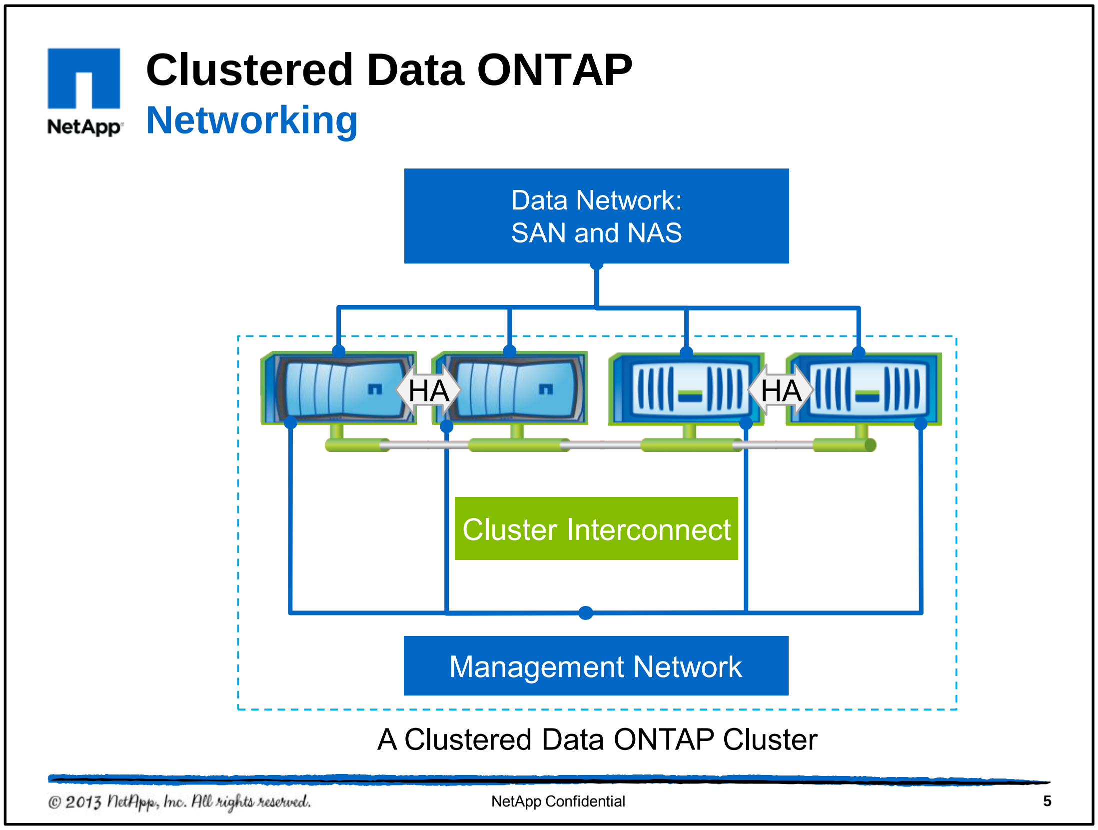
LESSON 1: IMPLEMENTING YOUR STORAGE DESIGN

Steps for Implementing Your Storage Design

1. Begin with a NetApp storage system or a clustered Data ONTAP cluster.
2. Create or delegate a Vserver to contain Oracle database storage entities.
3. Define interface groups and LIFs for the Oracle solution.
4. Provision storage for the Vserver.
5. Configure export policies.
6. Validate the implementation.

STEPS FOR IMPLEMENTING YOUR STORAGE DESIGN

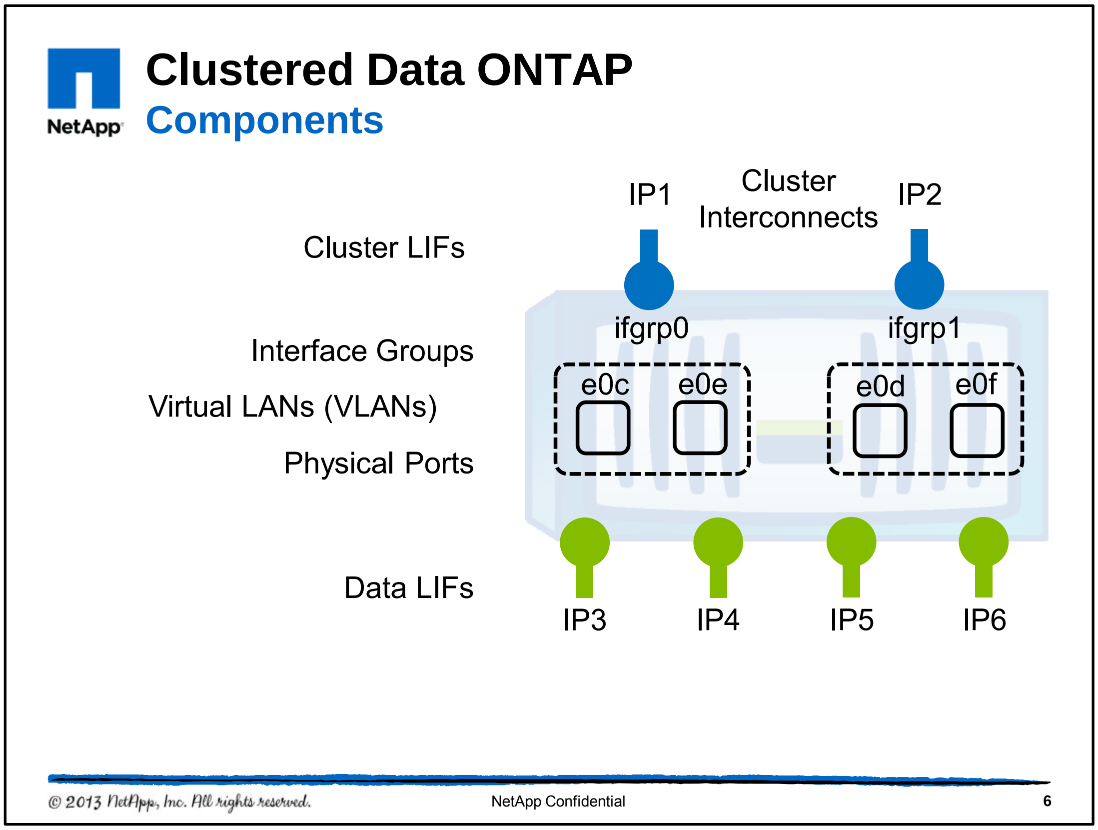
After you determine the supportability of each component on the NetApp Interoperability Matrix Tool (IMT) and design your storage layout, you implement your storage design.



CLUSTERED DATA ONTAP: NETWORKING

Application servers that operate in a networked environment are connected by SANs or NAS to shared storage. You can configure clustered Data ONTAP in clusters of 1 to 24 nodes, which communicate management or data transactions over a specialized network called a cluster interconnect. You can configure pairs of nodes as high-availability (HA) failover partners.

Data ONTAP shared storage systems or clustered Data ONTAP clusters serve SAN and NAS clients simultaneously. SAN transport protocols that are supported by Data ONTAP are iSCSI, FC, and FCoE; NAS transport protocols are NFS and CIFS.



CLUSTERED DATA ONTAP: COMPONENTS

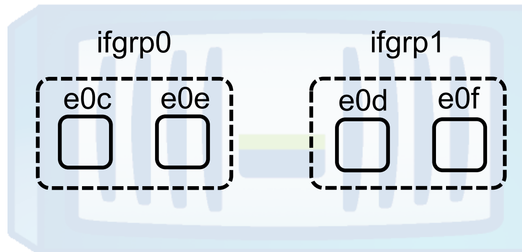
Notice the components of the clustered Data ONTAP operating system in the slide. This course focuses on the types of LIFs in the clustered Data ONTAP operating system that are key to data access and management.

Notice how the interface groups (ifgrp0 and ifgrp1) are on top of ports or VLANs and consist of the Ethernet ports e0a, e0b and e0c, e0d. The interface groups can consist of VLANs, instead of physical ports.

Data LIFs are used for client access to the storage, for example, by NFS clients with mount points. Data LIFs can reference interface groups or VLANs (if configured).

Interface Groups

- Interface group types:
  - Single-mode
  - Multimode
  - Link Aggregation Control Protocol (LACP)
- Only physical ports
- All ports on the same physical node
- All ports with the data role (required)

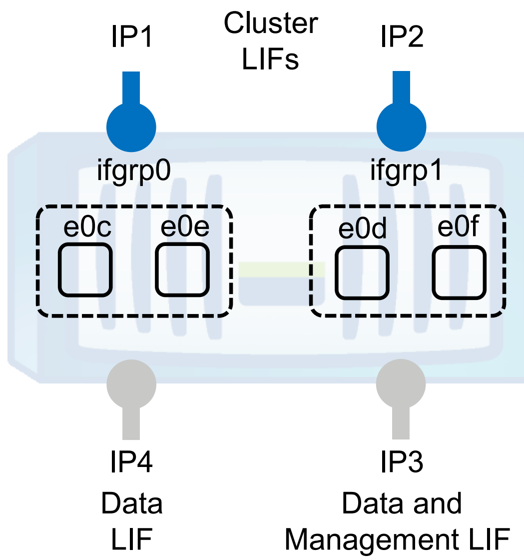


INTERFACE GROUPS

Notice the use of the Ethernet ports that are included as members of each interface group.

LIFs

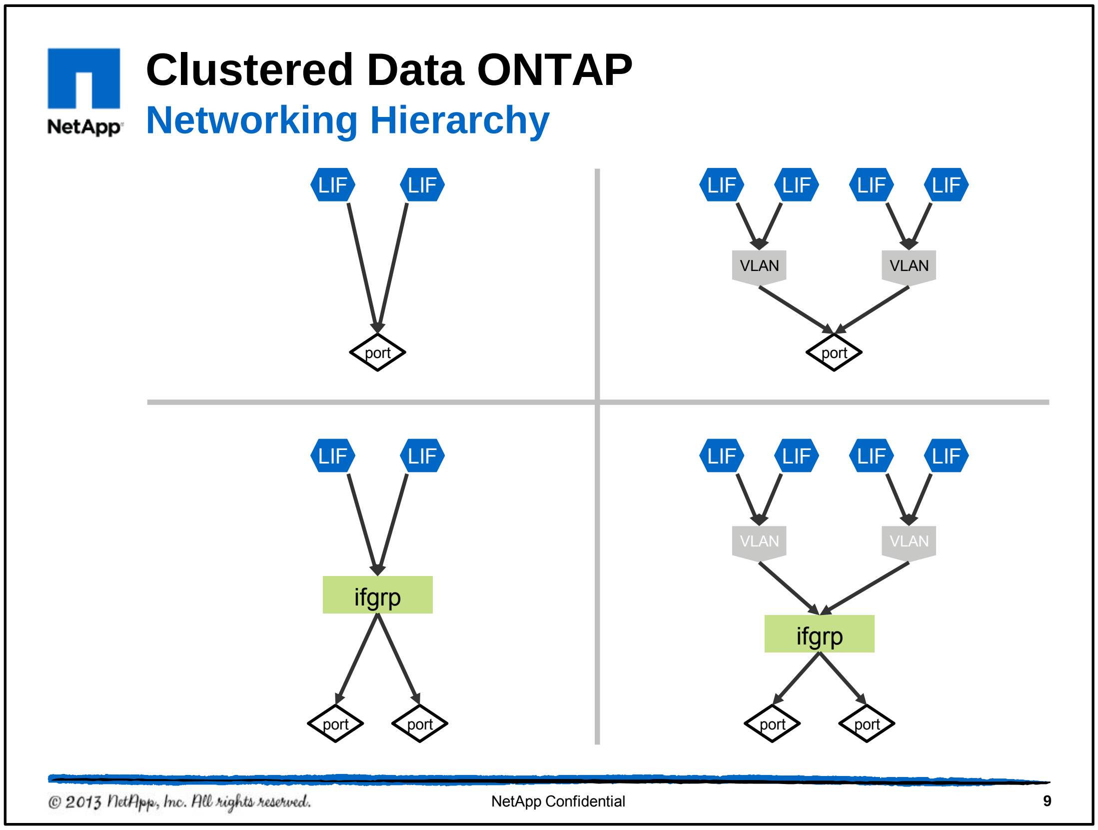
- LIFs are logical IP interfaces that are assigned to a home port.
- Multiple LIFs can exist on one port.
- An IP address is assigned to each LIF.
- The LIF IP address is what the NFS client uses for mounts.
- You add the LIF IP address to the host file.



LIFS

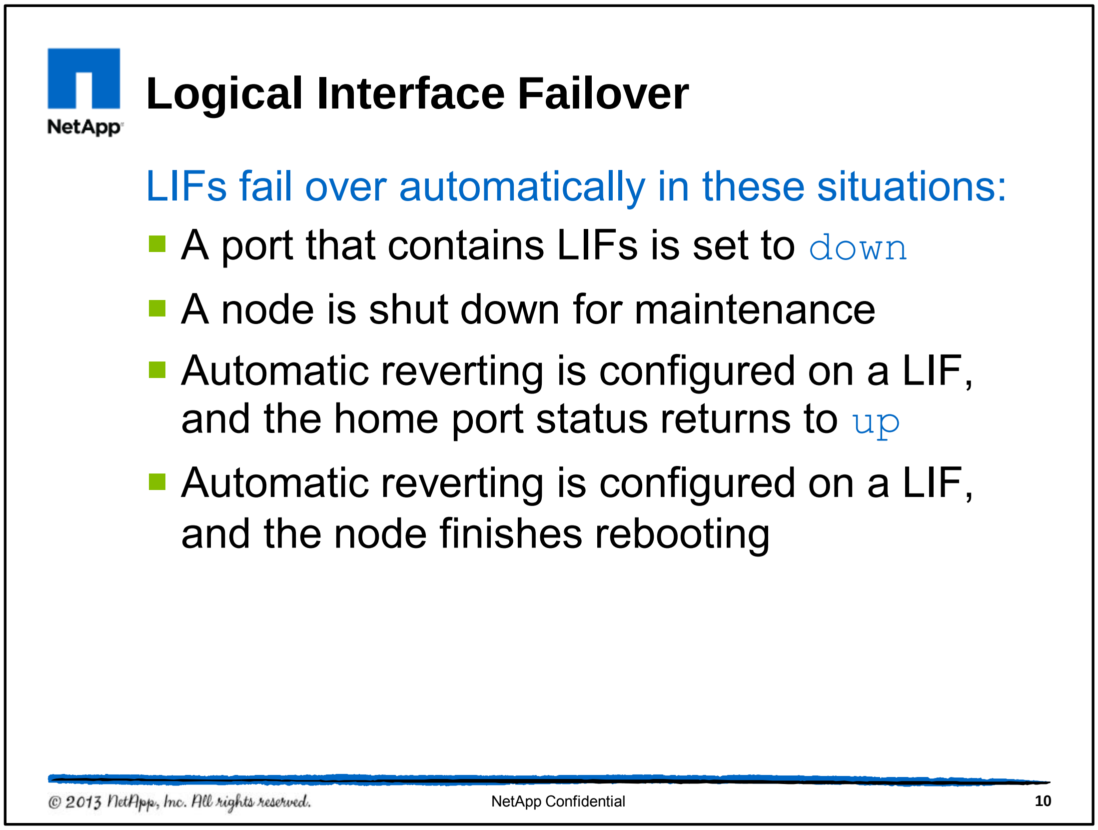
LIFs are logical representations for access to the components of the Vserver. Multiple LIFs can reside on one Ethernet port. With clustered Data ONTAP, the IP address is associated to the LIF, not the physical port.

A LIF can serve as a data LIF, management LIF, or both. A management LIF is used by tools like SnapDrive for UNIX and Snap Creator Framework; a data LIF is used only for access by a protocol. (For example, with NFS, the NFSv3 protocol is the most relevant protocol for a data LIF in a database.)



CLUSTERED DATA ONTAP: NETWORKING HIERARCHY

Notice how you can combine the network components.



LOGICAL INTERFACE FAILOVER

LIFs fail over automatically in these situations:

- A port that contains LIFs is set to down
- A node is shut down for maintenance
- Automatic reverting is configured on a LIF, and the home port status returns to up
- Automatic reverting is configured on a LIF, and the node finishes rebooting

Implementing a Storage Design
Questions About Vservers

- How many Vservers do you need?
- Do you need to provide a level of isolation of storage entities?
- Are multiple organizations using the cluster?
- Do you need one Vserver per database?
- Do you have multiple business units?
- Do you need to isolate and separate resources for management?

NOTE:

- You can use one Vserver per UNIX client. All databases for that UNIX client use the same Vserver.
- The Vserver hierarchy depends on your needs and the management of the environments.

 NetApp Confidential

IMPLEMENTING A STORAGE DESIGN: QUESTIONS ABOUT VSERVERS

- How many Vservers do you need?
- Do you need to provide a level of isolation of storage entities?
- Are multiple organizations using the cluster?
- Do you need one Vserver per database?
- Do you have multiple business units?
- Do you need to isolate and separate resources for management?

NOTE:

- You can use one Vserver per UNIX client. All databases for that UNIX client use the same Vserver.
- The Vserver hierarchy depends on your needs and the management of the environments.

Implementing a Storage Design
Understanding LIFs

- Features of failover groups:
  – Are available as default failover groups
  – Provide redundancy for LIFs
- Features of interface groups (ifgrp):
  – Can be LACP or multimode
  – Provide an additional layer of resiliency
- Features of LIFs:
  – Are logical network interfaces that provide IP access points
  – Correspond to an IP address
  – Are tied to a physical port but can be migrated to different ports

IMPLEMENTING A STORAGE DESIGN: UNDERSTANDING LIFS

Features of failover groups:

- Are available as default failover groups
- Provide redundancy for LIFs

Features of interface groups (ifgrp):

- Can be LACP or multimode
- Provide an additional layer of resiliency

Features of LIFs:

- Are logical network interfaces that provide IP access points
- Correspond to an IP address
- Are tied to a physical port but can be migrated to different ports

Implementing a Storage Design
How Many LIFs Do You Need?

- Environment determines the number of LIFs per database.
- You have options for the number of LIFs per database.
- Clustered Data ONTAP features offer advantages.
- Your LIF design is based on scalability needs.

IMPLEMENTING A STORAGE DESIGN: HOW MANY LIFS DO YOU NEED?

The answer depends on your environment.
You can have one LIF per database, one LIF per NFS client, or multiple LIFs per database.
Use clustered Data ONTAP features to:

- Migrate a FlexVol volume between nodes of a cluster
- Migrate the LIF that is associated to the FlexVol volume to avoid indirect access

NOTE: Determine the required level of granularity for leveraging the benefits of the clustered Data ONTAP architecture. Your LIF design is based on your scalability needs.

Implementing a Storage Design
LIF Recommendations for NetApp Software

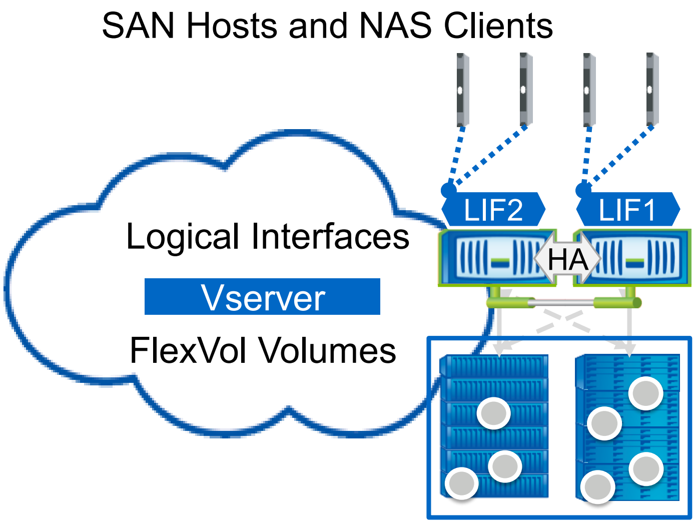
- LIFs can be data only, management only, or data and management.
- LIF designation depends on your network requirements and configuration.
- For SnapDrive for UNIX and Snap Creator Framework:
  – You must designate a LIF as management or data and management.
  – A LIF cannot be data only.

 NetApp Confidential 14

IMPLEMENTING A STORAGE DESIGN: LIF RECOMMENDATIONS FOR NETAPP SOFTWARE

- How you devise the LIFs depends wholly on your needs.
- The role of a LIF can be any combination of data and management, but when you use NetApp products such as SnapDrive for UNIX or Snap Creator Framework, the access to the Vserver must be through a management LIF. Therefore, at least one management LIF or a LIF that is a combination of data and management is required.

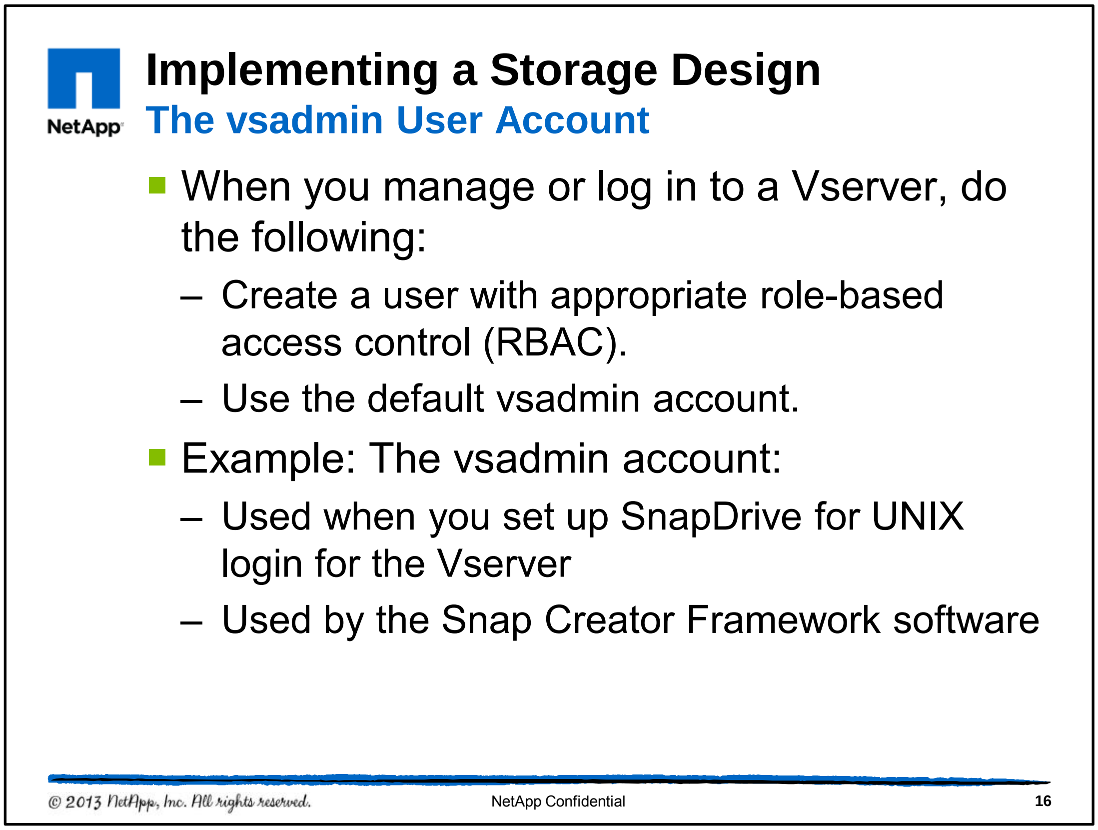
Implementing Vservers and LIFs



IMPLEMENTING VSERVERS AND LIFS

Key characteristics:

- A Vserver is a logical, flexible, secure resource pool for a NAS namespace and LUNs.
- All data access is provided through a Vserver that supports one or more protocols.
- The Vserver includes FlexVol volumes, LUNs, and LIFs.
- A minimum of one Vserver is required (hundreds can be supported)
- A Vserver can see only the resources that have been allocated to it, and not to other Vservers.
- The Vserver provides a secure multitenancy configuration.



IMPLEMENTING A STORAGE DESIGN: THE VSADMIN USER ACCOUNT

The vsadmin account:

- Is the Vserver administration account
- Has the proper roles and privileges to manage the environment
- Can be used by other NetApp products (such as SnapDrive for UNIX) to manage the environment

If you do not want to use the vsadmin account, you can create an additional account with proper access permissions and Vserver commands. (You could compare this method to the use of the Oracle Database SYS or SYSTEM users in the database space.) Consider creating your own user with the proper privileges, rather than using a default administration account.

Implementing a Storage Design
FlexVol Options

- Specific options for FlexVol volumes and Oracle:
  - `nvfail` on
  - `read_realloc` on
- Snapshot policies:
  - Assign a Snapshot policy of “none.”
  - The Snapshot copies that the Data ONTAP operating system generates for Oracle FlexVol volumes cannot typically be used in a recovery scenario.
  - These Snapshot copies must be user-created in conjunction with an Oracle hot backup.

IMPLEMENTING A STORAGE DESIGN: FLEXVOL OPTIONS

The FlexVol options that are recommended for an Oracle environment in clustered Data ONTAP for an Oracle environment in Data ONTAP operating in 7-Mode are the same.

Implementing a Storage Design
Provisioning Storage

When you provision storage for a Vserver, do the following:

- Log in to the cluster management IP with the “admin” user account.
- Use the following CLI syntax:

```
volume create -vserver <VS Name> -volume
<FlexVol Name> -aggregate <Aggregate> -size
<size m|g|t> -space-guarantee <option> -
security-style <unix|mixed> -junction-path
<Name Space Path> -nvfail on -read-realloc on
```

- Use the `-junction-path` option. The junction path is the name that is exported for NFS clients to mount, and junction path becomes part of the /etc/fstab syntax.

IMPLEMENTING A STORAGE DESIGN: PROVISIONING STORAGE

You provision storage for a Vserver on an aggregate when you create the Vserver.

Notice that the `-junction-path` option with the namespace path is used later with the Linux host, when you define the entries within the /etc/fstab syntax.

Implementing a Storage Design
Export Policies

- Features of a clustered Data ONTAP export policy are as follows:
  - Created within the Vserver
  - Used at the FlexVol volume level
- Ensure that the root volume of the Vserver has proper export policy permissions.

IMPLEMENTING A STORAGE DESIGN: EXPORT POLICIES

Remember:

- Export policies are at the FlexVol level.
- All qtrees within the FlexVol volume have the same export permissions.

NOTE: The issue of ensuring the proper export policy permissions for the root volume of the Vserver is more relevant when you use Oracle Direct NFS (dNFS).

Module Summary

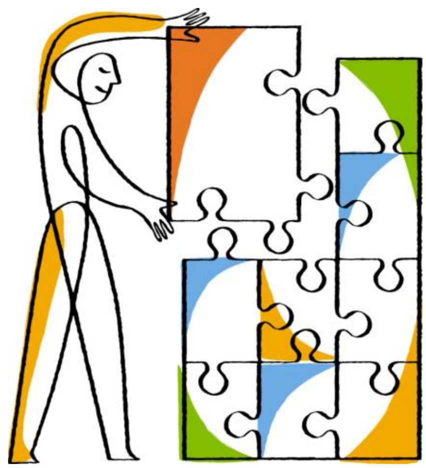
Now that you have completed this module, you should be able to:

- Configure clustered Data ONTAP network interface groups, logical interfaces (LIFs), and interface failover
- Configure clustered Data ONTAP Vservers
- Provision storage for a Vserver
- Access a Data ONTAP cluster
- Configure export policies
- Implement and validate a storage design on the clustered Data ONTAP operating system

 NetApp Confidential

MODULE SUMMARY

Learning Activity Questions



 NetApp Confidential

LEARNING ACTIVITY QUESTIONS

Learning Activity: Questions

1. Place the steps for implementing your storage design in the correct sequence.
   a. Validate the implementation.
   b. Define interface groups and LIFs for the Oracle solution.
   c. Create or delegate a Vserver to contain Oracle database storage entities.
   d. Configure export policies.
   e. Provision storage for the Vserver.

LEARNING ACTIVITY: QUESTIONS

Learning Activity: Questions

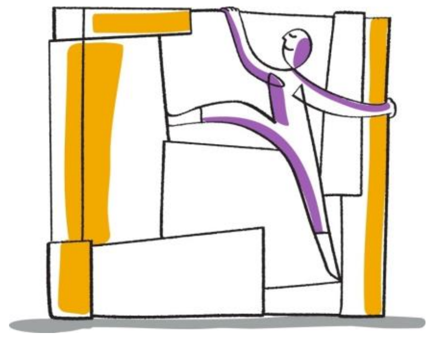
2. Which two of the following statements are true? (Choose two.)
   a. The clustered Data ONTAP operating system enables you to segregate network traffic and configure network redundancy.
   b. You use failover groups for the interfaces that are used by LIFs.
   c. SnapDrive for UNIX and Snap Creator Framework require data LIFs only.
   d. Export policies are set at the qtree level.

LEARNING ACTIVITY: QUESTIONS

NetApp

Exercise

Time Estimate: 60 Minutes



 NetApp Confidential 24

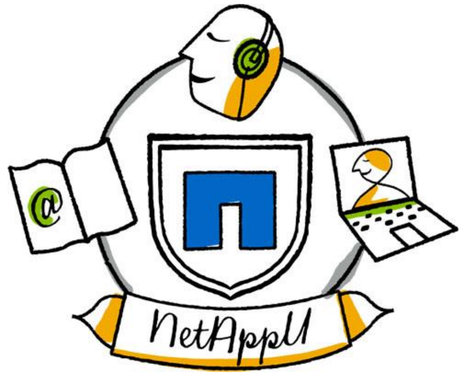
EXERCISE

Please refer to your exercise guide.

NetApp

Module 4

Installing an Oracle Server and Oracle Databases



 NetApp Confidential 1

MODULE 4: INSTALLING AN ORACLE SERVER AND ORACLE DATABASES

NetApp

Module Objectives

After this module, you should be able to:

- Describe requirements and prerequisites for installing an Oracle server and databases
- Install an Oracle database

 NetApp Confidential

MODULE OBJECTIVES

After this module, you should be able to:

- Describe requirements and prerequisites for installing an Oracle server and databases
- Install an Oracle database

Lesson 1

Installation Requirements and Prerequisites

LESSON 1: INSTALLATION REQUIREMENTS AND PREREQUISITES

Oracle Installation
Requirements

- Hardware requirements:
  - Sufficient CPU and memory on the host
  - Sufficient disk capacity on the storage server for Oracle binaries
- Software requirements:
  - Prerequisite RPM Package Managers (RPMs) for Oracle on Linux
  - Specific Oracle settings for Linux and NFS
  - Linux kernel settings
  - A shared or non-shared Oracle binary for all databases

 4

ORACLE INSTALLATION: REQUIREMENTS

Hardware requirements include sufficient CPU and memory on the host and sufficient disk capacity on the storage server for Oracle binaries.

Software requirements include a list of RPMs for Oracle on Linux. (In this context, RPM, which originally denoted “Red Hat Package Manager,” is an acronym for "RPM Package Manager.”)

You must decide whether to implement Oracle databases with shared or non-shared Oracle binaries.

Oracle Installations
Shared Binaries

- Shared binaries are installation files that are used by multiple databases on the same host or by RAC implementations.
- Advantages include the reduction of duplicate Oracle binaries.
- Disadvantages involve cumbersome upgrades and patching.

ORACLE INSTALLATIONS: SHARED BINARIES

Many Oracle DBAs prefer shared binaries. Reasons exist to use both shared and non-shared binaries, but this issue is not listed as a best practice or recommendation for deploying Oracle on NetApp storage.

A more important question is how many FlexVols to use for Oracle binaries. You can use one FlexVol, with multiple qtrees for different Oracle installations, which reduces the required number of FlexVols. This allows DBAs to manage Oracle installations to standards and to take advantage of the NetApp technology for patching, upgrades, and testing, without affecting other databases.

Oracle Installations
Non-Shared Binaries

- Non-shared binaries are installation files that are used by a single Oracle database.
- One FlexVol volume with qtrees is used for multiple Oracle binary installations to:
  – Provide individual application Oracle binaries
  – Provide upgrading and patching for individual installations
  – Limit the FlexVol volume count
- Because NFS export policies are set at the FlexVol volume level, all qtrees within a volume share permissions.

ORACLE INSTALLATIONS: NON-SHARED BINARIES

You can use Data ONTAP FlexVol volumes and qtrees to implement non-shared binaries. One FlexVol volume with qtrees is used for multiple Oracle binary installations.

Qtrees:

- Are specialized directories that you create in a Data ONTAP FlexVol to separate data.
- Can each contain binaries for an individual Oracle application or database.

Non-shared binaries provide upgrading and patching for individual installations. Data ONTAP FlexVol volumes limit volume count by using qtree directories to contain binaries for each database in one FlexVol volume.

NOTE: NFS export policies are managed at the FlexVol volume level. All qtrees within a volume share NFS export policies; therefore, many hosts have access to the same FlexVol volume.

Oracle Software Installation
Storage Considerations

The storage space required for an Oracle binary installation depends on the following:

- Type of Oracle installation (Standard or Enterprise)
- Use of shared or non-shared binaries
- Number of single or RAC servers
- Whether Oracle Grid Engine is installed
- Use of NFS protocol
- NetApp Snapshot copy space reserve

ORACLE SOFTWARE INSTALLATION: STORAGE CONSIDERATIONS

Storage space considerations for an Oracle binary installation include the following:

- Are you using the Oracle Standard or the Enterprise Edition? The Oracle 11gR2 version installation requires at least 5 gigabytes (GB).
- The space required is multiplied by the number of single or RAC servers installed. Each node of a RAC cluster must be the same version of Oracle software.
- You can install multiple databases with shared or non-shared binaries.
- An additional 7 GB of storage is required if you install the Oracle GRID Infrastructure and Oracle Automatic Storage Management (ASM).
- Specific NFS mount options are required, when you are deploying NFS for an Oracle software installation,. See KB3010189 for critical information about these options.*
- The Snapshot copy space reserve and change rate should be calculated into the space requirements for the FlexVol volume size.

*For example, if you are not sharing the Oracle installation directory, the use of actimeo=0 as a mount option provides terrible performance as part of the installation or if you relink the Oracle binaries. Traditionally this option is used when a file system needs to share the file system (in other words, a clustered file system) between NFS clients.

Linux Preinstallation Requirements

- Linux host requirements for Oracle databases are documented by Oracle.
- Validate the requirements for the OS and kernel:
  – Install several RPMs on the Linux kernel.
  – Use a YUM server to complete download and install RPMs.
- Implementing Oracle on clustered Data ONTAP does not affect host prerequisites.

LINUX PREINSTALLATION REQUIREMENTS

NOTE that the Linux host (or other OS) prerequisites for an Oracle deployment are documented by Oracle, and they are not affected by deploying Oracle on the clustered Data ONTAP operating system. You must validate the requirements for the OS and kernel.

If possible, use a YUM* server to download and install the RPMs that are required by Oracle:

- Several RPMs must be installed on a base Linux kernel.
- Some may already be installed on your Linux host.
- Some of these RPMs have a long dependency trail.

*YUM = Yellow Dog Updater, Modified; a revision of the Yellow Dog Updater (YUP). Yellow Dog is a version of Linux server written by the Linux community to maintain RPM-based systems.

Linux Preinstallation Requirements
NetApp Interoperability

For Linux distributions:

- Most Oracle Linux and Red Hat Enterprise Linux versions are supported by NetApp for NFS.
- Verify that Oracle supports the OS version for your specific database.
- Use the NetApp Interoperability Matrix Tool (IMT) to validate the OS.

LINUX PREINSTALLATION REQUIREMENTS: NETAPP INTEROPERABILITY

Guidelines for validating NetApp support of your OS:

- NetApp supports most OSs that conform to the IETF RFC specifications for NFS.
- You need to validate that Oracle supports your versions of the Linux server OS and Oracle database server.
- NetApp for NFS supports most Oracle Linux and Red Hat Enterprise Linux versions.
- Verify that NetApp supports your version of the Linux server and the FC infrastructure, when you are implementing Oracle in a SAN environment.
- If you are using FC, verify that NetApp supports your OS.
- Use the NetApp Interoperability Matrix Tool (IMT) to confirm supportability.

Linux Kernel Requirements

- For up-to-date information, see the Oracle web site: http://docs.oracle.com/cd/E11882_01/install.112/e24321/pre_install.htm#CHDCFJJE.
- For Linux distributions:
  - Find the specific kernel version for your deployment.
  - Validate with Oracle documentation and My Oracle Support.
  - Note this example of how to determine your kernel: 2.62.32-131.0.15.el6.x86_64:
    - Kernel: 2.62.32
    - Errata level: 131.0.15.el6

LINUX KERNEL REQUIREMENTS

To determine Linux or other OS preinstallation requirements, use the updated documentation on the Oracle web site (which is noted on the slide).

Linux Configuration Requirements
OS Kernel Settings

- Check Oracle documentation for your OS and version.
- Edit /etc/sysctl.conf, and use `sysctl –p` to set the kernel settings.
- Review the minimum settings:
  - fs.suid_dumpable = 1
  - fs.file-max = 6815744
  - kernel.shmmax = 536870912
  - kernel.sem = 250 32000 100 128
  - net.core.rmem_default = 262144
  - net.core.wmem_default = 262144
  - kernel.sem = 250 32000 100 128
  - fs.aio-max-nr = 1048576
  - kernel.shmall = 2097152
  - kernel.shmmni = 4096
  - net.ipv4.ip_local_port_range = 9000 65500
  - net.core.rmem_max = 4194304
  - net.core.wmem_max = 1048586

LINUX CONFIGURATION REQUIREMENTS: OS KERNEL SETTINGS

Semaphores are counters that provide synchronization between processes or between threads within a process for shared resources (like shared memories).

Many administrators set the semaphore parameters to a high value based on their host and database configuration.

For your implementations, always check the Oracle documentation for your OS and version.

View the slide for an example of the Linux kernel minimum semaphore parameters that Oracle recommends for a Red Hat Enterprise Linux 6.1 deployment.

If your parameters do not meet the minimum, add the correct semaphore parameters to the end of the /etc/sysctl.conf file. To make the parameters of the /etc/sysctl.conf file persistent, run the sysctl –p command. To ensure that these settings are persistent, reboot the host.

Rarely, you might need to run the sysctl –p command as part of a /etc/rc.d startup script, due to the order of some of the startup script in the networking stack.

Linux Configuration Requirements

UDP and TCP Settings for Firewalls

- Define User Datagram Protocol (UDP) and TCP settings for the local-port-range parameters.
- Use the /etc/sys/net/ipv4/ip_local_port_range configuration file.
- Port range: 9000 to 65500

LINUX CONFIGURATION REQUIREMENTS: UDP AND TCP SETTINGS FOR FIREWALLS

Find the resource limits and their settings in the Oracle documentation. If installing the Oracle Grid Infrastructure, add resource limits for the Unix user that is defined for the Grid Infrastructure. (In our lab, that is the Unix user “grid”.)

You must define the UDP (User Datagram Protocol) and TCP settings. One of the most important settings is for the local-port-range parameters, with which you specify the range of source ports that are used to communicate with Tivoli Firewall Security Toolbox components (endpoint proxies, gateway proxies, and relays). If you do not specify the local-port-range, the operating system chooses a port at run time. If no ports in that range are available, connection attempts through the firewall fail.

Set local-port-range in the /etc/sys/net/ipv4/ip_local_port_range to 9000 to 65500.

Linux Configuration Requirements
Security Settings

- Validate the resource limits for Oracle software users.
- Use the /etc/security.limits configuration file.

User	Mount	Security	Permissions
oracle	soft	nproc	2047
oracle	hard	nproc	16384
oracle	soft	nofile	1024
oracle	hard	nofile	65536
oracle	soft	stack	10240

LINUX CONFIGURATION REQUIREMENTS: SECURITY SETTINGS

To control access to an Oracle database, configure the soft and hard resource limits for each Oracle software user by starting the database as that user and then editing the /etc/security.limits file.

In the example in the slide, the oracle user has a “soft limit” for the maximum number of processes (nproc) the oracle user can run, which is set to 2047. The soft limit defines the number of processes that are available to the user when logging in. If an error message appears indicating the user is running out of process, then the number of processes can increase up to 16384, which is the "hard limit.”

Set your maximum nproc to be higher than your hard security “nofile” limit, to leave resources to run the Linux OS.

Required Red Hat Enterprise Linux RPMs

rpm -Uvh kernel-headers-2.6.32-220.el6.x86_64.rpm
rpm -Uvh glibc-headers-2.12-1.47.el6.x86_64.rpm
rpm -Uvh compat-libcap1-1.10-1.x86_64.rpm
rpm -Uvh libmpcdec-1.2.6-6.1.el6.x86_64.rpm
rpm -Uvh mpfr-2.4.1-6.el6.x86_64.rpm
rpm -Uvh cpp-4.4.6-3.el6.x86_64.rpm
rpm -Uvh libgomp-4.4.6-3.el6.x86_64.rpm
rpm -Uvh ppl-0.10.2-11.el6.x86_64.rpm
rpm -Uvh cloog-ppl-0.15.7-1.2.el6.x86_64.rpm
rpm -Uvh gcc-4*x86_64*
rpm -Uvh binutils-2*x86_64*
rpm -Uvh glibc-2*x86_64* nss-softokn-freebl-3*x86_64*
rpm -Uvh glibc-2*i686* nss-softokn-freebl-3*i686*
rpm -Uvh compat-libstdc++-33*x86_64*
rpm -Uvh glibc-common-2*x86_64*
rpm -Uvh glibc-devel-2*x86_64*
rpm -Uvh sysstat-9*x86_64*
rpm -Uvh compat-libstdc++-33*i686*
rpm -Uvh glibc-devel-2*i686*
rpm -Uvh glibc-headers-2*x86_64*
rpm -Uvh elfutils-libelf-0*x86_64*
rpm -Uvh elfutils-libelf-devel-0*x86_64*
rpm -Uvh gcc-4*x86_64*
rpm -Uvh gcc-c++-4*x86_64*
rpm -Uvh ksh-*x86_64*
rpm -Uvh libaio-0*x86_64*
rpm -Uvh libaio-devel-0*x86_64*
rpm -Uvh libaio-0*i686*
rpm -Uvh libaio-devel-0*i686*
rpm -Uvh libgcc-4*x86_64*
rpm -Uvh libgcc-4*i686*
rpm -Uvh libstdc++-4*x86_64*
rpm -Uvh libstdc++-4*i686*
rpm -Uvh libstdc++-devel-4*x86_64*
rpm -Uvh make-3.81*x86_64*
rpm -Uvh numactl-devel-2*x86_64*
rpm -Uvh compat-libcap*

 NetApp Confidential 14

REQUIRED RED HAT ENTERPRISE LINUX RPMS

The slide lists the RPM commands for all of the RPMs required for an Oracle deployment, based on the Oracle documentation. The list appears in the proper order for dependency, generally. However, your mileage may vary depending on the version of the OS that is used.

Linux Considerations and Settings
NFS Mount Options

- Use the recommended NFS mount options to ensure a successful (and avoid a failed) deployment.
- Locate details on NFS mount options at: https://kb.netapp.com/support/index?page=content&id=3010189
- Follow the recommendations about ORACLE_HOME patching and mount options to avert performance issues.

NOTE: Linux performance issues can be caused by inappropriate use of the actimeo=0 setting.

 NetApp Confidential 15

LINUX CONSIDERATIONS AND SETTINGS: NFS MOUNT OPTIONS

- It is imperative that you follow the KB article to obtain the proper NFS mount options, in order to have a successful deployment.
- These mount options are continually reviewed in collaboration with Oracle.
- The latest Oracle documentation also directs you to the NFS mount options for your NAS vendor.

Linux Considerations and Settings
File System I/O Options

The `FILESYSTEMIO_OPTIONS` parameter enables you to fine-tune disk I/O to database files on file systems.

- This Oracle initialization parameter controls the use of `ASYNCH_IO` and `Direct I/O`.
- The best value to set for this parameter is "`setall`," which enables Oracle to improve performance.
- ASM uses `ASYNCH_IO` and `Direct I/O`.

 NetApp Confidential 16

LINUX CONSIDERATIONS AND SETTINGS: FILE SYSTEM I/O OPTIONS

FILESYSTEMIO_OPTIONS is an Oracle instance initialization parameter that gives finer control over I/O to database files on file systems.

DISK_ASYNCH_IO is a master switch that allows you to turn off async I/O to file system files but keep async I/O to raw devices if the "master" switch DISK_ASYNCH_IO is set to true.

FILESYSTEMIO_OPTIONS has four options:

1. "asynch": means buffered I/O + async I/O
2. "directIO": means direct I/O only
3. "setall": means direct I/O + async I/O
4. "none": disables async I/O and direct I/O

The Oracle INIT.ORA parameter should have the value of "setall" in order to improve performance. It lets Oracle decide when to use direct I/O or when it needs to use async I/O.

Using direct I/O to bypass the Unix Buffer Cache improves performance of the Oracle database I/O.

Linux Considerations and Settings

Database Read and Table Entry Settings

Multiblock reads—for example, index range scans, full-table scans, or index fast-full scans—are common in Oracle.

- Multiblock reads are automatically tuned by Oracle.
- The `db_multi_read_block_count` should not be changed in the Oracle `init.parameter`.
- Let the Oracle relational database management system (RDBMS) set this value as needed.

LINUX CONSIDERATIONS AND SETTINGS: DATABASE READ AND TABLE ENTRY SETTINGS

It is strongly recommended not to set the db_multi_read_block_count in the initialization parameter file. Even Oracle recommends to let Oracle define the appropriate value.

Linux Considerations and Settings

Maximum Number of In-Flight RPCs

The `sunrpc.tcp_slot_table_entries` setting increases the maximum number of in-flight RPCs.

- Edit `sysctl.conf` and adjust this entry to 128.
- This setting improves NFS performance by controlling the number of remote procedure calls on the Linux system.

LINUX CONSIDERATIONS AND SETTINGS: MAXIMUM NUMBER OF IN-FLIGHT RPCS

Another sysctl.conf parameter that needs to be set for NFS is the sunrpc.tcp_slot_entries kernel parameter. The incorrect setting for this kernel parameter can significantly affect performance, depending on your application workload.

Increasing this parameter from the default of 16 to the maximum of 128 increases the number of in-flight remote procedure calls (RPCs), which increases the number of NFS operations.

Be sure to edit `/etc/init.d/netfs to call /sbin/sysctl -p` in the first line of the script, when you change the value of the `sunrpc.tcp_slot_table_entries`, so that sunrpc.tcp_slot_table_entries is set before NFS mounts any file systems. If NFS mounts the file systems before this parameter is set, the default value of 16 is in force.

Linux Considerations and Settings
NFS Performance Settings

For optimum network performance:

- Increase the number of TCP messages that can be transmitted at one time between the storage system and the client.
- `Options nfs.tcp.recvwindowsize = 262144`
- `Options nfs.tcp.xfersize = 65536`
- Be sure to set the window size and transfer sizes on the Linux host to match the storage system settings.

 NetApp Confidential 19

LINUX CONSIDERATIONS AND SETTINGS: NFS PERFORMANCE SETTINGS

For best performance, you need to change certain settings on all nodes of the Data ONTAP cluster and the Linux hosts. Use these recommendations with the NFS or Oracle direct NFS (dNFS) protocols for a database.

The `nfs.tcp.recvwindowsize` and `nfs.tcp.xfersize` control the number of TCP messages that can be transmitted over the network at one time between the storage system and the client. Increasing these two options to their maximum settings on both the system and the client can improve performance for large transfers, if the network is reliable and packet loss is not taking place. To alter these settings, go into the node shell.

SAN Considerations

Determining the Number of Required LUNs

- The goal is to increase throughput with Oracle Parallel I/O.
- Examples are logical volume managers (LVMs), such as Veritas Volume Manager, ASM, or native LVMs.
  - Typically, a disk group contains up to eight LUNs.
  - You need more than eight LUNs for large-capacity disk groups.
  - Best practice is to make your LUNs a consistent size.

SAN CONSIDERATIONS: DETERMINING THE NUMBER OF REQUIRED LUNS

In a SAN implementation, you must calculate the optimum number of LUNs to place in the disk group that contains the Oracle databases.

To optimize disk writes, the goal of your LUN layout is to increase throughput, using the Parallel Execution feature in the Oracle Database (also known as parallel I/O). Parallel Execution increases the speed of operations by splitting a task into subtasks.

If a SAN environment includes ASM or an LVM, performance improves when you use four to eight LUNs per disk group. (More than eight LUNs may not be as beneficial, but it does not hinder performance.)

Use consistently sized LUNs for ease of management.

Lesson 2

Installing Oracle Databases

 NetApp Confidential 21

LESSON 2: INSTALLING ORACLE DATABASES

Installing an Oracle Database
Step 1 of 4

Plan:

- Which Oracle database version do you want to use?
- Is your version supported by the NetApp data management solutions you want to use?
- For software installation, which components do you want to install, and what are they are licensed for?

INSTALLING AN ORACLE DATABASE: STEP 1 OF 4

The Oracle database version you select depends on the needs of the application.

Verify supportability by NetApp data management solutions you plan to use, for example:

- Snap Creator Framework
- SnapDrive for UNIX
- SnapManager for Oracle (SMO)

Installing an Oracle Database

Step 2 of 4

Prepare to install:

- Assemble the Oracle database software.
- Determine the location and space requirements.
- Determine whether to use a shared or non-shared binary.
- Validate settings for:
  – $ORACLE_BASE
  – $ORACLE_HOME
  – Oracle inventory locations

 NetApp Confidential

INSTALLING AN ORACLE DATABASE: STEP 2 OF 4

Different DBAs use different ways to configure the Unix user account (the “owner” of the Oracle software); these do not matter, from a NetApp perspective.

However, if various users or organizations are managing databases on the same Unix host, using Vservers in the infrastructure can be helpful.

Installing an Oracle Database

Step 3 of 4

Install using either method:

- Oracle Database Configuration Assistant (DBCA):
  - Install X-Windows on the Linux host.
  - Access the GUI with VNC Viewer for X-Windows.
- Silent installation method:
  - Does not require X-Windows
  - Requires knowledge of the installation and how to configure an Oracle response file

INSTALLING AN ORACLE DATABASE: STEP 3 OF 4

You can use one of two methods to install an Oracle database:

- Oracle DBCA is a GUI wizard, which requires you to install the X Window System (or X-Windows, commonly known as X11) on the Linux host. You can access the X-Windows GUI remotely with the VNC Viewer client.
- Most shops use the Oracle silent installation method, which uses a “response” file as input to the process.

Installing an Oracle Database
Step 4 of 4

Validate the installation:

- Validate file systems, mount options, and permissions.
- For FC implementations, validate permissions on devices.
- Validate UNIX user and group configurations.

INSTALLING AN ORACLE DATABASE: STEP 4 OF 4

Possible issues when validating the installation:

- Be sure to use correct NFS mount option settings.
- Use ASM to ensure proper permissions for MPIO devices in a SAN environment.
- Use proper design options for FlexVol volumes that are dedicated to Oracle Database files.
- Use separate volumes for database components so that you can back up and restore individual databases.
- With ASM, to optimize NetApp Snapshot copy technology, do not place multiple databases within the same disk groups. (For instance, if you put three databases in one disk group made up of eight LUNs, restoring one database affects the others.)

Key Recommendations

- Comply with the recommendations about NetApp NFS mount options for NFS databases.
- Comply with the recommendations about Oracle-defined prerequisites for OS, kernel, and RPMs.
- Deduplication is not recommended for Oracle databases.
- Set specific TCP parameters on the NetApp controller.
- Verify specific init.ora Oracle parameters:
  - Filesystemoptions_io
  - db_multi_block_read_count

KEY RECOMMENDATIONS

Installing an Oracle Database
Class Exercise Environment

For the database installation lab in this course:

- You use the storage design that was created in the previous lab.
- The database is an NFS database.
- You log in to your UNIX node from your Windows jump host.
- You follow the lab guide for an Oracle DBCA installation.

INSTALLING AN ORACLE DATABASE: CLASS EXERCISE ENVIRONMENT

In this lab you will check the host prerequisites, validate several kernel parameters and the NetApp settings. These settings should be already defined although the lab will show you what and where to check. You will create the necessary entries in the /etc/fstab for the correct mount options. You can use the KB article that was mentioned earlier or you can review the entries already in the /etc/fstab for the demo database within the lab. This lab will also use the Oracle DBCA tool to build the database. But as an option; there is a section in the lab guide that will allow you to use the silent install. If you have any issues with the silent install; then revert back to the DBCA installation process. You will use the kernel NFS initially, and then in a later module, convert the database to use Oracle's dNFS.

Module Summary

Now that you have completed this module, you should be able to:

- Describe requirements and prerequisites for installing an Oracle server and databases
- Install an Oracle database

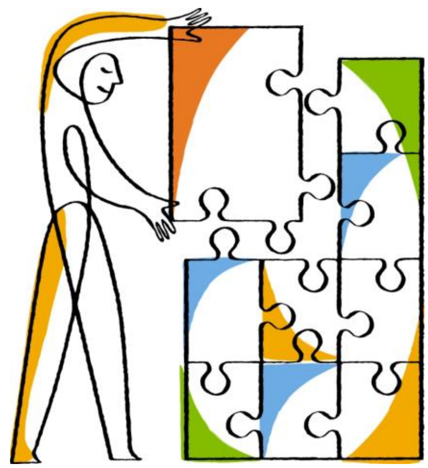
MODULE SUMMARY

Now that you have completed this module, you should be able to:

- Describe requirements and prerequisites for installing an Oracle server and databases
- Install an Oracle database

NetApp

Learning Activity Questions



 NetApp Confidential 29

LEARNING ACTIVITY QUESTIONS

Learning Activity: Questions

1. Which two statements about storage prerequisites for implementing Oracle on NetApp storage are true? (Choose two.)
   a. Oracle binaries require approximately 100 GB of storage for an installation.
   b. Volume Snapshot reserve space is not required for an installation.
   c. To install Oracle software using NFS, specific mount options are required.
   d. Each node of a RAC cluster must be the same version of Oracle software.

LEARNING ACTIVITY: QUESTIONS

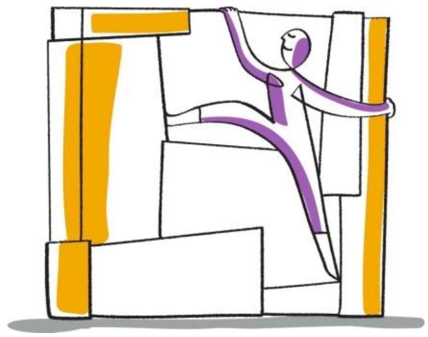
Learning Activity: Questions

2. After you install an Oracle database, which three components of the install should you validate? (Choose three.)
   a. Validate file systems, mount options, and permissions.
   b. For FC implementations, validate permissions on devices.
   c. Validate that clustered Data ONTAP qtree export permissions are correct.
   d. Validate the UNIX user and group configurations.

LEARNING ACTIVITY: QUESTIONS

Exercise

Time Estimate: 45 Minutes



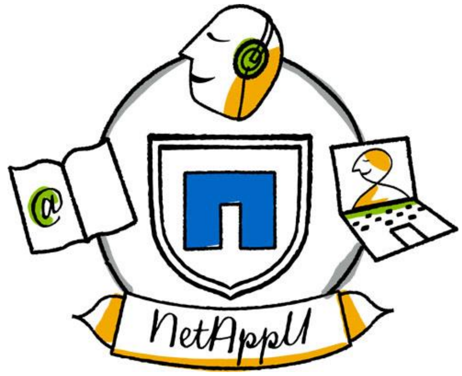
 NetApp Confidential

EXERCISE

Please refer to your exercise guide.

Module 5

Oracle dNFS and NetApp Storage



 NetApp Confidential 1

MODULE 5: ORACLE DNFS AND NETAPP STORAGE

Module Objectives

After this module, you should be able to do the following:

- Enable direct NFS (dNFS) for an Oracle database
- Explain what dNFS is and how it differs from kernel Network File Systems (kNFS)
- List the database objects that show you the dNFS database traffic
- Configure multiple paths for dNFS

MODULE OBJECTIVES

Lesson 1

dNFS Scalability and Performance

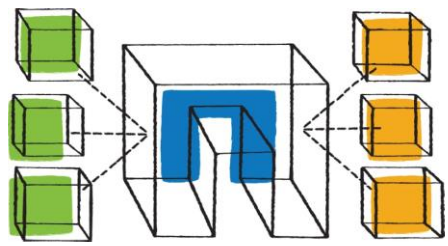
 NetApp Confidential 3

LESSON 1: DNFS SCALABILITY AND PERFORMANCE

Databases on NFS
Benefits

- Are simple and quick to deploy
- Provide low-cost infrastructure and low TCO
- Increase flexibility, to enable you to share and virtualize

NOTE: NFS is the industry standard).

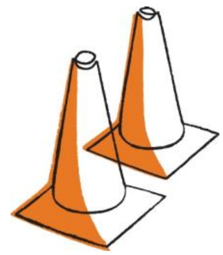


 NetApp Confidential 4

DATABASES ON NFS: BENEFITS

Databases on NFS
Challenges

- The NFS client's demand on CPU resources
- Inconsistent performance and configuration between platforms
- The scalability of the NFS client
- The requirement of a complex network configuration for implementing high availability and increased bandwidth



 NetApp Confidential

DATABASES ON NFS: CHALLENGES

- CPU resources can be strained, depending on the configuration.
- The I/O patterns of a database differ from the patterns of most standard OS file operations. The database I/O is not accommodated well by most OS NFS kernels.
- The inconsistency between platforms results from the way that the NFS clients manage typical I/O caching.

Databases on NFS
Challenges

One TCP connection per storage controller from the database server

```
[root@sunx4600-sv101 ~]# netstat -tpn
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address               Foreign Address             State       PID/Program name
tcp        0      0 172.17.38.230:33731         172.17.38.230:1521          ESTABLISHED 12929/ora_pmon_DB1
tcp        0    284 172.17.38.230:22            10.55.73.211:2516           ESTABLISHED 12672/2
tcp        0      0 172.17.38.230:1521          172.17.38.230:33731         ESTABLISHED 7613/tnslsnr
tcp        0      0 172.17.38.230:807           172.17.38.221:2049          ESTABLISHED -
tcp        0      0 172.17.38.230:702           172.17.38.221:4045          ESTABLISHED -
[root@sunx4600-sv101 ~]#
```


DATABASES ON NFS: CHALLENGES

With kNFS, there is one TCP connection per storage controller per host.

Oracle dNFS

- Integrates NFS client functionality in the Oracle relational database management system (RDBMS) server
- Was introduced in the Oracle Database 11g RDBMS
- Supports NFSv3 standards

 NetApp Confidential 7

ORACLE DNFS

Currently dNFS does not support NFSv4 or NFSv4.1. It will be part of the support plan for Oracle in the near future.

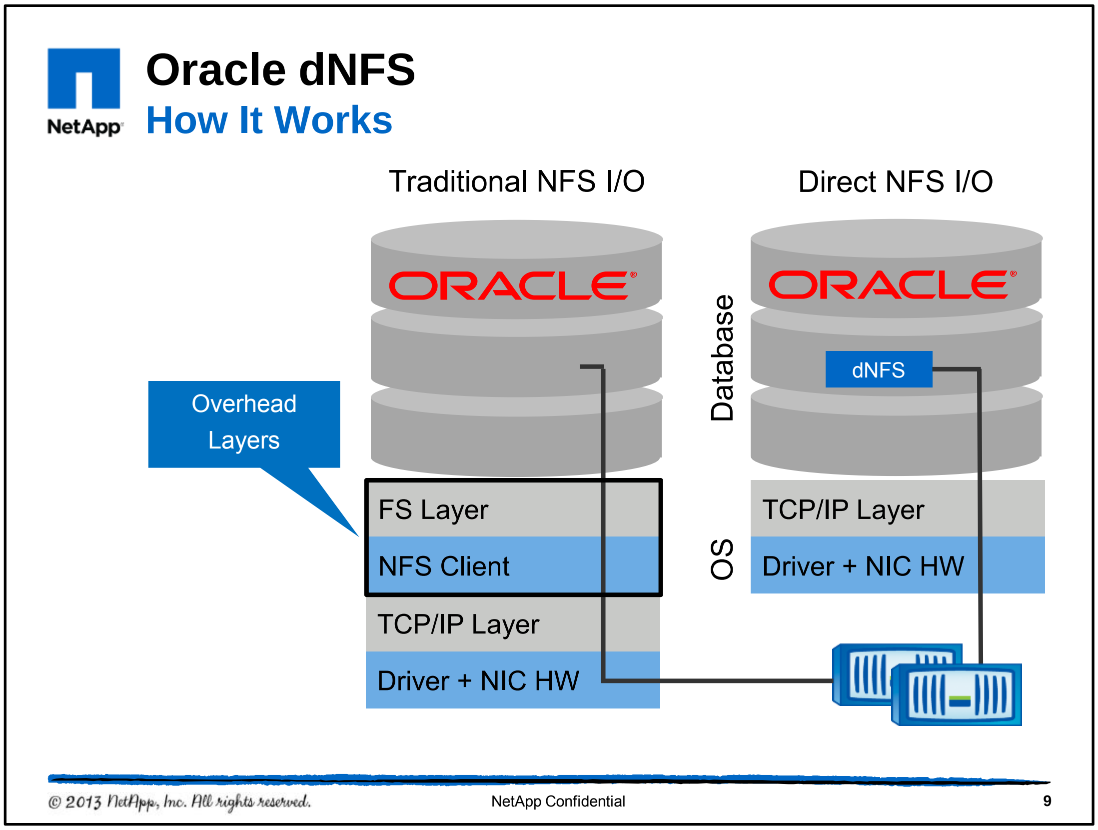
Oracle dNFS
Advantages

- Eliminates the use of the NFS client
- Enables you to access NFS files directly from within Oracle
- Provides direct I/O and asynchronous I/O by default
- Optimizes the NFS code path and mount point options
- Supports lower I/O latencies
- Provides consistent implementation and configuration across platforms

 NetApp Confidential 8

ORACLE DNFS: ADVANTAGES

- dNFS provides consistent NFS performance across multiple platforms.
- dNFS kernel is modified to enable better cache and I/O patterns.p
- dNFS is embedded within the RDBMS engine and should result in fewer attribute calls for the NFS stack.



ORACLE DNFS: HOW IT WORKS

Notice in the diagram that the file system (FS) and NFS client layers of the stack are bypassed.

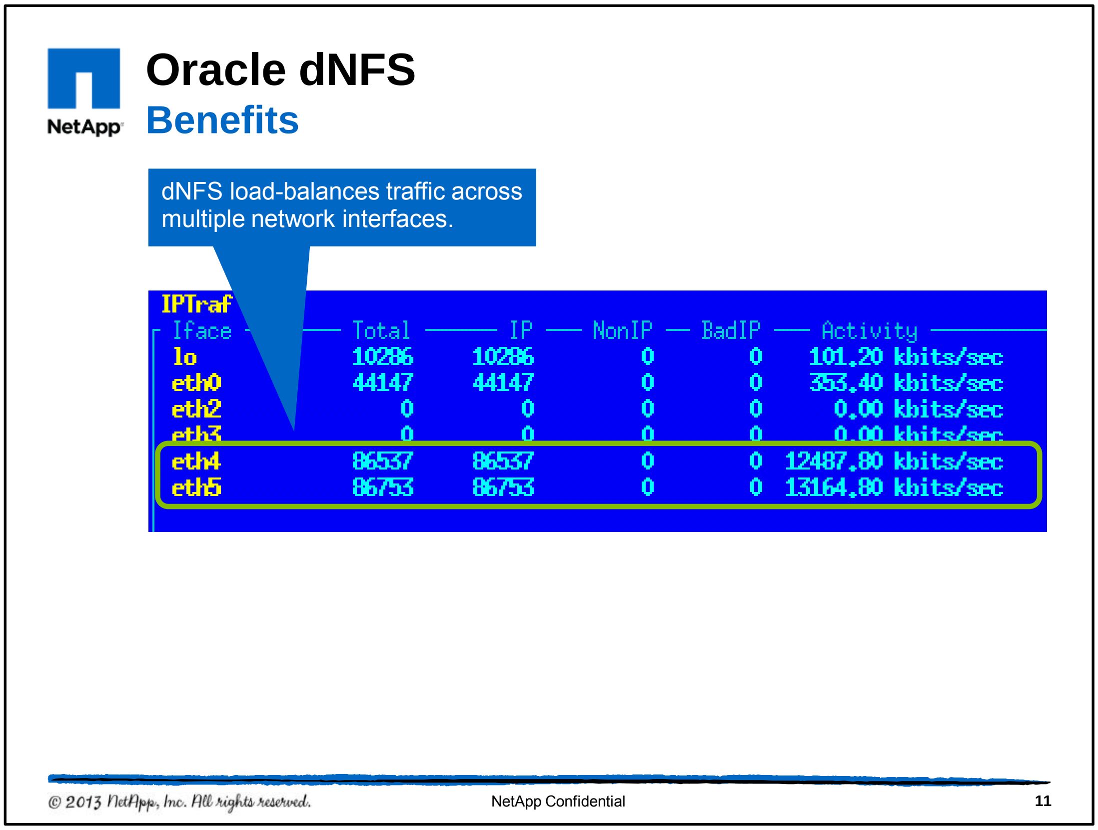
NIC HW = Network Interface Card hardware

Oracle dNFS
What It Provides

Oracle dNFS provides scalability, load balancing, and high availability, with several features:

- Supports up to four physical paths
- Load-balances I/O across all paths
- Scales linearly with paths
- Guarantees path failover in the case of multiple paths
- Increases I/O parallelism
- Lowers I/O latency, compared to kNFS

ORACLE DNFS: WHAT IT PROVIDES



ORACLE DNFS: BENEFITS

The output from the iptraf command shows that dNFS has load-balanced over the eth4 and eth5 interfaces.

Benefits of Oracle dNFS:

- Oracle dNFS can deliver performance and latency similar to, if not better than, that of an FC environment
- More important to a customer, Oracle dNFS is not a licensed product like other components of the Oracle software package.

NetApp

Oracle dNFS

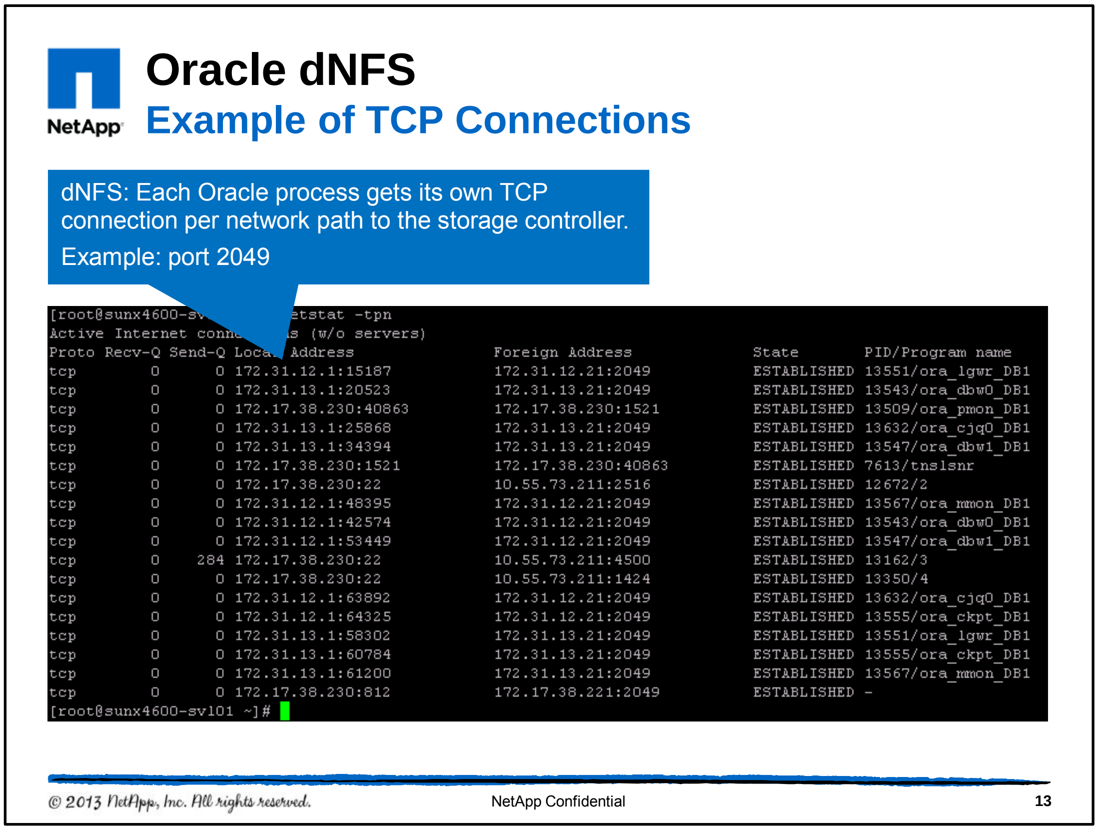
Additional Benefits

- Delivers performance and throughput better than FC SAN does
- Further simplifies Oracle database deployment on NAS storage
- Is a free option in the Oracle Database 11g RDBMS

 NetApp Confidential 12

ORACLE DNFS: ADDITIONAL BENEFITS

Several tests and technical reports compare a dNFS environment to an FC environment. Results show that you obtain the performance gain and manageability of NFS within the NetApp controller when you implement Oracle on NetApp storage with Oracle dNFS enabled.



ORACLE DNFS: EXAMPLE OF TCP CONNECTIONS

Notice that dNFS opens a connection to each IP address on the controller for each Oracle process. With kNFS, only one connection to the IP address of the NetApp controller interface opens. The multiple connections that dNFS provides enable Oracle dNFS to improve scalability and performance.

Configuring dNFS
Enabling dNFS

- Before Oracle Database 11gR2:
  – `cd $ORACLE_HOME/lib`
  – `rm libodm11.so` (`libodm11.so` is a soft link to `libodmd11.so`.)
  – `ln –s libnfsodm11.so libodm11.so`

  NOTE: `libodmd11.so` is for kNFS; `libnfsodm11.so` is for dNFS.

- In Oracle Database 11gR2:
  – `cd $ORACLE_HOME/rdbms/lib`
  – `make -f ins_rdbms.mk dnfs_on`

  NOTE: Use `dnfs_off` to disable dNFS.

CONFIGURING DNFS: ENABLING DNFS

Enabling dNFS for your Oracle software installation:

- Before you enable dNFS, you must shut down any database that uses the $ORACLE_HOME installation.
- The process to enable dNFS requires several minutes.

Configuring dNFS
Mount Points and the Oranfstab File

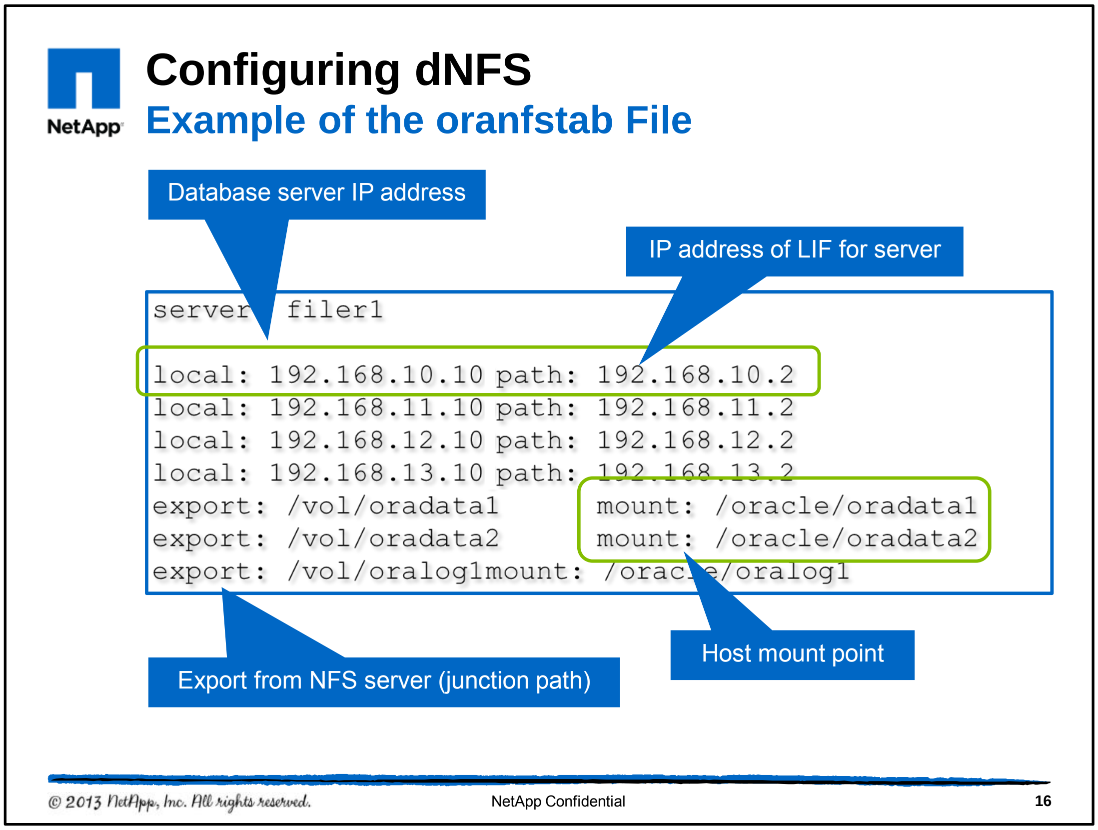
- Configure NFS mount points for datafile volumes as per normal guidelines.
- dNFS verifies mount entries in/etc/mtab.
- The oranfstab file is needed only if multiple paths are used.
- If you use multiple network paths, use separate subnets for optimal load balancing and scalability.

CONFIGURING DNFS: MOUNT POINTS AND THE ORANFSTAB FILE

dNFS uses a configuration file, the oranfstab file. The file is required when you use multiple subnets and paths for access to the storage.

If the server includes only one subnet environment, you do not need the Oracle oranfstab file.

You must verify that the NFS mount options are appropriately configured in /etc/fstab, when you use dNFS.



CONFIGURING DNFS: EXAMPLE OF THE ORANFSTAB FILE

The sections of the oranfstab file and the definition of each component are as follows:

- The NFS server: The NetApp Vserver IP address is used in the server:filer1 stanza.
- The local:192.168.10.10 portion of the file is the network path on the database server.
- The path:192.168.10.2 entry is the IP address of the storage system.
- The logical interface (LIF) IP address is used in an NFS mount statement or /etc/fstab entry.
- The oranfstab file entry, export: /vol/oradata1, exports the NFS share from the storage system and is the junction path that is used to export the NFS share.
- The mount command, mount: /oracle/oradata1, mounts the NFS share on the database server.

Configuring dNFS

With Multiple Network Paths

- In the case of multiple network paths, use separate subnets for optimal load balancing and scalability.
- If multiple network paths are in the same subnet, load balancing might not work effectively.
- The Linux kernel defaults to the first route in the route table.

CONFIGURING DNFS: WITH MULTIPLE NETWORK PATHS

Configuring dNFS
Additional Points

- The automounter and autofs are not supported. The volumes must be mounted explicitly as NFS volumes and be visible through `/etc/mtab`.
- NFSv4 is currently not supported by dNFS.
- For reference, dNFS searches for mount entries in the following order:
  – `$ORACLE_HOME/dbs/oranfstab`
  – `etc/oranfstab`
  – `etc/mtab`

 NetApp Confidential 18

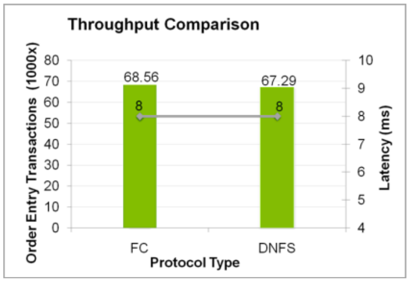
CONFIGURING DNFS: ADDITIONAL POINTS

Be sure that you mount the file systems before you start the database, when you use dNFS/.

- Upon initiation, when dNFS is searching for the mount information for file systems that are used for the database, dNFS looks first for the oranfstab file in the $ORACLE_HOME/dbs directory.
- If the file is not in the expected location, dNFS looks in the /etc directory.
- If dNFS does not find the oranfstab file, it uses what is currently mounted on the OS via the /etc/mtab file.

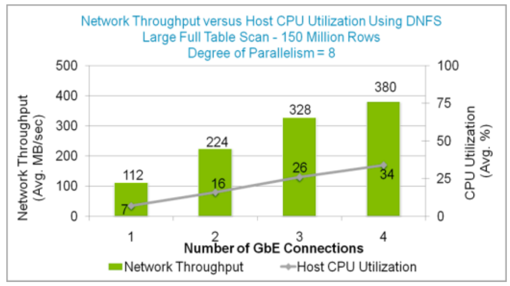
NetApp

Throughput and CPU Use



FC and dNFS
Throughput and Latency Comparison

Throughput and CPU Use:
Scaling from One to Four NICs



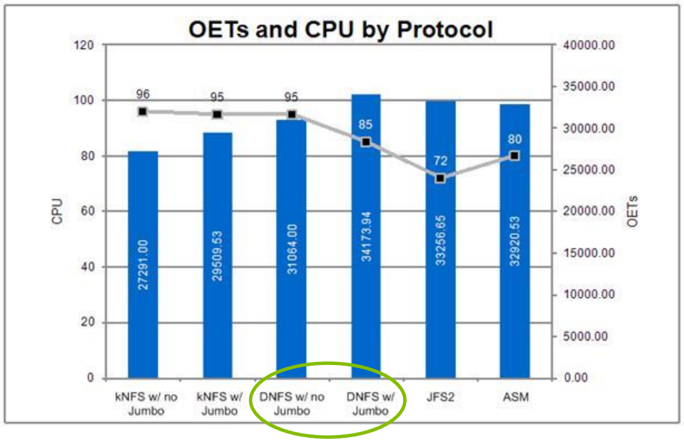
Charts are courtesy of Oracle.

 NetApp Confidential 19

THROUGHPUT AND CPU USE

These diagrams compare an FC protocol environment to dNFS and indicate how dNFS can scale when there are multiple paths.

Comparison to Other Protocols



Throughput and CPU Use: OLTP Transactions
http://media.netapp.com/documents/tr-3871.pdf

 NetApp Confidential

COMPARISON TO OTHER PROTOCOLS

OET = Order Entry Transaction

NetApp

Lesson 2

More About dNFS

 NetApp Confidential 21

LESSON2: MORE ABOUT DNFS

dNFS with Clustered Data ONTAP
Ownership and Permissions

Ensure that ownership and permission on the root volume or junction path are set correctly to enable access for the Oracle user ID (UID) or group ID (GID).

A mount error might occur with incorrect permission on the volume path.

```
Direct NFS: warn could not mount /fra/fra04 on
  svr core-br-4-data2 via dNFS
Direct NFS: warn could not get mount handle from
  svr core-br-4-data2 nfsport 2049 mntport 635
```

 NetApp Confidential 22

DNFS WITH CLUSTERED DATA ONTAP: OWNERSHIP AND PERMISSIONS

If Oracle receives a "permission denied" message from the NFS server, it places an error message (see example in slide) in an Oracle-generated trace file.

To diagnose:

- Examine the export policy.
- If still unresolved, examine the permissions on the root volume of the Vserver.
- If necessary, you can also examine the junction path of the NFS share.

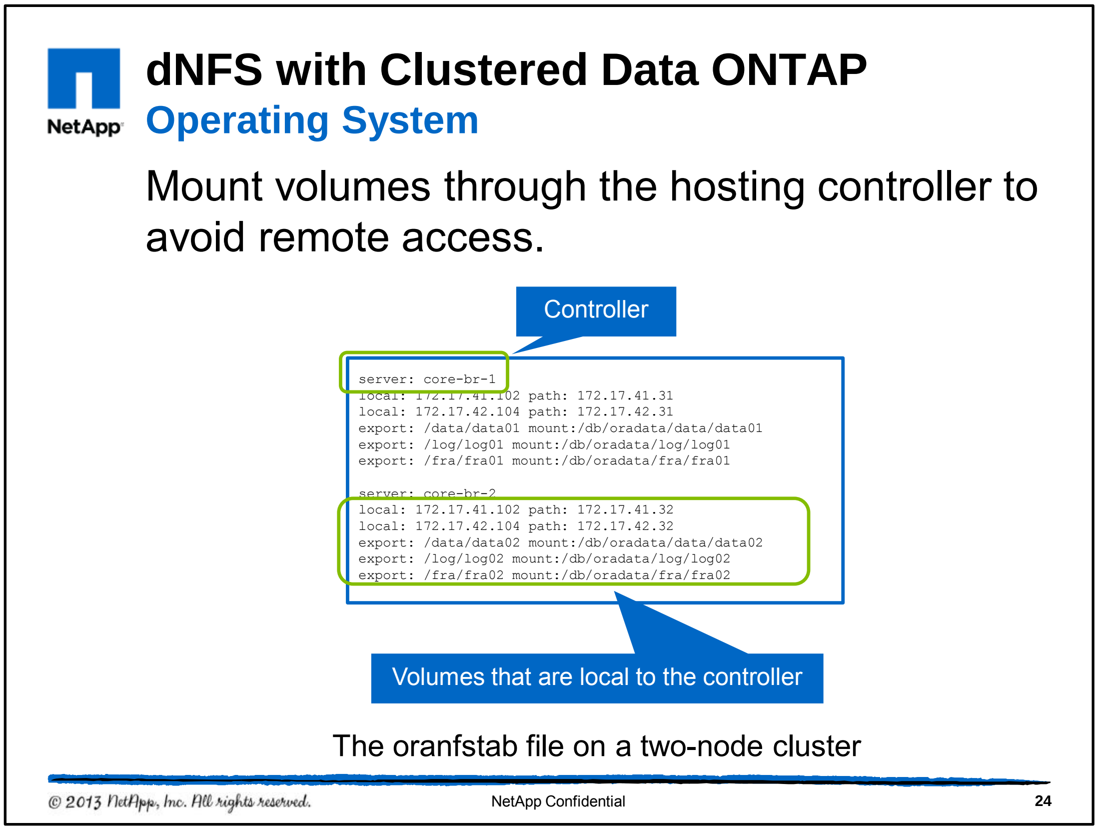
dNFS with Clustered Data ONTAP
Setting Permissions

Set the permission either way:

- Use `volume modify -vserver vs1 -volume root_vol –user <user> -group <group>`.
- Set the appropriate read/write permission on the root junction.

DNFS WITH CLUSTERED DATA ONTAP: SETTING PERMISSIONS

This clustered Data ONTAP command helps you resolve error messages about denied permission.



DNFS WITH CLUSTERED DATA ONTAP: OPERATING SYSTEM

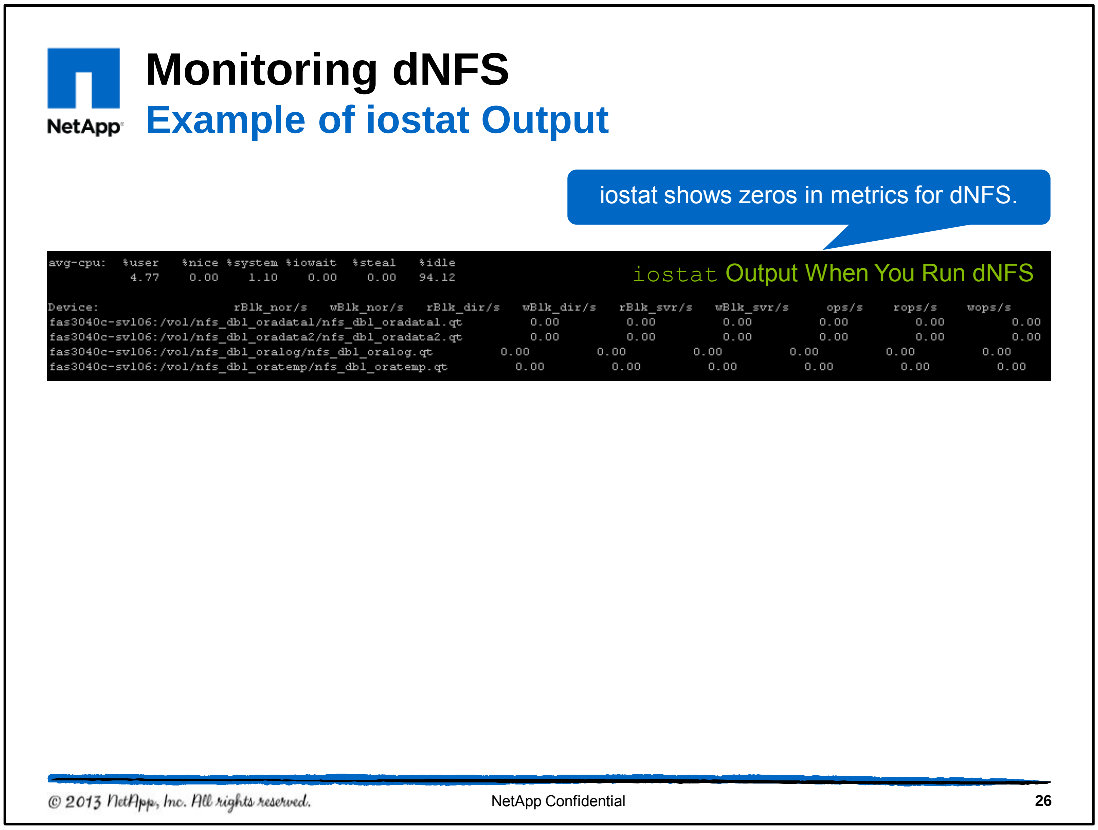
This example of an oranfstab file shows a configuration that you can use to avoid remote access of data. This configuration reduces network traffic across the cluster interconnect.

Monitoring dNFS
isostat

- iostat does not report dNFS traffic. (iostat reports statistics only on NFS mount points.)
- Use a combination of options:
  – Query v$dnfs_stats view
  – iptraf or dstat on database servers
  – sysstat on NetApp storage systems

 NetApp Confidential 25

MONITORING DNFS: ISOSTAT



MONITORING DNFS: EXAMPLE OF IOSTAT OUTPUT

Notice that, when dNFS is used, the output displays zeros. Zeroes are shown because the NFS traffic is managed by dNFS.

dNFS v$ Views

v$dnfs_servers

v$dnfs_servers displays entries for the volumes that are mounted through dNFS (per volume server) with the maximum wsize and rsize.

```
SQL> select id, svrname, dirname, mntport, nfsport, wtmax, rtmax from v$dnfs_servers;

 ID SVRNAME         DIRNAME                                      MNTPORT NFSPORT  WTMAX  RTMAX
--- --------------- -------------------------------------------- ------- ------- ------ ------
  1 fas3040c-sv106  /vol/nfs_db1_oratemp/nfs_db1_oratemp.qt         4046    2049  65536  65536
  2 fas3040c-sv106  /vol/nfs_db1_oradata1/nfs_db1_oradata1.qt       4046    2049  65536  65536
  3 fas3040c-sv106  /vol/nfs_db1_oradata2/nfs_db1_oradata2.qt       4046    2049  65536  65536
  4 fas3040c-sv106  /vol/nfs_db1_oralog/nfs_db1_oralog.qt           4046    2049  65536  65536
```

 NetApp Confidential

DNFS V$ VIEWS: V$DNFS_SERVERS

The v$dnfs_servers database object shows you which NFS servers are being used for the database. Here you can see the NetApp FAS3040 storage system mapped to the Oracle database. You can also see the NFS mounts and port information.

dNFS v$ Views
v$dnfs_files

v$dnfs_files displays all the files that are currently open through dNFS by Oracle processes (CKPT, DBW0, and LGWR).

```
SQL> select filename, pid, spid, pname, username from v$dnfs_files, v$process where pnum=pid;

FILENAME                                                      PID SPID   PNAME USERNAME
------------------------------------------------------------ ----- ------ ----- --------
/oracle/oratemp/DB1/controlfile/o1_mf_793plkjo_.ctl           13 13555  CKPT  oracle
/oracle/oradata1/DB1/datafile/o1_mf_system_793plt6z_.dbf      10 13543  DBW0  oracle
/oracle/oradata1/DB1/datafile/o1_mf_sysaux_793pmjq8_.dbf      10 13543  DBW0  oracle
/oracle/oradata1/DB1/datafile/o1_mf_undotbs1_793pn6c1_.dbf    10 13543  DBW0  oracle
/oracle/oradata1/DB1/datafile/o1_mf_users_793pntvr_.dbf       10 13543  DBW0  oracle
/oracle/oradata2/DB1/soe.dbf                                  10 13543  DBW0  oracle
/oracle/oratemp/temp01.dbf                                    10 13543  DBW0  oracle
/oracle/oralog/DB1/onlinelog/o1_mf_1_793plkr8_.log            12 13551  LGWR  oracle
/oracle/oralog/DB1/onlinelog/o1_mf_2_793plndw_.log            12 13551  LGWR  oracle
/oracle/oralog/DB1/onlinelog/o1_mf_3_793plq2x_.log            12 13551  LGWR  oracle

10 rows selected.
```

 NetApp Confidential

DNFS V$ VIEWS: V$DNFS_FILES

dNFS v$ Views
v$dnfs_channels

v$dnfs_channels displays the open network connections to NFS servers that are created for Oracle processes.

```
SQL> select pnum, pname, svrname, svr_id, local, path, ch_id, sends, recvs, pings from v$
dnfs_channels, v$process where pnum=pid;

 PNUM PNAME SVRNAME          SVR_ID LOCAL        PATH         CH_ID SENDS RECVS PINGS
----- ----- ---------------- ------ ------------ ------------ ----- ----- ----- -----
    7 DBRM  fas3040c-sv106        1 172.31.12.1  172.31.12.21     0     0     0     0
    7 DBRM  fas3040c-sv106        1 172.31.13.1  172.31.13.21     1     0     0     0
   10 DBW0  fas3040c-sv106        1 172.31.12.1  172.31.12.21     0     3     6     0
   10 DBW0  fas3040c-sv106        1 172.31.13.1  172.31.13.21     1     3     6     0
   11 DBW1  fas3040c-sv106        1 172.31.12.1  172.31.12.21     0     2     4     0
   11 DBW1  fas3040c-sv106        1 172.31.13.1  172.31.13.21     1     2     4     0
   12 LGWR  fas3040c-sv106        1 172.31.12.1  172.31.12.21     0     3     6     0
   12 LGWR  fas3040c-sv106        1 172.31.13.1  172.31.13.21     1     4     6     0
   13 CKPT  fas3040c-sv106        1 172.31.12.1  172.31.12.21     0     3     8     0
   13 CKPT  fas3040c-sv106        1 172.31.13.1  172.31.13.21     1     4    10     0
   14 SMON  fas3040c-sv106        1 172.31.12.1  172.31.12.21     0     0     0     0
```


DNFS V$ VIEWS: V$DNFS_CHANNELS

dNFS v$ Views
v$dnfs_stats

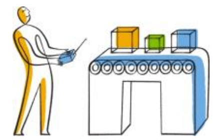
v$dnfs_stats displays the statistics for all NFS read and write operations that are performed by Oracle processes.

```
SQL> select pid, spid, pname, username, program, nfs_read, nfs_write from v$dnfs_sta
ts, v$process where pnum=pid order by (nfs_write + nfs_read) desc;

  PID SPID   PNAME USERNAME PROGRAM                            NFS_READ NFS_WRITE
----- ------ ----- -------- ---------------------------------- --------- ---------
   12 9610   LGWR  oracle   oracle@sunx4600-sv101 (LGWR)            1064   3813463
   10 9602   DBW0  oracle   oracle@sunx4600-sv101 (DBW0)              28   2806773
   11 9606   DBW1  oracle   oracle@sunx4600-sv101 (DBW1)               0   2806180
   13 9614   CKPT  oracle   oracle@sunx4600-sv101 (CKPT)           10446      6868
  159 18723        oracle   oracle@sunx4600-sv101                  12959         0
  191 19099        oracle   oracle@sunx4600-sv101                  12885         0
  179 18911        oracle   oracle@sunx4600-sv101                  12832         0
```


DNFS V$ VIEWS: V$DNFS_STATS

The v$dnfs_stats database object enables you to identify the process that is doing the most I/O in your database.

Tuning Tips
Database Server (Client)



- Increase size of the TCP Receive window:
  - `net.core.rmem_default=262144`
  - `net.core.rmem_max=4194304`
- Increase the size of the TCP Send window:
  - `net.core.wmem_default=262144`
  - `net.core.wmem_max=4194304`
- Set tcp_window_scaling to support large TCP windows:

  `tcp_window_scaling=1`

TUNING TIPS: DATABASE SERVER (CLIENT)

Tuning Tips
Data ONTAP Operating System

- Increase the size of the TCP Receive window for NFS:

  `nfs.tcp.recvwindowsize=262144`

- Set the size of the TCP Transfer window:

  `nfs.tcp.xfersize=65536`

TUNING TIPS: DATA ONTAP OPERATING SYSTEM

Tuning Tips
Hardware Configuration

Leverage the interfaces from different Peripheral Component Interconnect (PCI) buses, when you deploy multiple gigabit Ethernet (GbE) interfaces.

TUNING TIPS: HARDWARE CONFIGURATION

The use of different PCI buses helps avoid the bottleneck that the use of one PCI bus can create.

Debugging dNFS
Event Trace

Set event trace:

```
ALTER SYSTEM SET event='19392 trace name context forever,
level 8','19394 trace name context forever, level 31','19396
trace name context forever, level 2';
```

Or set event trace in the init.ora file:

Event trace numbers are related to dNFS.

```
*.event=‘19392 trace name context forever, level 8’ # kgnfs
*.event=‘19394 trace name context forever, level 31’ # skgnfs
*.event=‘19396 trace name context forever, level 2’ # kgodm
```


DEBUGGING DNFS: EVENT TRACE

Oracle has defined some events that you can use to obtain trace files.

Debugging dNFS
Detecting Mount Issues

- Event trace can help you detect mount issues, as shown in the following example.
- You can use network tools such as Wireshark to capture the packet trace.

MNT FAIL shows in trace file.

```
netapp_ckpt_12975.trc: [1619394935] kgnfs_mntrsp:8232:
KGNFS_NFSPROC3_MNT FAIL 13
```


DEBUGGING DNFS: DETECTING MOUNT ISSUES

Typically, only experienced Oracle support engineers can accurately interpret trace files.

However, trace files sometimes show obvious conditions, such as permissions errors or failed mounts.

To use event trace output to debug issues:

- Start a database that uses dNFS.
- If your database does not start:
  1. Open any of the Oracle trace files or the Oracle alert log.
  2. Search for the text "kgnfs."

dNFS-Related Oracle Patches

- Check Oracle's support site.
- Patches for dNFS and releases of Oracle evolve.

 NetApp Confidential 36

DNFS-RELATED ORACLE PATCHES

Key Takeaways

Oracle dNFS:

- Increases throughput and scalability
- Improves high availability through failover and load balancing
- Simplifies configuration and provides consistent implementation and performance across platforms

NOTE: The export policy for the Vserver root volume must be set.

KEY TAKEAWAYS

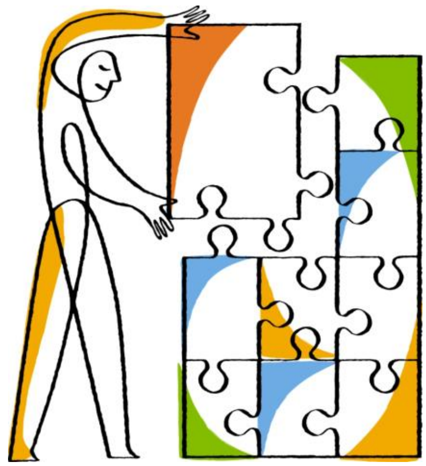
Module Summary

Now that you have completed this module, you should be able to:

- Enable dNFS for an Oracle database
- Explain what dNFS is and how it differs from kNFS
- List the database objects that show you the dNFS database traffic
- Configure multiple paths for dNFS

MODULE SUMMARY

Learning Activity Questions



© 2013 NetApp, Inc. All rights reserved. NetApp Confidential 39

LEARNING ACTIVITY QUESTIONS

Learning Activity: Question

1. Do dNFS volumes need to be mounted first by the OS?

LEARNING ACTIVITY: QUESTION

Assume that you are using clustered Data ONTAP, and you encounter issues with dNFS at startup. The dNFS trace files can help you determine whether there are permission issues and whether the FlexVol volume is available. In the slide example, the FlexVol volume for the database was not mounted to the OS.

Learning Activity: Question

2. When does dNFS mount the volumes?

LEARNING ACTIVITY: QUESTION

The multiple trace files that are available from Oracle can provide you with ideas about issues, when you use dNFS. Trace files can also provide details when Oracle successfully mounts the appropriate FlexVols and file systems.

Learning Activity: Question

3. What happens if dNFS encounters errors the first time that the database is opened?

LEARNING ACTIVITY: QUESTION

It is strongly recommended for you to ensure that your mount options are correct. Use the Netapp KB article to help you. If your configuration fails back to kNFS, it means that you have the proper options configured, and the database should continue to function.

Learning Activity: Question

4. What happens if all dNFS paths are unavailable during the first time that the database is opened?

 NetApp Confidential 43

LEARNING ACTIVITY: QUESTION

The control file is one of the first items that Oracle reads at database startup. If the paths to the storage are not up, or if they are incorrect, Oracle times out and fails to start.
What happens if all dNFS paths are unavailable during the first time that the database is opened?
What happens if all dNFS network paths are down during database startup?
The answer to both questions is still the same; the database does not start.

Learning Activity: Question

5. What is the memory consumption of dNFS?

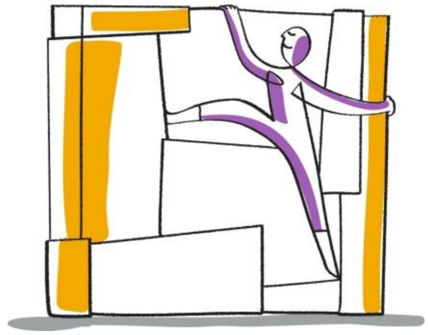
 NetApp Confidential 44

LEARNING ACTIVITY: QUESTION

There is an Oracle process that is spawned for each network path and for each controller, when you use dNFS. Each process uses approximately 512K of memory. Ensure that your host can handle the additional memory requirements when you use dNFS. Most current servers have more than enough memory for these processes, but be aware of the dNFS memory requirements.

Exercise

Time Estimate: 45 Minutes



 NetApp Confidential 45

EXERCISE

Please refer to your exercise guide.

NetApp

Module 6

Using Oracle ASM
with NetApp Storage

 NetApp Confidential 1

MODULE 6: USING ORACLE ASM WITH NETAPP STORAGE

Module Objectives

After this module, you should be able to:

- Define Automatic Storage Management (ASM) for an Oracle database on NetApp storage
- Define the Oracle ASM Library (ASMLib)
- Describe how to install and configure ASM and ASMLib to provision and configure storage and LUNs
- Create an ASM database
- Use ASM to create an application database

 NetApp Confidential 2

MODULE OBJECTIVES

NetApp

Lesson 1

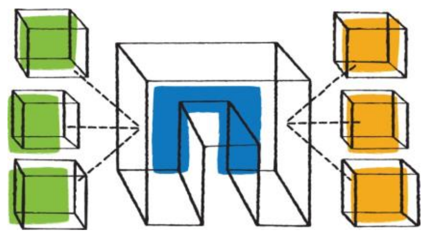
Defining ASM

 NetApp Confidential

LESSON 1: DEFINING ASM

What Is Oracle ASM?

- Is a logical volume manager (LVM) and file system that is built into Oracle
- Provides a cluster file system for Oracle Real Application Clusters (RAC)
- Is usable for RAC and others
- Enables load balancing



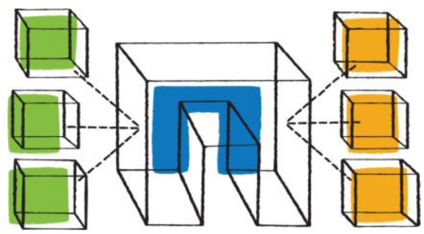
 NetApp Confidential 4

WHAT IS ORACLE ASM?

- Enables multiple nodes of an Oracle RAC cluster to access the same LUNs for a database
- Can be used for single-instance databases and RAC
- Is primarily intended as storage for an Oracle RAC environment
- Offers an alternative to systems such as Veritas Cluster File Systems

Benefits of ASM

- Simplifies the administration of devices and disk groups that are used for an Oracle database
- Is an extension of Oracle Managed Files (OMF)
- Can stripe and mirror



BENEFITS OF ASM

NetApp

ASM Features and Functions

- Manages groups of disks
- Manages disk groups for use by a database
- Provides redundancy within a disk group
- Provides I/O balancing
- Overcomes some of the limitations of clustered file systems

ASM FEATURES AND FUNCTIONS

Characteristics of an ASM Environment

- ASM is an instance that runs on the host.
- One instance exists per host and can serve many databases.
- Each database instance coordinates file access through the ASM instance on the host.
- Data files, SPFILE, redo logs, archive logs, and Oracle Flash Recovery Area (FRA) are managed by ASM.

 NetApp Confidential

CHARACTERISTICS OF AN ASM ENVIRONMENT

There is typically one ASM instance that runs on each host, whether or not you use ASMLib.

Functions *Not* Managed by ASM

- Several functions are not managed by ASM:
  - Binaries
  - Alert logs
  - init.ora
  - Password files
- Some functions can be managed outside of ASM:
  - SPFILE
  - Archive logs

FUNCTIONS NOT MANAGED BY ASM

SPFILE and Archive logs are examples.

Disk Group Redundancy Options

ASM provides these options:

- External redundancy:
  - Redundancy of the storage raid arrays
  - Disk-based redundancy protection that is provided by NetApp RAID-DP technology
- Normal redundancy:
  - Two-way mirroring that is provided by ASM
  - A minimum requirement of two failure groups
- High redundancy:
  - Three-way mirroring that is performed by ASM
  - A minimum requirement of three failure groups

 NetApp Confidential 9

DISK GROUP REDUNDANCY OPTIONS

- External redundancy that is provided by NetApp RAID-DP technology is recommended.
- RAID-DP technology provides data protection against disk failure at the storage layer without doubling or tripling storage requirements.
- Normal or high-redundancy options require additional devices and consume additional disk capacity.

Lesson 2

Defining ASMLib

 NetApp Confidential 10

LESSON 2: DEFINING ASMLIB

What is Oracle ASMLib?

- An optional support library for the Oracle ASM
- A way for an Oracle database that uses ASM to more efficiently access disk groups
- An additional layer that assists with the management and persistence of devices on a Linux host
- Helpful for new users of FC and ASM

WHAT IS ORACLE ASMLIB?

ASMLib Features and Functions

- Provides a method for more efficient management of disk devices that are used for ASM storage
- Assists with device discovery
- Provides naming capability of ASM devices (NOTE: API commands are available.)
- Identifies devices for ASM disk groups regardless of device persistence
- Maintains permissions on the devices after a reboot
- Labels the header of an ASM LUN

ASMLIB FEATURES AND FUNCTIONS

In a Linux environment, ASMLib defines the appropriate device permissions without any udev rules.

ASMLib-Compatible OSs

- Red Hat Enterprise Linux, Oracle Linux (OL), and Oracle Unbreakable Enterprise Kernel (UEK)
  - Available for Red Hat Enterprise Linux 4 and 5
  - Not available for Red Hat Enterprise Linux 6 or OL6 RHCK
  - Kernel module available in OL and UEK
- SUSE Linux Enterprise Server (SLES) OS (for all Linux builds)

ASMLIB-COMPATIBLE OSS

Oracle does not offer the ASMLib Red Hat Package Manager for Red Hat Enterprise Linux 6 or for Oracle Enterprise Linux 6 using the Red Hat Compatible Kernel (RHCK). However, ASMLib is part of the Oracle UEK kernel.

Using ASM without ASMLib

- ASM without ASMLib indicates that the OS does not have ASMLib Red Hat Package Manager.
- Without ASMLib:
  – Take steps to manage the devices.
  – Create udev rules for permissions (important).
  – You have no device naming functionality.
  – Multipath I/O aliases are helpful.

 NetApp Confidential 14

USING ASM WITHOUT ASMLIB

Work with udev rules to ensure the proper permissions of the devices after a reboot. (This should not be a problem, as you have to ensure permissions are correct with ASMLib.)

ASMLib provides some capability of naming the device on the host. The device mapper also provides that capability with the configuration file. You achieve the same result, but you use different mechanisms.

NetApp

Lesson 3

Configuring ASM and ASMLib on Linux Hosts

 NetApp Confidential

LESSON 3: CONFIGURING ASM AND ASMLIB ON LINUX HOSTS

Installing Oracle with ASM and ASMLib

- Installation requires three Red Hat Package Manager builds for Linux.
- Download is based on OS and kernel version.
- See Red Hat Enterprise Linux 5 2.6.18-308.24 (for an example):
  - oracleasm-support-2.1.7-1.el5.x86_64.rpm
  - oracleasmlib-2.0.4-1.el5.x86_64.rpm
  - oracleasm-2.6.18-308.24.1.el5-2.0.5-1.el5.x86_64.rpm
- Verify OS version, kernel, and architecture.

INSTALLING ORACLE WITH ASM AND ASMLIB

The Oracle support site provides the following:

- Prerequisites
- Requirements
- List of Red Hat Package Manager builds
- Step-by-step guide installation guide (for Linux or UNIX server)

The installation of ASM and ASMLib is the same with Data ONTAP operating in 7-Mode and clustered Data ONTAP.

Refer to the Interoperability Matrix Tool (IMT) on the NetApp support site to verify that all components of your environment meet the guidelines that are provided for supportability.

Configuring ASM init.ora Parameters

For each ASM instance:

- `ASM_DISKSTRING` is used to scan for devices that are used by, or available to, ASM.
- `ASM_DISKGROUPS`
  - If no disk groups are defined, this parameter is null.
  - If you created disk groups manually, add them to this parameter.
  - If this parameter is set, the disk groups are mounted at database startup.
- `Filesystem io_options` is not used with `ASM, ASYNCH I/O`.

 NetApp Confidential 17

CONFIGURING ASM INIT.ORA PARAMETERS

Typically, when you define or create an ASM instance, these parameters are dynamically set. They are defined as you build out and create disk groups.

FILESYSTEMIO_OPTIONS parameter:

- It is important to set this parameter properly when you use NFS.
- This parameter is ignored if you use ASM, and ASM uses ASYNCH I/O.
- Ensure that the DISK_ASYNCH_IO parameter is set to True for the ASM instance.
- ASM inherently performs Asynch I/O, regardless of the FILE SYSETMIO_OPTIONS parameter.

ASM with ASMLib Scans for Disk Devices

- ASMLib examines each disk to determine whether the disk was marked for ASMLib.
- Disks marked for ASMLib are available to ASMLib.
- ASMLib scans disks in the order in which the OS lists the disks.
- Change the scan order by editing the ASMLib configuration file: `/etc/sysconfig/oracleasm`.

 NetApp Confidential 18

ASM WITH ASMLIB SCANS FOR DISK DEVICES

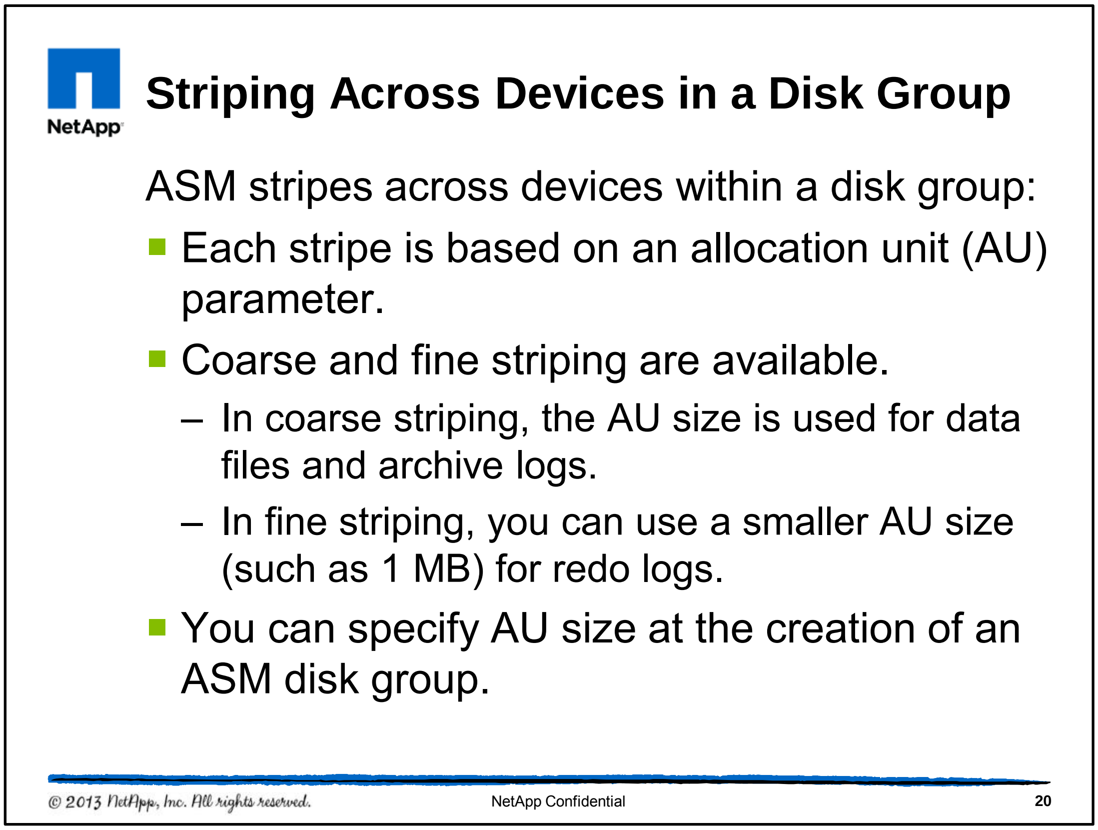
ASMLib considers multipath disks first and chooses only one path. ASM cannot manage multiple devices on Microsoft Multipath I/O (MPIO).

How ASM Recognizes Devices

With or Without ASMLib

- ASM uses the ASM_DISKSTRING parameter to discover devices, for example:
  - /dev/mapper/dm-12
  - /dev/mapper/oradatap1
- If no devices are available, do the following:
  - Check the permissions of the devices.
  - Determine if the devices are discovered on the host.
  - Validate the ASM_DISKSTRING parameter.
  - Use the MPIO device.

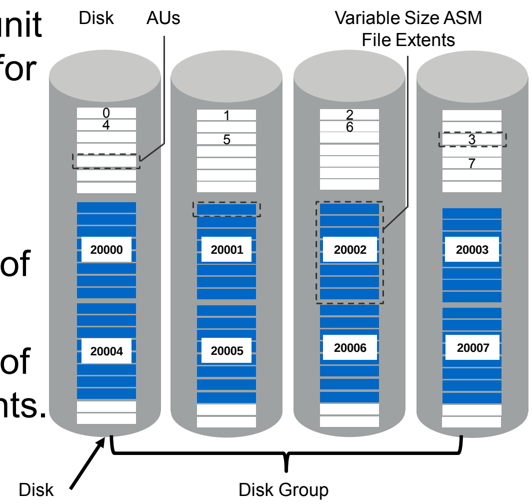
HOW ASM RECOGNIZES DEVICES: WITH OR WITHOUT ASMLIB



STRIPING ACROSS DEVICES IN A DISK GROUP

ASM AU Hierarchy

- The AU is the basic unit of storage allocation for disk groups.
- Every ASM disk is divided into AUs.
- A file extent consists of one or more AUs.
- An ASM file consists of one or more file extents.



NetApp Confidential

ASM AU HIERARCHY

ASM AU Size Values on Oracle Versions

Oracle Server Version	Size in MBs
Oracle Database 11g Most efficient ASM AU size for performance = 64 MB	1 2 4 8 16 32 64
Oracle Database 10g	Default is 1 MB

ASM AU SIZE VALUES ON ORACLE VERSIONS

ASM Deployment

- Oracle 11g Release 2 (11gR2):
  – Requires the installation of the Oracle Grid Infrastructure (Grid)
  – Is available as standalone or RAC
  – Creates a default +ASM instance
- Configure all devices before building ASM.
- SPFILE exists for each ASM instance.
- When you install Grid and build ASM, Grid places the ASM instance SPFILE in the first disk group that is created.

 NetApp Confidential

ASM DEPLOYMENT

By default, Oracle requires a disk group for the placement of the ASM SPFILE. After the Grid Infrastructure is installed, and the ASM instance is running, you can move the SPFILE to a file system. However, you need a disk group for the SPFILE for the initial installation and setup.

ASM Deployment
ASM Files

- Data files for ASM differ somewhat from a regular file system.
- ASM files are Oracle Managed Files (OMF files).
- See examples of different naming conventions.

ASM DEPLOYMENT: ASM FILES

ASM Deployment
Host Prerequisites

- NetApp Host Utilities is installed and available. (Follow the guidelines.)
- The host MPIO (device mapper) is configured.
- Asymmetric Logical Unit Access (ALUA) must be available. ALUA drives the optimized path selection.)

ASM DEPLOYMENT: HOST PREREQUISITES

Querying the ASM AU Size

Use the following commands to query for the AU size of a disk group.

```
column name format A30
column value format A20

SELECT nam.ksppinm NAME, val.KSPPSTVL VALUE
FROM x$ksppi nam, x$ksppsv val
WHERE nam.indx = val.indx and nam.ksppinm like
'%asm_%size'
```


QUERYING THE ASM AU SIZE

ASM Deployment
Storage Overview

- Build your Data ONTAP Vserver.
- Create your logical interfaces (LIFs) at the Vserver:
  – SCSI LIFs for FC ports
  – iSCSI LIFs on network ports
- Create your LUNs, and map them to the appropriate initiator group (igroup).
- Discover the LUNs at the host.

ASM DEPLOYMENT: STORAGE OVERVIEW

ASM Deployment
Storage Overview, Continued

Verify paths with the SANLUN utility:

- Verify that the MPIO (device mapper) paths are correct:
  – The SANLUN utility
  – Multipath utilities
- Partition your LUNs.
- Validate permission of devices:
  – ASMLib
  – udev rules

ASM DEPLOYMENT: STORAGE OVERVIEW, CONTINUED

Lesson 4

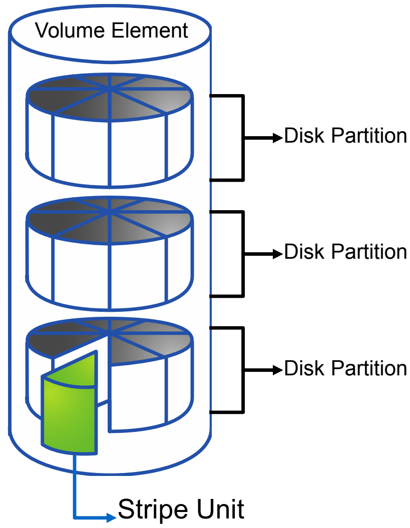
LUN Alignment

 NetApp Confidential

LESSON 4: LUN ALIGNMENT

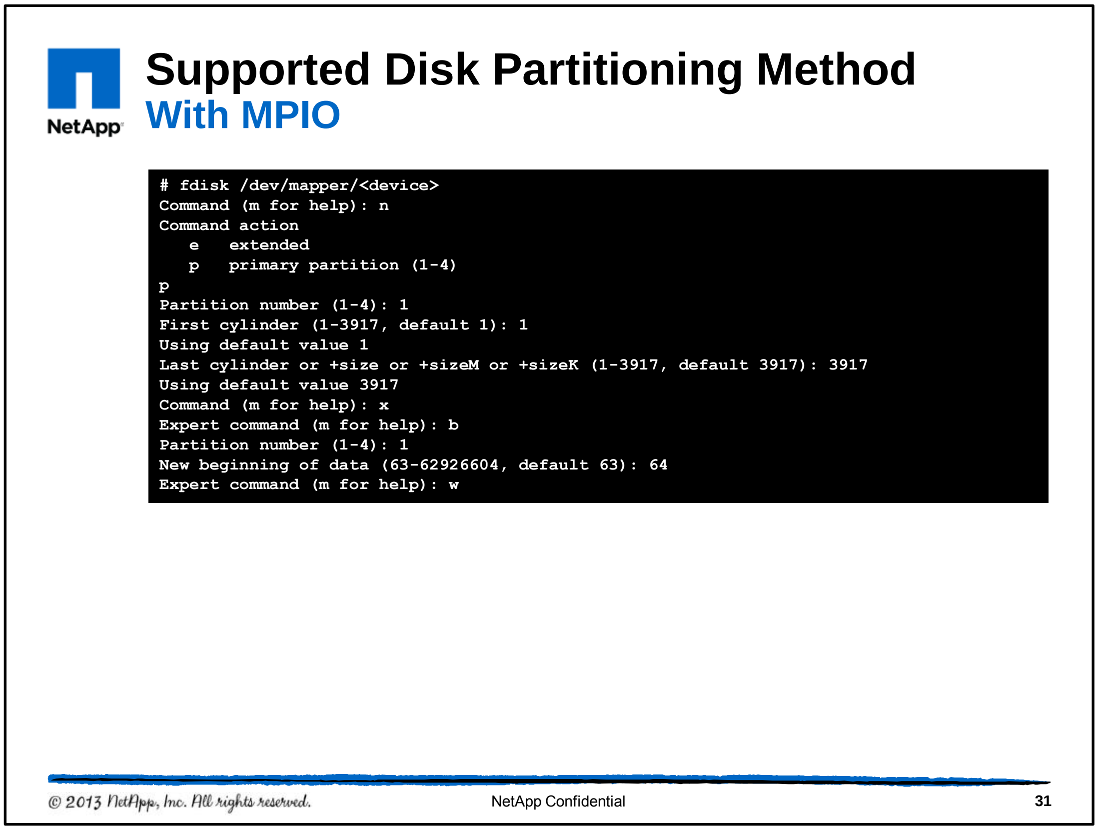
Partitioning Your Disk

- Follow the method that is supported.
- Use the tools that are supported.



PARTITIONING YOUR DISK

It is key to partition your disk correctly. Partitioning that is done incorrectly can introduce substandard performance due to LUN misalignment.



THE SUPPORTED DISK PARTITIONING METHOD: WITH MPIO

Oracle ASM deployment requires devices to be partitioned according to Oracle documentation. This slide shows an example of the partitioning of a LUN. To align the LUN properly, use a starting address that is divisible by 8.

Supported Disk Partitioning Method
With MPIO, Continued

```
# kpartx -a -p p /dev/mapper/<device>
```

 32

THE SUPPORTED DISK PARTITIONING METHOD: WITH MPIO, CONTINUED

After you partition the LUN, tell the Linux host to reread the partition table of the device. The kpartx or partprobe utility does this for you and creates the necessary devices for ASM to use.

Unaligned LUNs

Remember to configure LUN alignment when you partition disks:

- When a LUN is created in the Data ONTAP operating system, a specific amount of space is created in the form of 4-KB blocks.
- The issue of unaligned LUN I/O occurs when the partitioning scheme that is used by the host OS does not match the block boundaries inside the LUN.
- When you partition a LUN, ensure that the sectors are divisible by 8.

UNALIGNED LUNS

LUN Alignment
Example 1

When you partition a LUN, ensure that the sectors are divisible by 8.

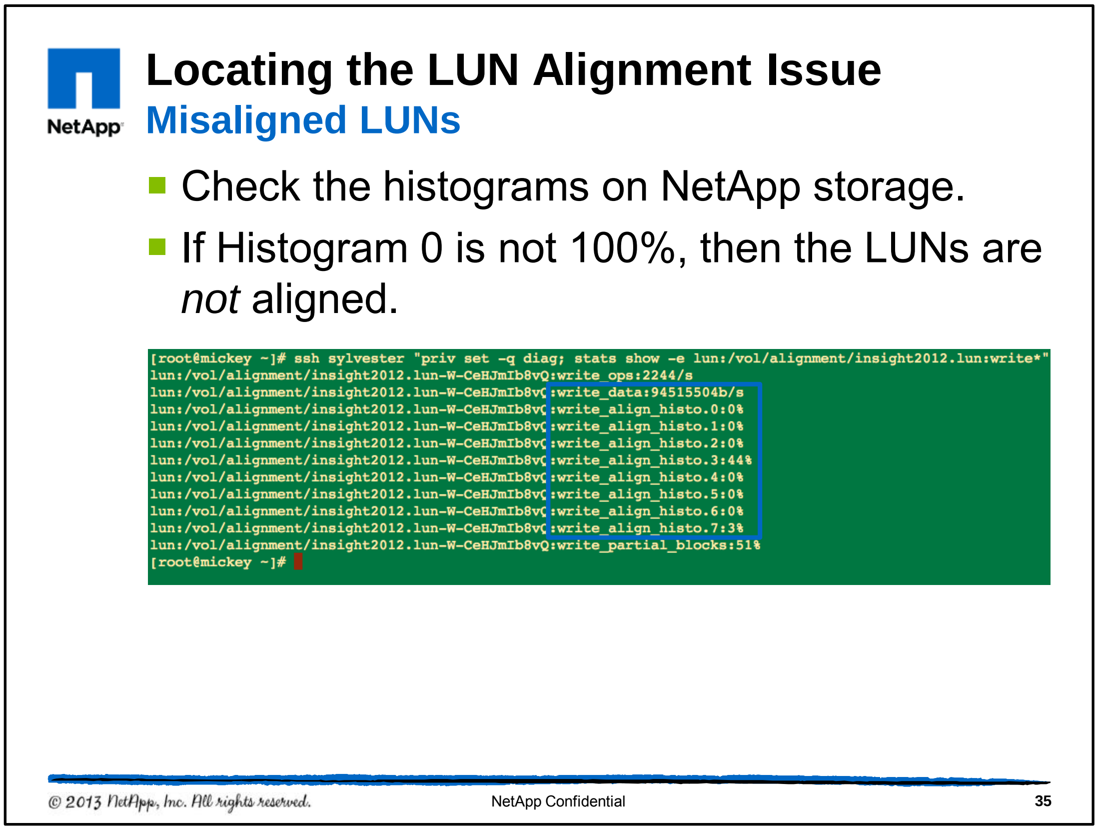
```
neto — Insight 2012 — ssh — 101x11
[root@mickey ~]# fdisk -lu /dev/mapper/360a98000572d4365484a6d4962387651

Disk /dev/mapper/360a98000572d4365484a6d4962387651: 107.3 GB, 107374182400 bytes
255 heads, 63 sectors/track, 13054 cylinders, total 209715200 sectors
Units = sectors of 1 * 512 = 512 bytes

                                        Device Boot      Start         End      Blocks   Id  System
/dev/mapper/360a98000572d4365484a6d4962387651p1             63   209712509   104856223+  83  Linux
[root@mickey ~]#
```

The partition offset is 63.

Is it aligned correctly?

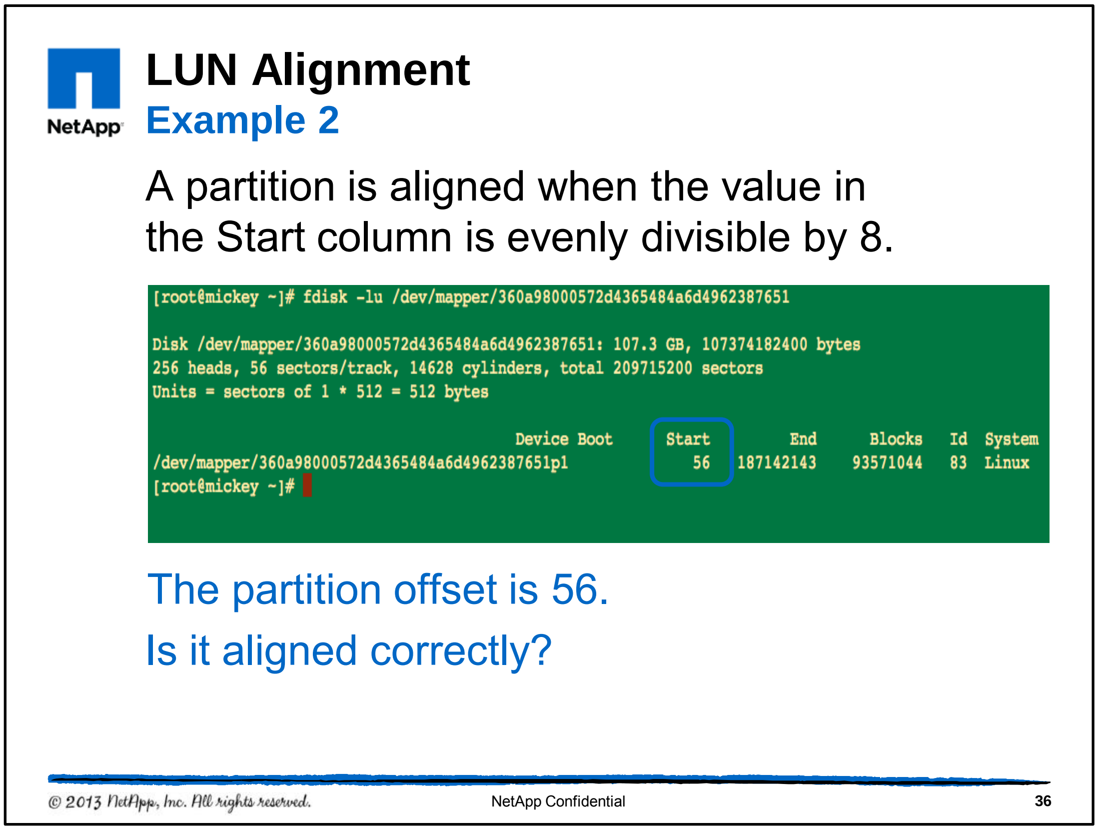
LUN ALIGNMENT: EXAMPLE 1

If you take the default starting sector address when partitioning a LUN, you create a misaligned LUN. Examine the example screen shot and determine if this LUN is properly aligned.



LOCATING THE LUN ALIGNMENT ISSUE: MISALIGNED LUNS

To identify a misaligned LUN, view the stats command for the LUN. For an aligned LUN, you will see that almost 100% of the writes are in Histogram 0. In this example, the writes are in different histogram buckets.



LUN ALIGNMENT: EXAMPLE 2

Examine this example screen shot and notice that the partition has a starting address that is divisible by 8.

Locating the LUN Alignment Issue

Aligned LUNs

- Check histograms on NetApp storage.
- Histogram 0 is 100% aligned.

```
[root@mickey ~]# ssh sylvester "priv set -q diag; stats show -e lun:/vol/alignment/insight2012.lun:write*"
lun:/vol/alignment/insight2012.lun-W-CeHJmIb8vQ:write_ops:668/s
lun:/vol/alignment/insight2012.lun-W-CeHJmIb8vQ:write_data:227691063b/s
lun:/vol/alignment/insight2012.lun-W-CeHJmIb8vQ:write_align_histo.0:100%
lun:/vol/alignment/insight2012.lun-W-CeHJmIb8vQ:write_align_histo.1:0%
lun:/vol/alignment/insight2012.lun-W-CeHJmIb8vQ:write_align_histo.2:0%
lun:/vol/alignment/insight2012.lun-W-CeHJmIb8vQ:write_align_histo.3:0%
lun:/vol/alignment/insight2012.lun-W-CeHJmIb8vQ:write_align_histo.4:0%
lun:/vol/alignment/insight2012.lun-W-CeHJmIb8vQ:write_align_histo.5:0%
lun:/vol/alignment/insight2012.lun-W-CeHJmIb8vQ:write_align_histo.6:0%
lun:/vol/alignment/insight2012.lun-W-CeHJmIb8vQ:write_align_histo.7:0%
lun:/vol/alignment/insight2012.lun-W-CeHJmIb8vQ:write_partial_blocks:0%
[root@mickey ~]#
```

 NetApp Confidential

LOCATING THE LUN ALIGNMENT ISSUE: ALIGNED LUNS

Examine this example screen. The starting Sector address is divisible by 8; notice that the Write I/O is in Histogram 0.

Redo Logs and I/O Alignment

- Oracle redo logs perform circular overwrites of a single file from the first byte to the last byte.
- Redo log I/O is sequential and synchronous.
- The redo log is written in small chunks, in multiples of 512 bytes.
- Redo logs are not aligned by design, but that does not mean that they are misaligned.
- To check alignment, see the NetApp device histograms.

REDO LOGS AND I/O ALIGNMENT

By definition, Oracle redo logs do not ever provide aligned I/O. This should not cause concern, because Data ONTAP uses 4-KB blocks, and the Oracle redo logs write in chunks of 512 bytes.

Sequential and synchronous means that each operation must be completed before another operation begins.

The redo log is written in small chunks in multiples of 512 bytes, depending on the OS; select max(lebsz) from x$kccle.

For Oracle redo logs, check alignment in the NetApp device histograms (see examples). The LUN `show` command does contain a "misalignment" field.

Lesson 5

Disk Groups

LESSON 5: DISK GROUPS

Disk Group Planning

Consider the following performance enhancements before you create disk groups:

- Determine optimum LUN size and quantity.
- Ensure all LUNs in the disk group are of equal size.
- Assign more than one LUN per disk group for better performance.
- Place multiple device queues on the host to improve performance.
- Use NetApp RAID-DP technology for disk I/O redundancy protection, not ASM redundancy.

 NetApp Confidential 40

DISK GROUP PLANNING

NetApp

Using ASMCA

Steps to Create Disk Groups

1. Determine the available LUNs on the host.
2. Use Oracle ASM Configuration Assistant (ASMCA) to create disk groups.
3. Change the discovery path.
4. Select a device for the disk group.
5. Create the disk group.

USING ASMCA: STEPS TO CREATE DISK GROUPS

Using ASMCA
Determine Available LUNs

- Log into the Linux server as root.
- Run: `ls -latr /dev/mapper/*p1`

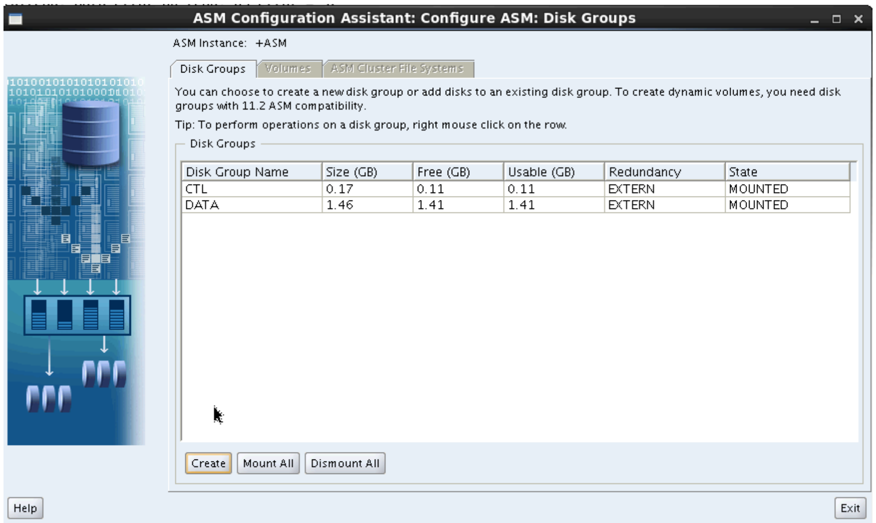
```
[root@linux mapper]# ls -latr /dev/mapper/*p1
lrwxrwxrwx 1 root root 7 Dec  1 01:14 /dev/mapper/oradata1p1 -> ../dm-8
lrwxrwxrwx 1 root root 7 Dec  1 01:14 /dev/mapper/oratempp1 -> ../dm-9
lrwxrwxrwx 1 root root 8 Dec  1 01:14 /dev/mapper/oraredop1 -> ../dm-10
lrwxrwxrwx 1 root root 7 Dec  1 01:14 /dev/mapper/oractlp1 -> ../dm-6
lrwxrwxrwx 1 root root 8 Dec  1 01:14 /dev/mapper/oraarchp1 -> ../dm-11
[root@linux mapper]#
```


USING ASMCA: DETERMINE AVAILABLE LUNS

When you use the Oracle ASMCA GUI tool to create an ASM disk group, first ensure that your device is available and that you are using partitioned devices.

Using ASMCA
Device Availability

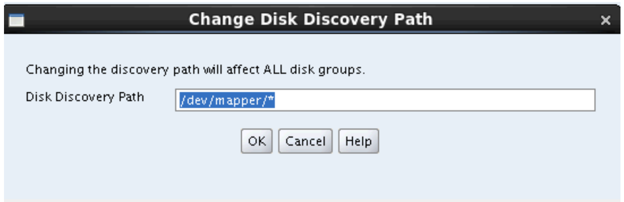
Use the ASMCA to create disk groups.



USING ASMCA: DEVICE AVAILABILITY

Your permissions on the host devices might be incorrect, if your devices are not available when you create an ASM disk group. Ensure that your ASM_DISKSTRING parameter is correct. Be sure that you use the MPIO device.

Using ASMCA
Change the Discovery Path

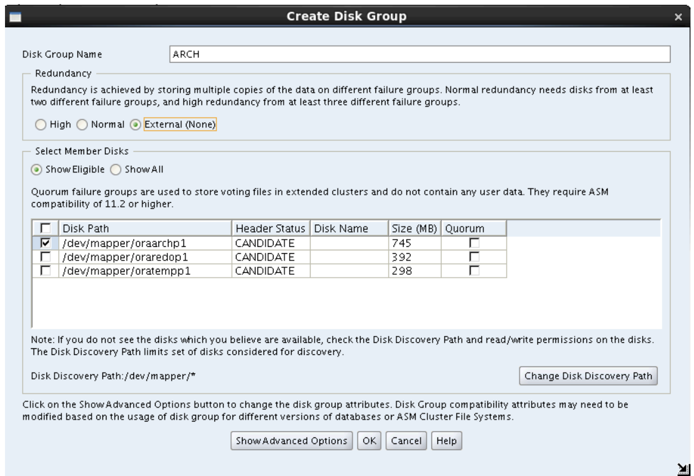


 NetApp Confidential

USING ASMCA: CHANGING THE DISCOVERY PATH

Using ASCMA
Select a Device

- Select external redundancy.
- Select the disk path.



 NetApp Confidential

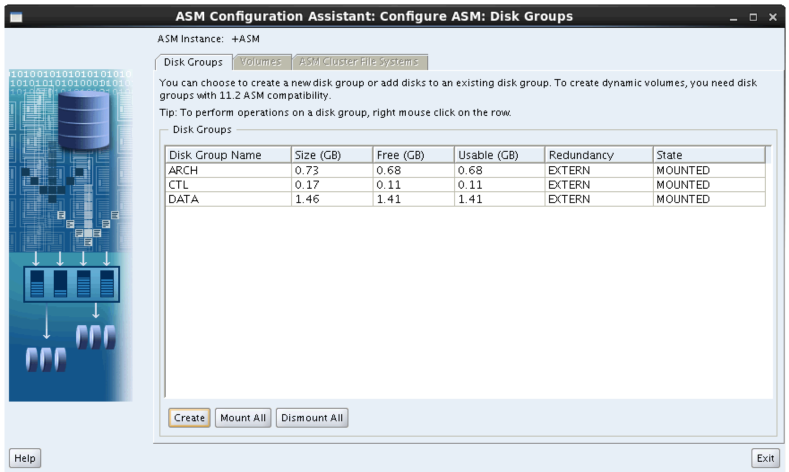
USING ASCMA: SELECT A DEVICE

After you change the Disk Discovery Path to reflect your environment, you should see the devices that are available. In this example, the host devices result from using aliases with the Linux device mapping configuration file.

- Select one or more devices for your disk group.
- Provide a proper disk group name.
- Select the external redundancy option.
- Then select OK to create the disk group.

Using ASCMA
Create Disk Groups

- Create the new disk group.
- Add disks to an existing disk group.

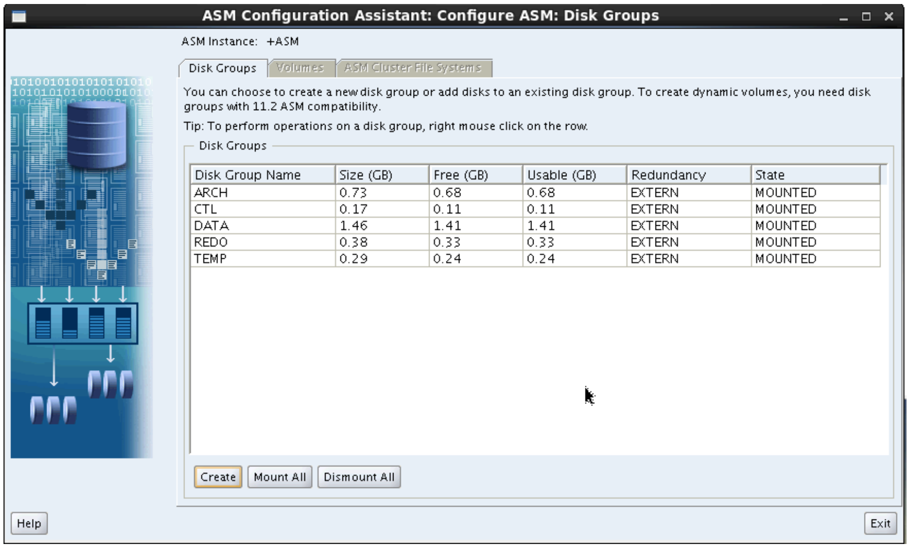


 NetApp Confidential 46

USING ASCMA: CREATE DISK GROUPS

Using ASCMA

Review Available Disk Groups



 NetApp Confidential

USING ASCMA: REVIEW AVAILABLE DISK GROUPS

After you have created all of your disk groups, select the Exit button to end the ASMCA process.

Module Summary

Now that you have completed this module, you should be able to:

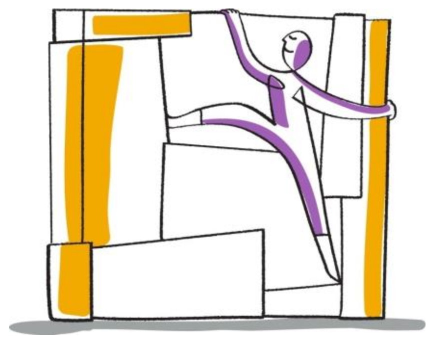
- Define ASM for an Oracle database on NetApp storage
- Define the Oracle ASMLib
- Describe how to install and configure ASM and ASMLib to provision and configure storage and LUNs
- Create an ASM database
- Use ASM to create an application database

MODULE SUMMARY

NetApp

Exercise

Time Estimate: 180 Minutes



 NetApp Confidential 49

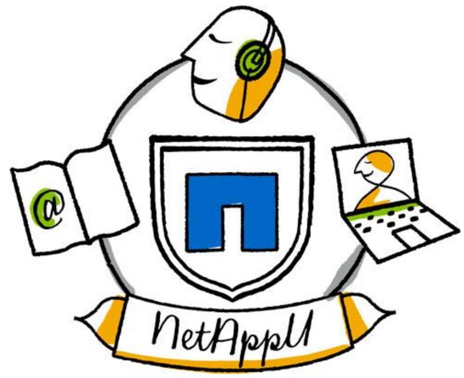
EXERCISE

Please refer to your exercise guide.

NetApp

Module 7

Backup and Recovery
Methods for Oracle



 NetApp Confidential 1

MODULE 7: BACKUP AND RECOVERY METHODS FOR ORACLE

Module Objectives

After this module, you should be able to:

- Describe specific storage design requirements for the backup and recovery of Oracle databases
- Back up and recover an Oracle database by using SnapManager for Oracle (SMO)
- Back up and recover an Oracle database by using Snap Creator Framework

MODULE OBJECTIVES

Lesson 1

Oracle Backup Basics

 3

LESSON 1: ORACLE BACKUP BASICS

This lesson discusses FlexVol layouts for Oracle environments and some backup options. The information is not necessarily specific to the clustered Data ONTAP operating system.

Many storage vendors require a complex spindle layout design as the first step to design storage. In contrast, the NetApp storage system uses aggregates. Thus, hotspots do not occur (unless the system is misconfigured), and most storage problems are eliminated.

The key to storage design for database backup options on NetApp storage is to use NetApp Snapshot technology.

Backing Up Oracle

- Types of backups:
  – Cold and hot
  – Normal operation and hot backup mode
- Backup and file system layout options:
  – A Snapshot copy of one FlexVol volume
  – A Snapshot copy across multiple FlexVol volumes
  – Replication options and space efficiency

 4

BACKING UP ORACLE

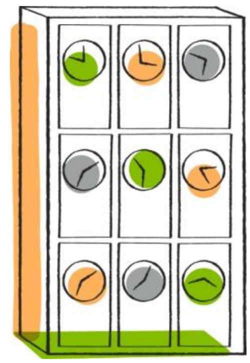
Cold backup: Database is shut down, and no one accesses or updates the data.

Hot backup: Database is up and available to users while backup takes place.

When backing up a database, you must have a separation of database entities to different FlexVol volumes. You create Snapshot copies that allow you to restore the database successfully.

Cold Backups

Step 1	Shut down the database.
Step 2	Create Snapshot copies of FlexVol volumes.



 NetApp Confidential 5

COLD BACKUPS

Hot Backups

- Database is up and running.
- Clients can access and update data.

HOT BACKUPS

Redo Logging
Normal Operation

- A redo log contains data that the database needs to restart after an interrupted write operation.
- The normal write-logging operation steps are as follows:
  1. Oracle writes the block delta of the intended changes of the data files into the redo logs.
  2. Oracle writes to the data files.
  3. Oracle updates the redo logs to record that the write was successful.

 NetApp Confidential 7

REDO LOGGING: NORMAL OPERATION

- Used to track transactions that occur against the database
- Used by Oracle to ensure data integrity for many situations

NOTE: You must understand redo logging to understand hot backups.

Redo Logging
Hot Backup Mode

The hot backup write-logging operation steps are as follows:

1. Oracle writes the full block image of the intended changes of the data files into the redo logs.
2. Oracle writes to the data files.
3. Oracle records that the write was successful into the redo logs.

 NetApp Confidential 8

REDO LOGGING: HOT BACKUP MODE

Databases see increased redo generation when a database is in hot backup mode. Because you are using Snapshot technology, this occurs for only a short time, thus the additional overhead is minimal.

NOTE: Do not confuse redo with undo. A redo log deals with physical data management as data flows into the database. Undo tablespaces are used to provide consistent query results when database changes are underway.

Hot Backup
Notes

- The database is not quiesced while in hot backup mode.
- The database is not made application-consistent while in hot backup mode.
- There is an increase in I/O during hot backup mode.
- A Snapshot copy of the data files alone while in hot backup mode is not usable.

HOT BACKUP: NOTES

Additional information:

Database not quiesced: Writes continue to the database and its data files.
Database not made application consistent: You still need the online redo logs and the Oracle archive logs.
Small increase in I/O: This is due to the change in the redo that was captured.
Snapshot copy not usable for a restore: You may need archive logs and data from the online redo logs.

Hot Backup
Myths

Be aware that other changes occur to the function of the database, but the full block images in the redo logs are key.

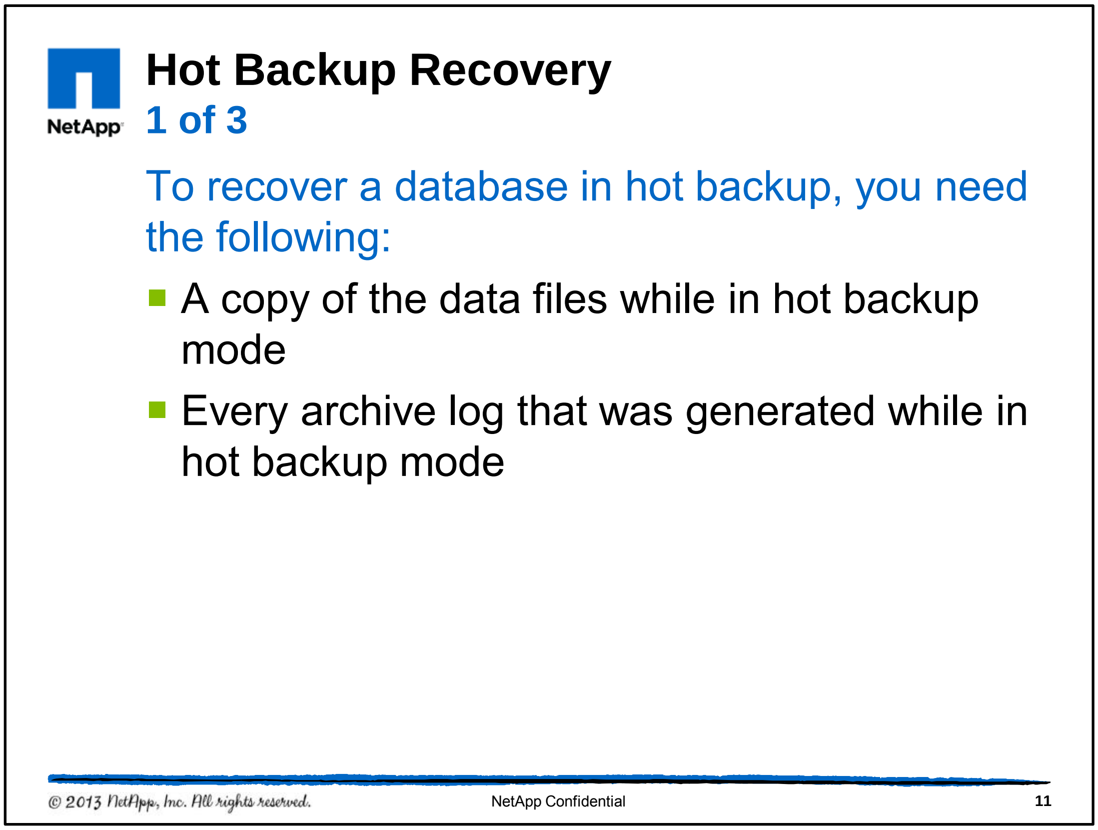
Myth: In hot backup mode, data files are not updated.

Myth: Hot backup mode quiesces a database. (In fact, I/O actually increases!)

Myth: Hot backup mode ensures that backed-up blocks are not fractured.

Myth: Data files protected via Snapshot copies, the SnapMirror process, or other means are usable alone.

HOT BACKUP: MYTHS



HOT BACKUP RECOVERY: 1 OF 3

You need the original redo logs:

- The most recent committed transactions are in the redo logs.

You need a copy of the data files while the database is in hot backup mode.

You need all of the redo logs that were generated while in hot backup mode:

- Always tell Oracle to bring its logs "current" after exiting hot backup mode.
- This ensures that you have archived all of the redo logs that were generated during the hot backup state.

Hot Backup Recovery
2 of 3

Why?

- The data files are your starting point, but they are inconsistent.
- The archive logs contain the data that is required to fix any data file corruption that was introduced by the backup process.

 NetApp Confidential

HOT BACKUP RECOVERY: 2 OF 3

Data files alone do not provide a consistent starting point for a recovery.

You also need:

- Archive logs (archived redo)
- Current data within the online redo logs (depending on your recovery scenario)

The archive logs:

- Repair the potential inconsistent data and the online redo logs
- Ensure that Oracle can roll forward and roll back the necessary transaction
  - This is because data is not quiesced during the hot backup state.
  - The archive logs and online redo logs allow you to do the necessary recovery.

Hot Backup Recovery
3 of 3

Is anything else needed?

- You need a control file, but you can re-create one, if needed.
- To recover every transaction before the failure, you need one of the original redo logs.

HOT BACKUP RECOVERY: 3 OF 3

The control file tells Oracle the physical and logical details of the database. Thus, the control file has information about the data files and their names, and it sets expectations to have all of those present upon startup, as well as for a recovery.

Lesson 2

Backups and File System Layout Options

 NetApp Confidential

LESSON 2: BACKUPS AND FILE SYSTEM LAYOUT OPTIONS

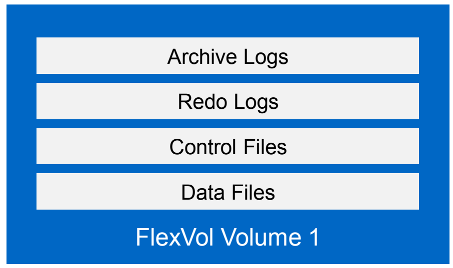
Backup and Recovery
The Simplest Method

Backup

Create a Snapshot copy.

Recovery

Recover the whole Snapshot copy.



BACKUP AND RECOVERY: THE SIMPLEST METHOD

Pros: This method is easy.

Cons: This method provides point-in-time recoverability only. You can recover to the moment of the Snapshot copy, but not beyond.

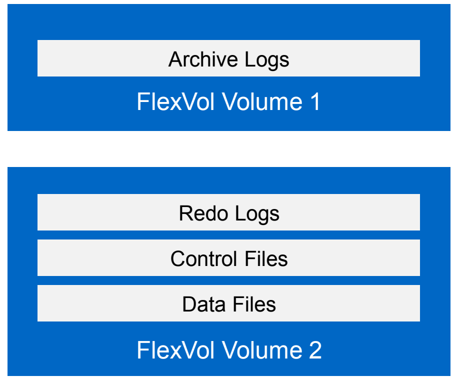
Backup and Recovery
Almost No Data Loss

Backup

1. Start hot backup mode.
2. Create a Snapshot copy of FlexVol 2.
3. End hot backup mode.
4. Switch the logs.
5. Create a Snapshot copy of FlexVol 1.

Recovery

1. Restore the Snapshot copy on FlexVol 2.
2. Apply archive log data.



 NetApp Confidential

BACKUP AND RECOVERY: ALMOST NO DATA LOSS

Pros: This method is easy.

Cons: You still lose unarchived transactions that were in the redo logs.

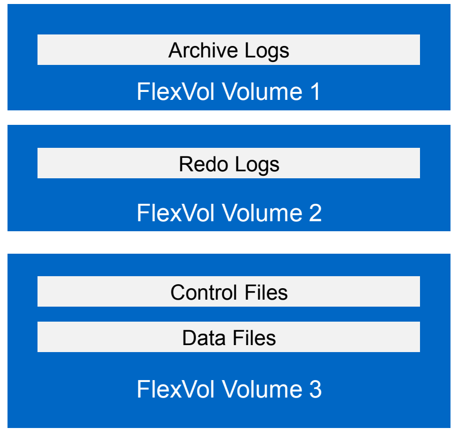
Backup and Recovery
No Data Loss (Except with Triple-Disk Failure)

Backup

1. Start hot backup mode.
2. Create a Snapshot copy of FlexVol 3.
3. End hot backup mode.
4. Switch the logs.
5. Create a Snapshot copy of FlexVol 1.

Recovery

1. Restore the Snapshot copy on FlexVol 3.
2. Apply the archive log data.
3. Apply the redo log data.



BACKUP AND RECOVERY: NO DATA LOSS (EXCEPT WITH TRIPLE-DISK FAILURE)

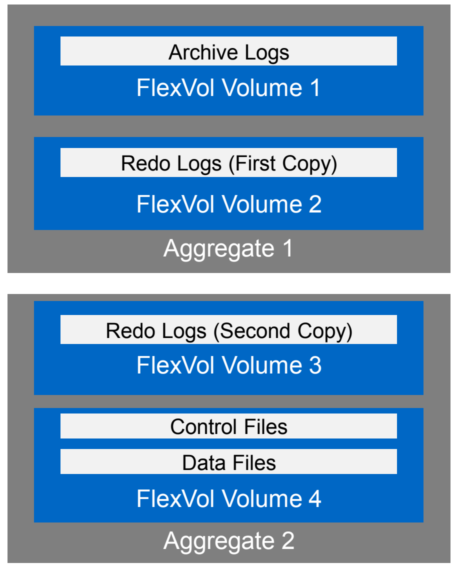
Pros: This method is easy, and you do not lose any transactions.

Cons: If the whole aggregate fails, you are still exposed.

Backup and Recovery
No Data Loss (Except with Total Site Loss)

Backup
1. Start hot backup mode.
2. Create a Snapshot copy of FlexVol 4.
3. End hot backup mode.
4. Switch the logs.
5. Create a Snapshot copy of FlexVol 1.
6. Create an external backup of FlexVol 4.

Recovery
1. Restore the Snapshot copy on FlexVol 4.
2. Apply the archive log data.
3. Apply the redo log data.

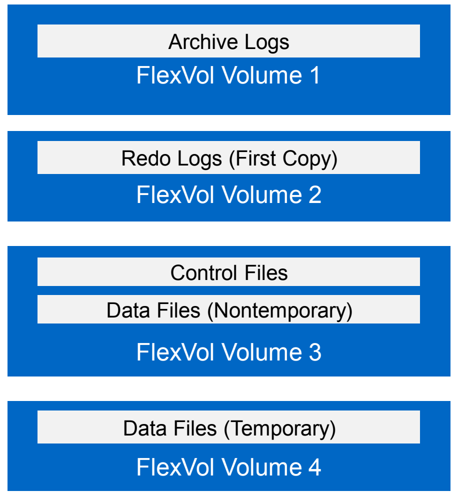


 NetApp Confidential 18

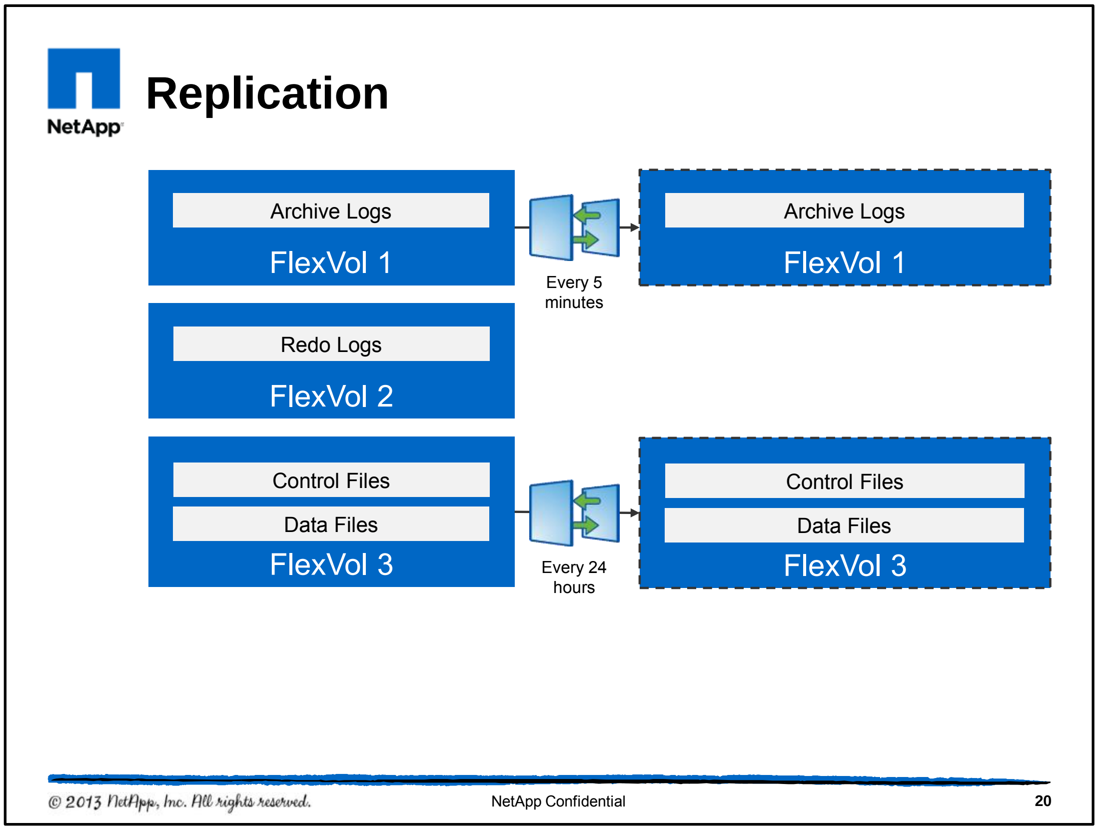
BACKUP AND RECOVERY: NO DATA LOSS (EXCEPT WITH TOTAL SITE LOSS)

Backup and Recovery
Important Issues

- As long as you keep a copy of FlexVol 4, you never lose a committed transaction, even if an aggregate fails.
- If Aggregate 1 fails, the database integrity is unaffected, because you still have the data files and one surviving copy of the redo logs.
- If Aggregate 2 fails, you must restore the data files, but you can subsequently replay archive logs and redo logs.



BACKUP AND RECOVERY: IMPORTANT ISSUES



REPLICATION

Example of a successful disaster recovery scenario:

Use a five-minute recovery point objective (RPO) with SnapMirror software and minimal transfer of data.

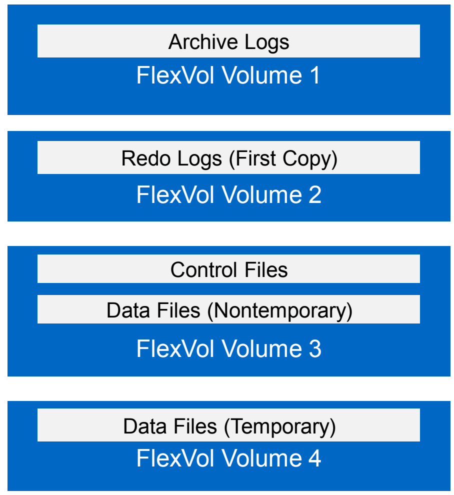
One Database
Maximum Space Efficiency

Backup

1. Start hot backup mode.
2. Create a Snapshot copy of FlexVol 3.
3. End hot backup mode.
4. Switch the logs.
5. Create a Snapshot copy of FlexVol 1.

Recovery

1. Restore the Snapshot copy on FlexVol 3.
2. Apply the archive log data.
3. Apply the redo log data.



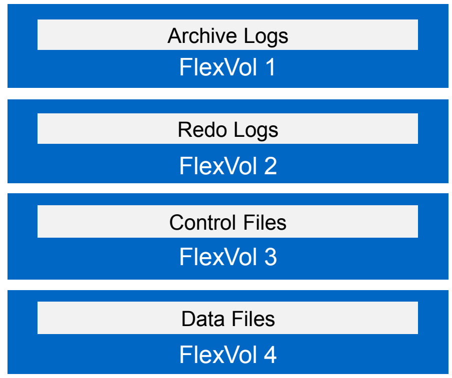
NOTE: Do not create Snapshot copies of unimportant data.

ONE DATABASE: MAXIMUM SPACE EFFICIENCY

SMO
Typical Backup Procedure

1. Start hot backup mode.
2. Create a Snapshot copy of FlexVol 4.
3. End hot backup mode.
4. Alter the system archive log current.
5. Create a Snapshot copy of FlexVol 1.
6. Create a Snapshot copy of FlexVol 3.

NOTE:
- Do not create Snapshot copies of unimportant data.
- Ignore FlexVol 2.



 NetApp Confidential 22

SMO: TYPICAL BACKUP PROCEDURE

SMO
Maximum Space Efficiency

SMO Backup Procedure

1. Start hot backup mode.
2. Create a Snapshot copy of FlexVol 4.
3. End hot backup mode.
4. Alter the system archive log current.
5. Create a Snapshot copy of FlexVol 1.
6. Create a Snapshot copy of FlexVol 3.

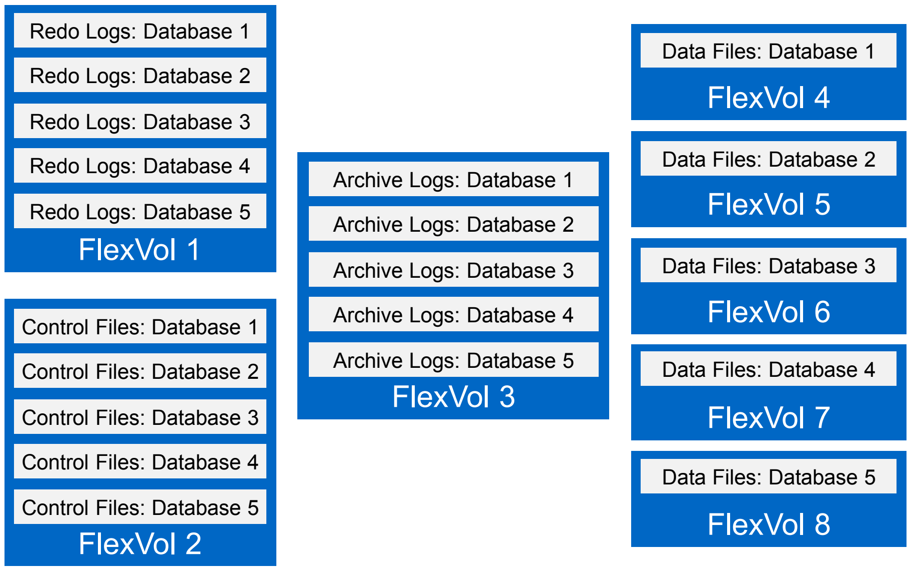
NOTE:

- Do not create Snapshot copies of unimportant data.
- Ignore FlexVol 2.
- Ignore FlexVol 5.

- Archive Logs — FlexVol Volume 1
- Redo Logs (First Copy) — FlexVol Volume 2
- Control Files — FlexVol Volume 3
- Data Files (Nontemporary) — FlexVol Volume 4
- Data Files (Temporary) — FlexVol Volume 5

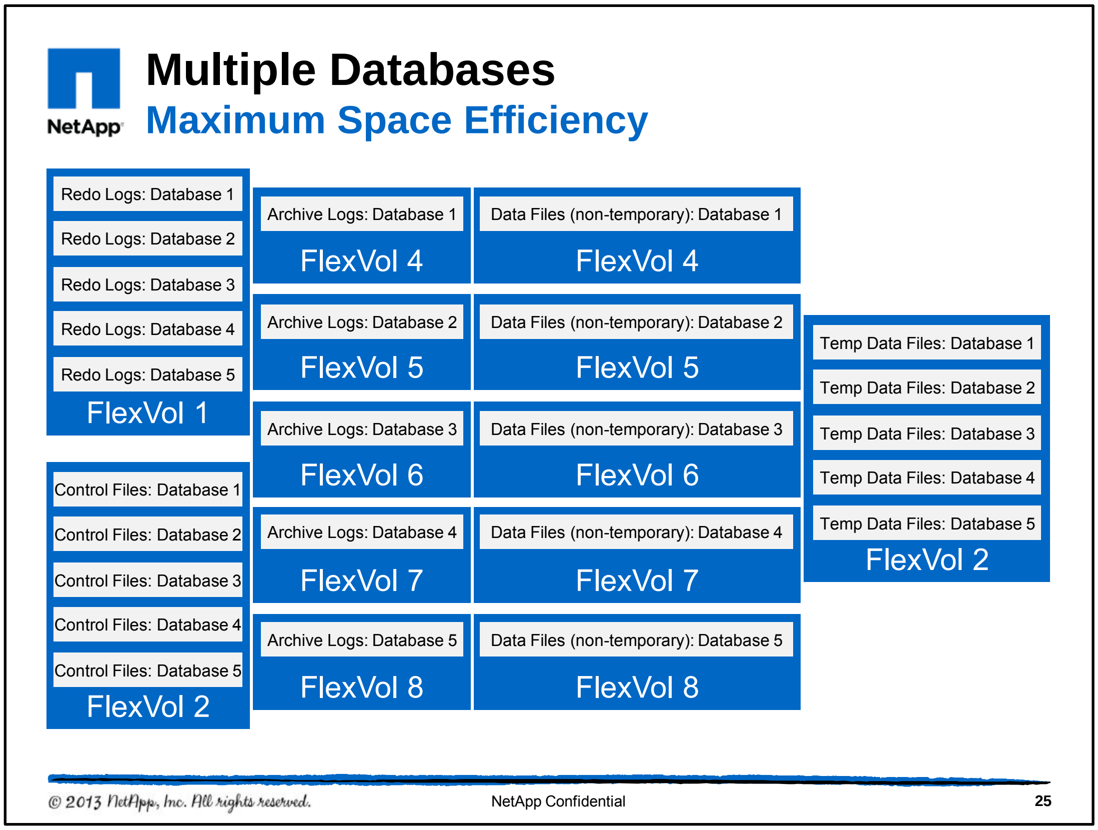
SMO: MAXIMUM SPACE EFFICIENCY

Multiple Databases



 NetApp Confidential 24

MULTIPLE DATABASES



MULTIPLE DATABASES: MAXIMUM SPACE EFFICIENCY

Hot Backup
Myths

Be aware that other changes occur to the function of the database, but the full block images in the redo logs are key.

Myth: In hot backup mode, data files are not updated.

Myth: Hot backup mode quiesces a database.
(In fact, I/O actually increases!)

Myth: Hot backup mode ensures that backed-up blocks are not fractured.

Myth: Data files protected via Snapshot copies, the SnapMirror process, or other means are usable alone.

HOT BACKUP: MYTHS

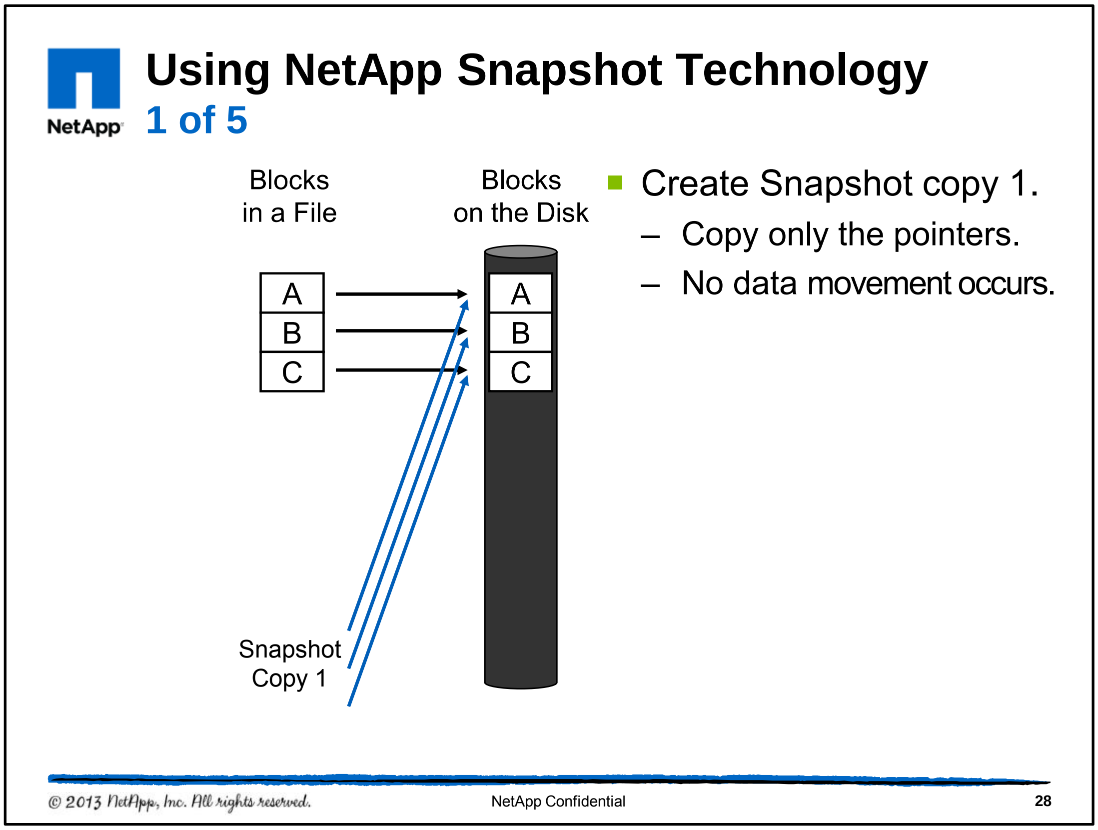
NetApp

Lesson 3

Using NetApp Snapshot Technology

 NetApp Confidential 27

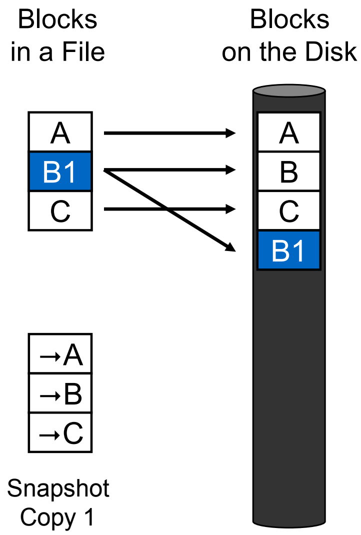
LESSON 3: USING NETAPP SNAPSHOT TECHNOLOGY



USING NETAPP SNAPSHOT TECHNOLOGY: 1 OF 5

The Data ONTAP operating system and its Snapshot feature provide several benefits. A Snapshot copy is a point-in-time picture of the file system.

Using NetApp Snapshot Technology
2 of 5



- Create Snapshot copy 1.
- Continue writing data.
  - Copy pointers only.
  - Write data anywhere.

 29

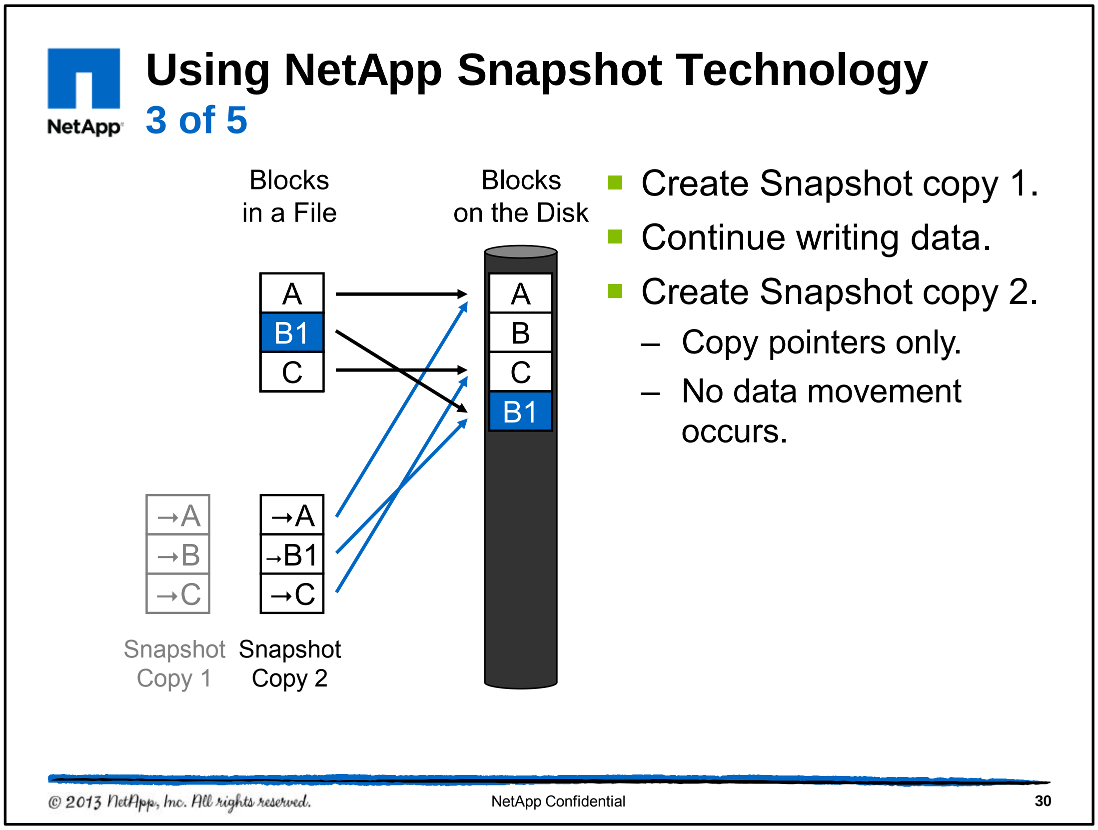
USING NETAPP SNAPSHOT TECHNOLOGY: 2 OF 5

Create Snapshot copy 1, which points to blocks A, B, and C.

The application (such as Oracle) continues to write data.

Thus, there is an update to data in Block B, (labeled B1 in the slide).

When a block has a snapshot tied to it, it is not released back to the free block pool.

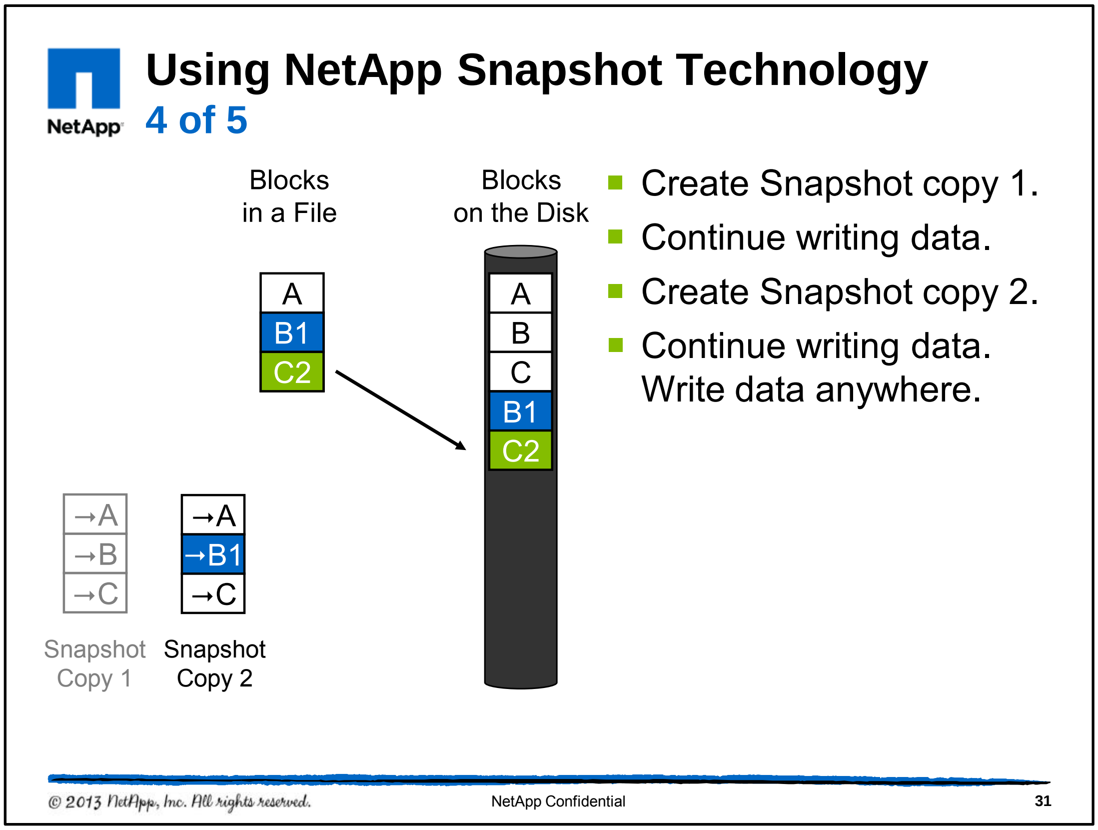


USING NETAPP SNAPSHOT TECHNOLOGY: 3 OF 5

Now, create another Snapshot copy. You now have Snapshot 1 and Snapshot 2.

Snapshot 2 points to blocks A, B1, and C.

Notice that the NetApp Snapshot technology does not move data (like the competitors' technology does).



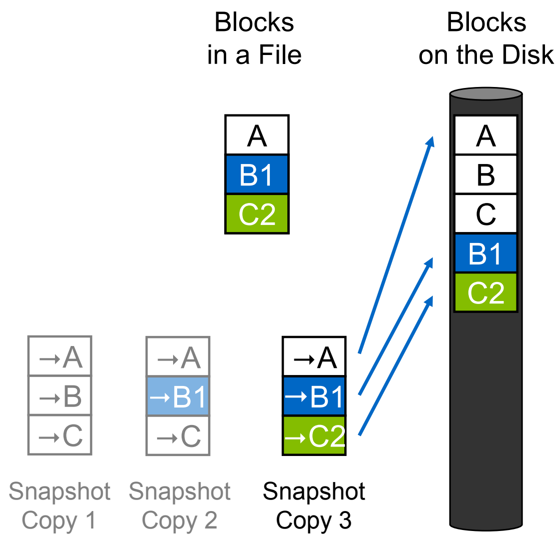
USING NETAPP SNAPSHOT TECHNOLOGY: 4 OF 5

After you create the second Snapshot copy, the application continues to write data.

You now have block C2.

At this point, the "active" blocks in your file system are A, B1, and C2.

Using NetApp Snapshot Technology
5 of 5



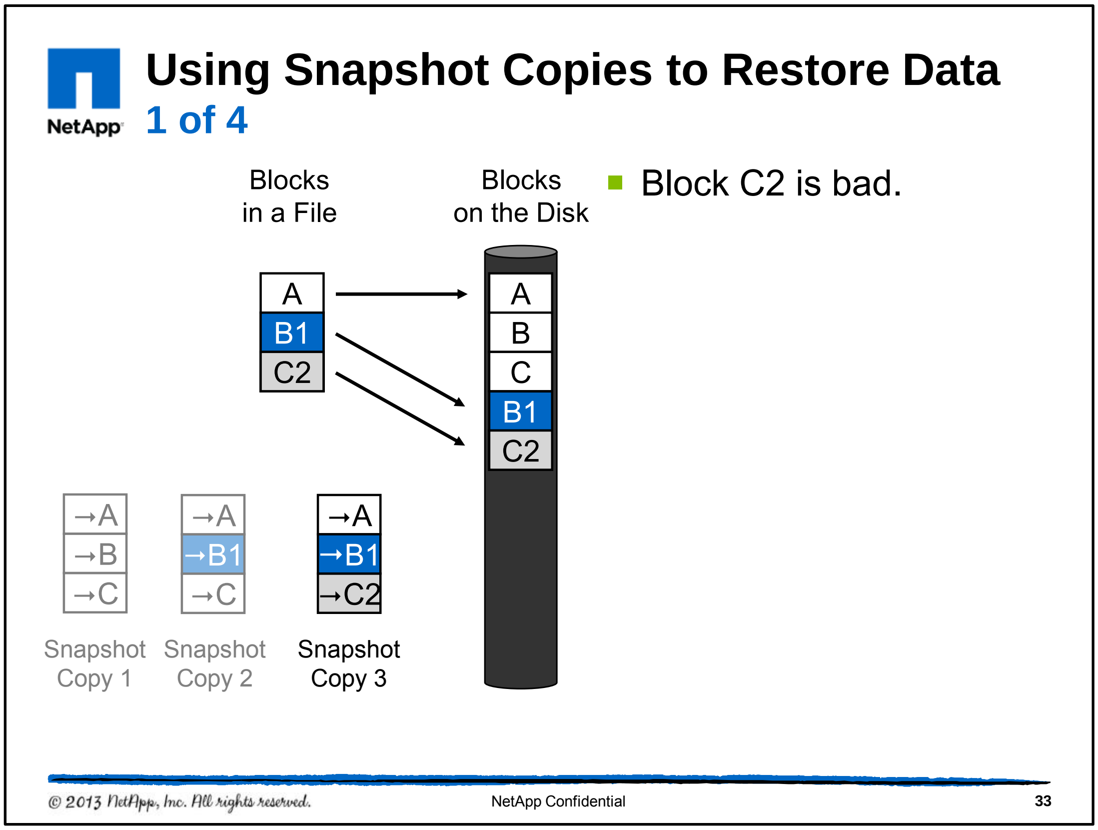
- Create Snapshot copy 1.
- Continue writing data.
- Create Snapshot copy 2.
- Continue writing data.
- Create Snapshot copy 3.
- Simplicity of model =
  - Best disk use.
  - Fastest performance.

USING NETAPP SNAPSHOT TECHNOLOGY: 5 OF 5

Now you create Snapshot copy 3, which points to blocks A, B1, and C2.

The Snapshot technology enables you to take an almost instantaneous backup of your database.

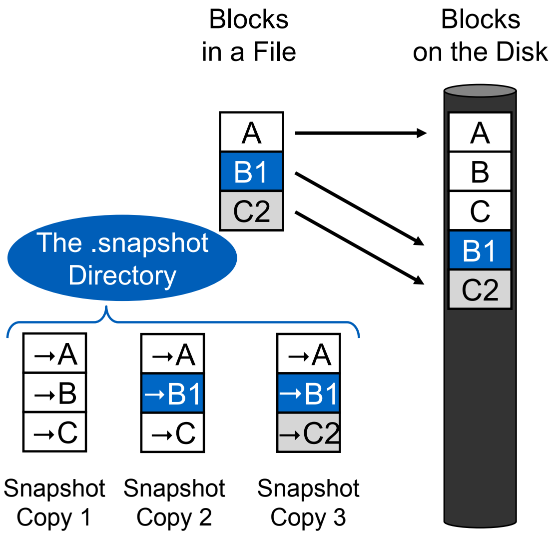
Thus, your database does not remain in the hot backup state for a long time, and there is no impact on performance.



USING SNAPSHOT COPIES TO RESTORE DATA: 1 OF 4

In this example, block C2 has bad data, due to an incorrect SQL update command or a software bug. This situation requires a database restore and recovery operation.

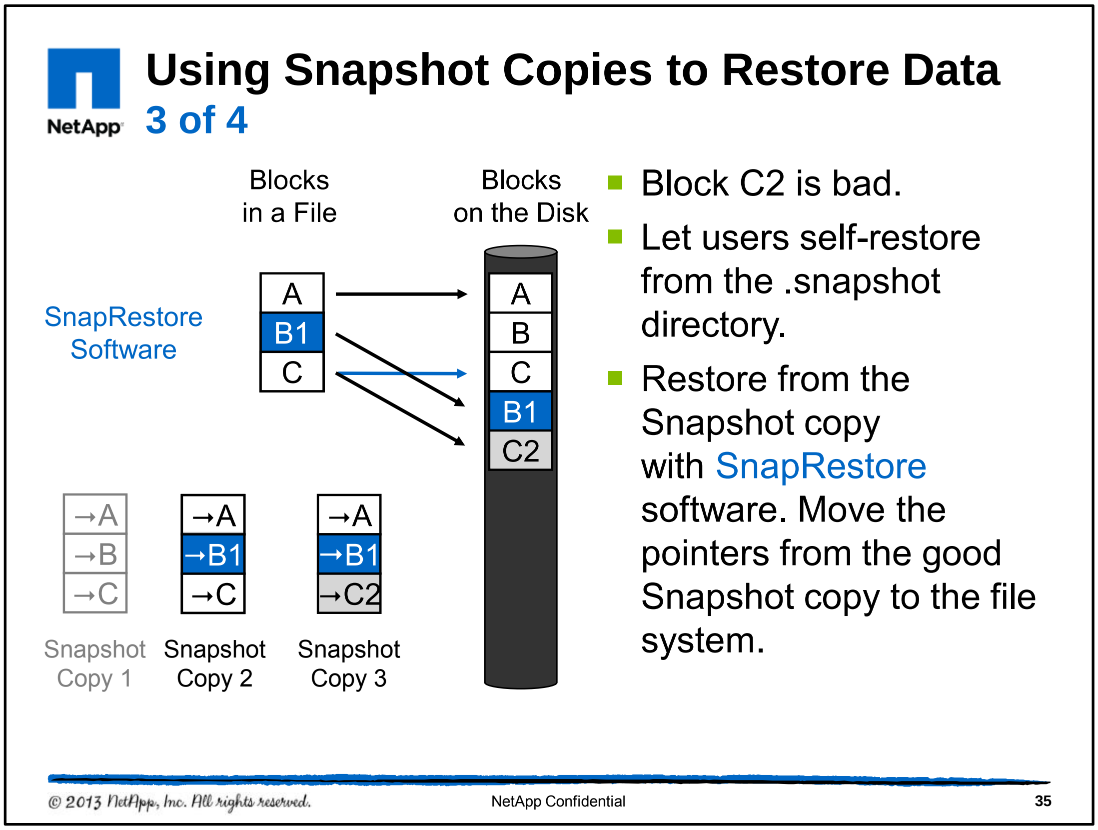
Using Snapshot Copies to Restore Data
2 of 4



- Block C2 is bad.
- Let users self-restore from the .snapshot directory.

USING SNAPSHOT COPIES TO RESTORE DATA: 2 OF 4

In a NFS or CIFs environment, you can use the .snapshot directory, which provides you with access to the data as it was when each Snapshot copy was created.

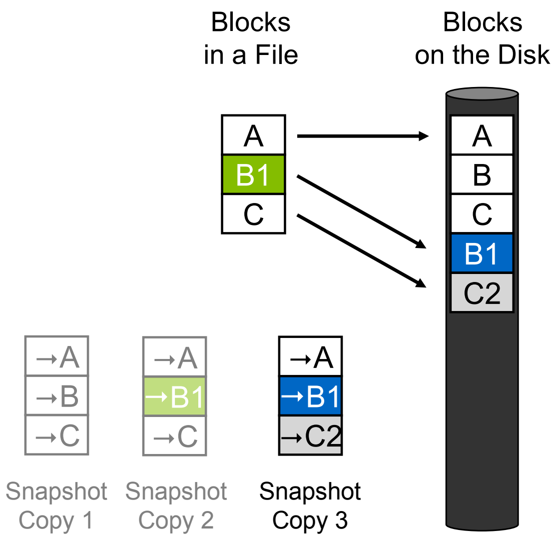


USING SNAPSHOT COPIES TO RESTORE DATA: 3 OF 4

Use the NetApp SnapRestore command to restore data from a Snapshot copy in the traditional manner.

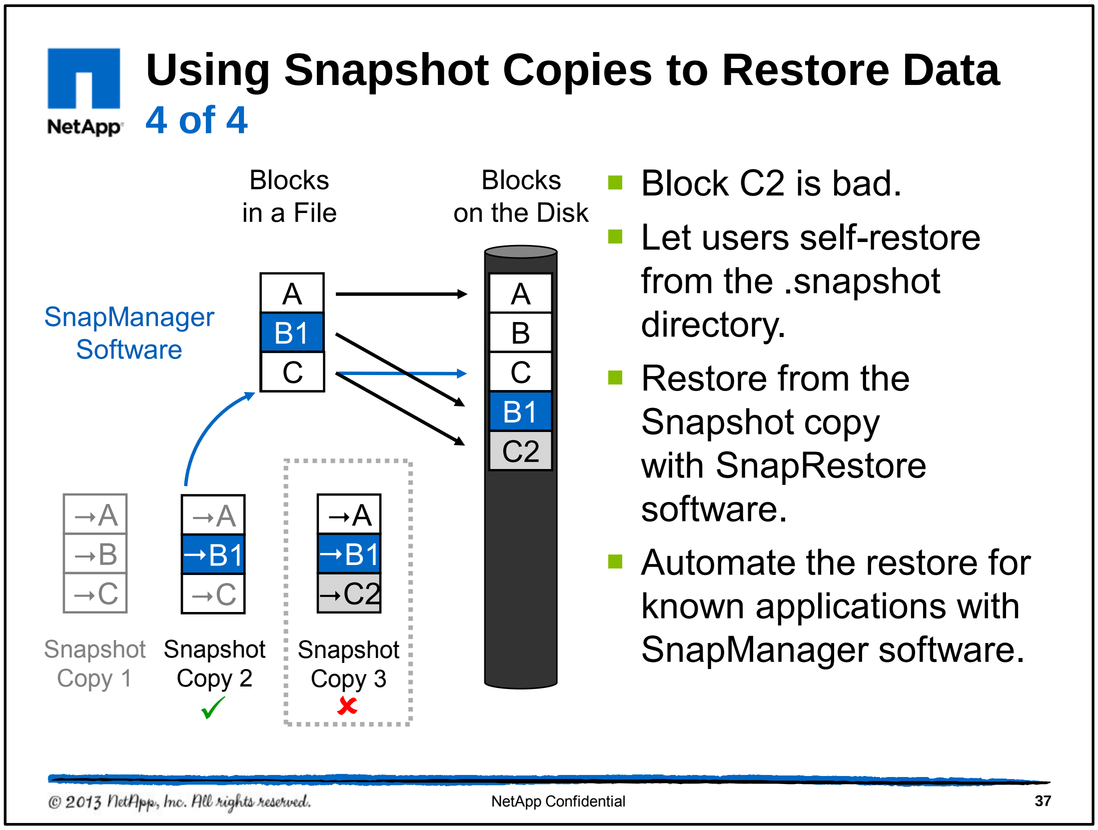
- The SnapRestore command "reverts" the active blocks to what they looked like at the time when the Snapshot copy was created.
- You restore the active blocks, or active file system, back to Snapshot 2.
- Now you have Blocks A, B1, and C. The blocks are "reverted".
- The pointers now reference the proper blocks, which are referenced to in Snapshot 2.

Using Snapshot Copies to Restore Data
Step 3, Continued



 NetApp Confidential

USING SNAPSHOT COPIES TO RESTORE DATA: STEP 3, CONTINUED



USING SNAPSHOT COPIES TO RESTORE DATA: 4 OF 4

Instead of using the .snapshot directory or the SnapRestore command, you can automate the restore with NetApp SnapManager products. You will learn how to use SnapManager for Oracle in the exercise for this module.

Notice that when you use Snapshot copies to restore data, the active file system reverts to what it looked like when you created the Snapshot copy. No data is moved, and the backup takes place as instantaneously as possible.

Snapshot Copies

- A Snapshot copy is a point-in-time “picture” of your file system or disk group.
- When you perform a volume Snapshot restore, everything in the FlexVol volume (or file system) is reverted to the point in time of the Snapshot copy creation.
- Think of a Snapshot restore as an in-place replacement of the data files.
- What is the impact when you combine Oracle data files with archive log files?

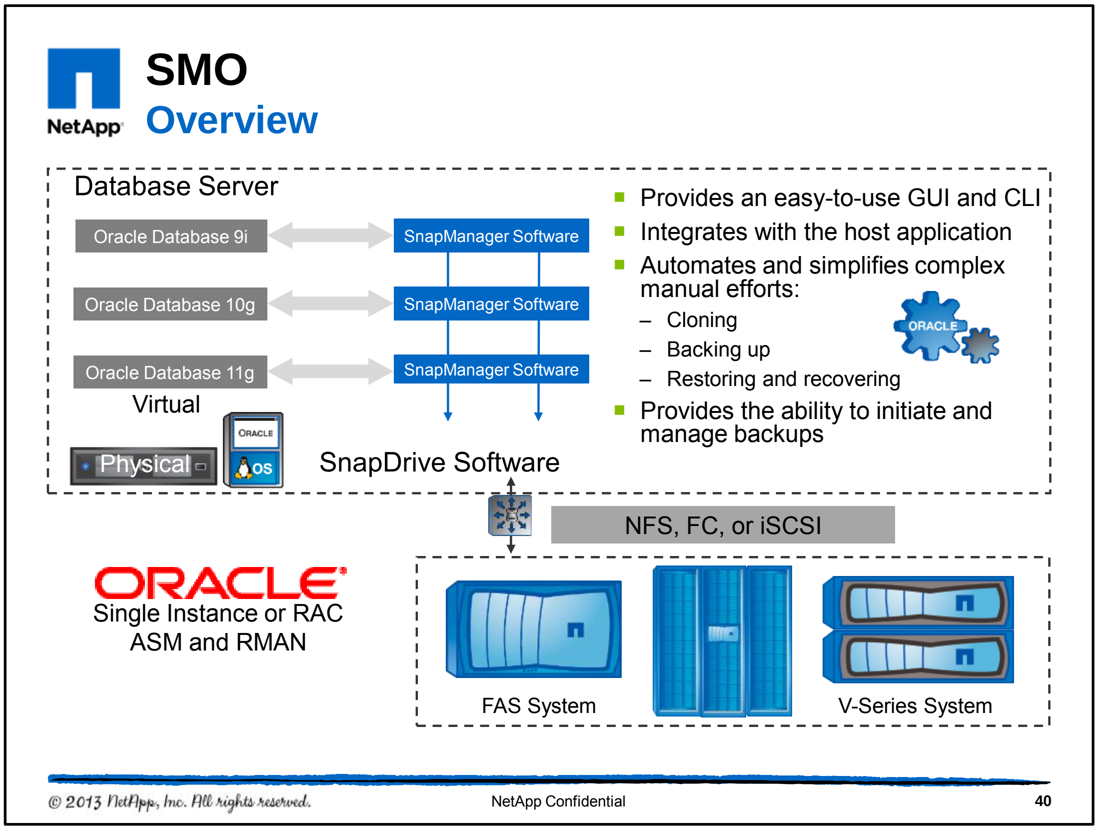
SNAPSHOT COPIES

Lesson 4

Using SnapManager for Oracle

 NetApp Confidential 39

LESSON 4: USING SNAPMANAGER FOR ORACLE

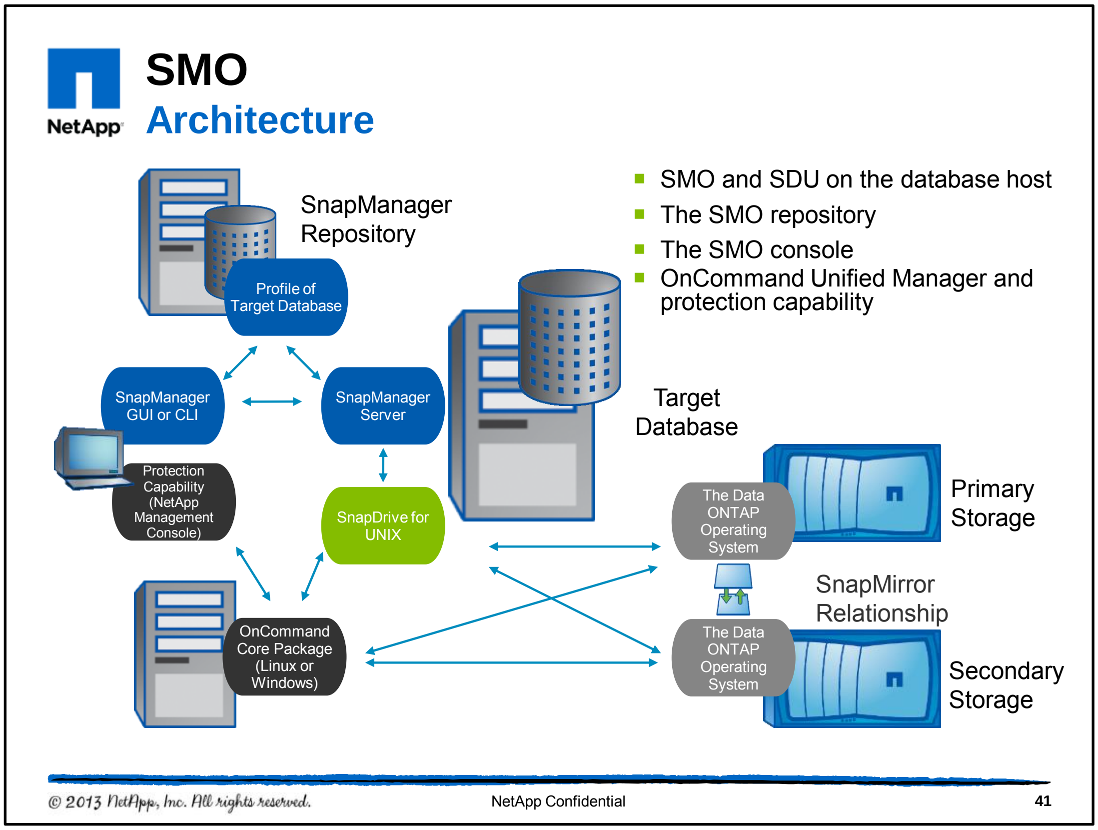


SMO: OVERVIEW

SMO:

- Enables backup, cloning and restoring a database.
- End users do not need to understand the granular details of storage commands.
- Provides a layer of abstraction between the database administrator (DBA) and the storage components.
- Enables creative problem-solving for DBAs.

RAC = Oracle Real Application Clusters



SMO: ARCHITECTURE

Installing and Configuring SMO

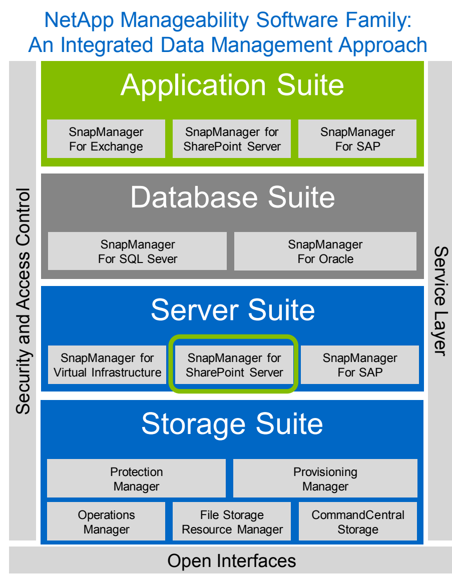
1. Install SDU prior to using SMO.
2. Install the SMO server.
3. Identify a location for the repository that SMO will use.
4. Create the repository.
5. Create a profile for your target database (including the retention policy).
6. Back up, restore, and clone your target database.
7. UNIX logs for each operation reside in `/var/log/smo` on the host where the operation is executed.

INSTALLING AND CONFIGURING SMO

- The SMO server is installed on the host where the target database resides. For this method, you must create a repository to maintain metadata of backups, databases, and configuration details. The repository requires a schema within an Oracle database.
- Connectivity to the repository database is provided through Java Database Connectivity (JDBC).This approach uses a small workload footprint; connectivity is used only during SMO operations.
- Depending on the target database and the retention of backups, each backup might require up to 50 KB of space. A profile is required for each target database to back up. The profile contains connectivity, retention, and protection details. Retention policies are based on user needs.
- This method requires the use of SDU, which communicates to the Data ONTAP operating system and the host. SMO communicates with your target database and performs the necessary Oracle commands to back up, recover, and clone your database. An account with DBA privileges is required.
- SDU communicates with NetApp Storage. SMO directs SDU and parses the results of commands that SDU executes.
- A Windows or Linux GUI or CLI is available. The GUI provides a wizard for operations.
- In addition to SMO and SDU, there is the capability of integration with OnCommand Unified Manager and the NetApp Management Console.

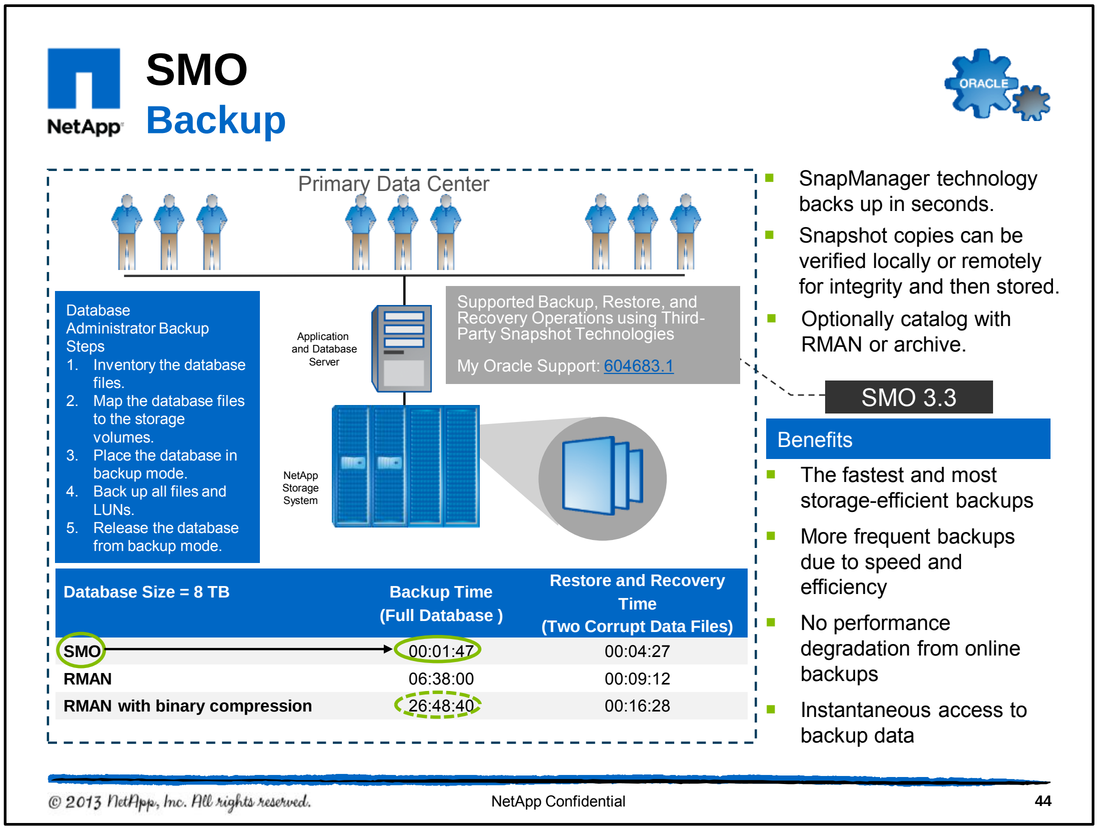
SDU Features

- Simplified storage provisioning
- Robust Snapshot copy management
- Increased storage utilization and flexibility
- Improved administrative productivity



 NetApp Confidential

SDU FEATURES



Database Size = 8 TB	Backup Time (Full Database)	Restore and Recovery Time (Two Corrupt Data Files)
SMO	00:01:47	00:04:27
RMAN	06:38:00	00:09:12
RMAN with binary compression	26:48:40	00:16:28

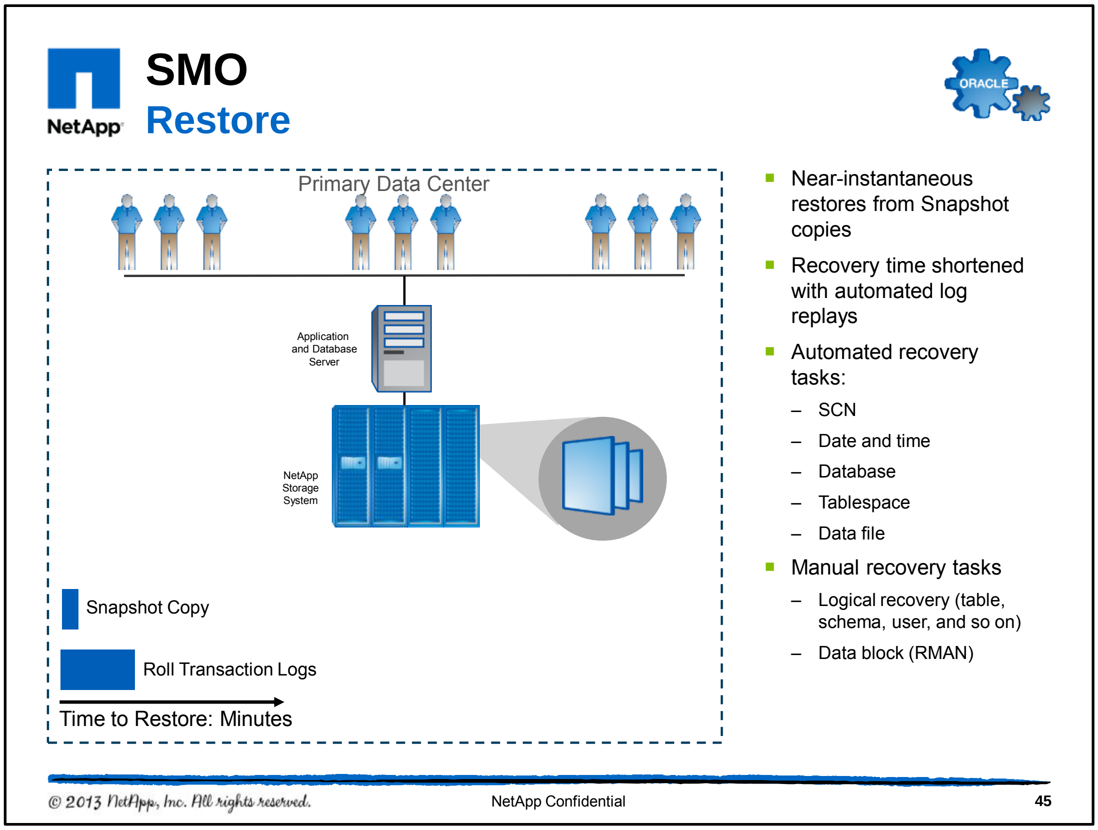
SMO: BACKUP

When SMO performs a backup, it does the following:

- Identifies database data files, file systems, and appropriate FlexVols and NetApp Controllers.
- Places the database in hot backup mode
- Creates a backup of the data files and control files
- Releases the database from hot backup mode
- Issues the command to bring all of its logs current
- Backs up the Oracle archive logs, based on the configuration

SMO enables you to perform operations that were previously impossible with large databases.

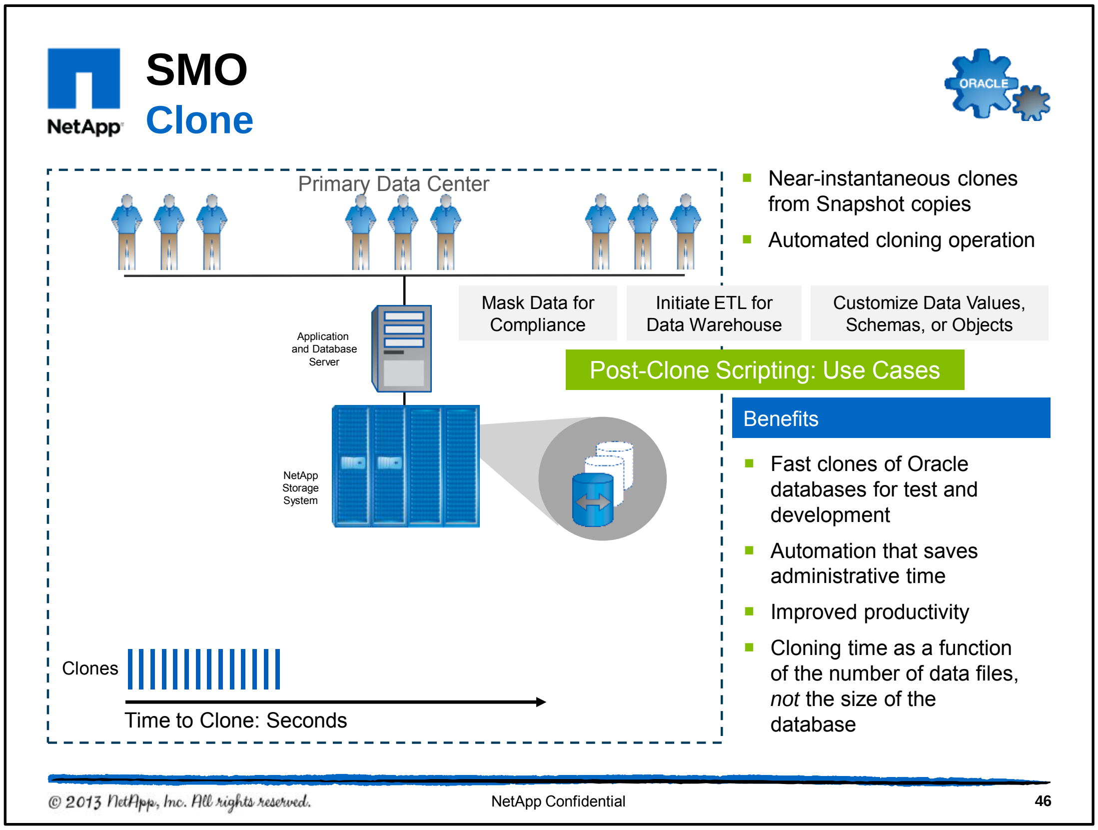
- Duration of backup with SMO compared to traditional Recovery Manager (RMAN):
- Complete backup of 8 TB database:
  - SMO = 1 minute and 47 seconds
  - RMAN = over 6 hours
- Complete restore and recovery:
  - SMO = 4 minutes and 27 seconds
  - RMAN = 9 minutes and 12 seconds.



SMO: RESTORE

SMO does database restore and recovery based on your requirements:

- Enables you to select specific options to drive the necessary steps to complete the database recovery.
- Enables the end user to define the steps to take for recovery (based on the scenario).
- Ensures that files are not overlaid that are not part of the database or were not part of the backup.



SMO: CLONE

SMO uses NetApp FlexClone technology to create a fully functioning database clone based on a specific backup.

ETL = Extract, Transform, and Load

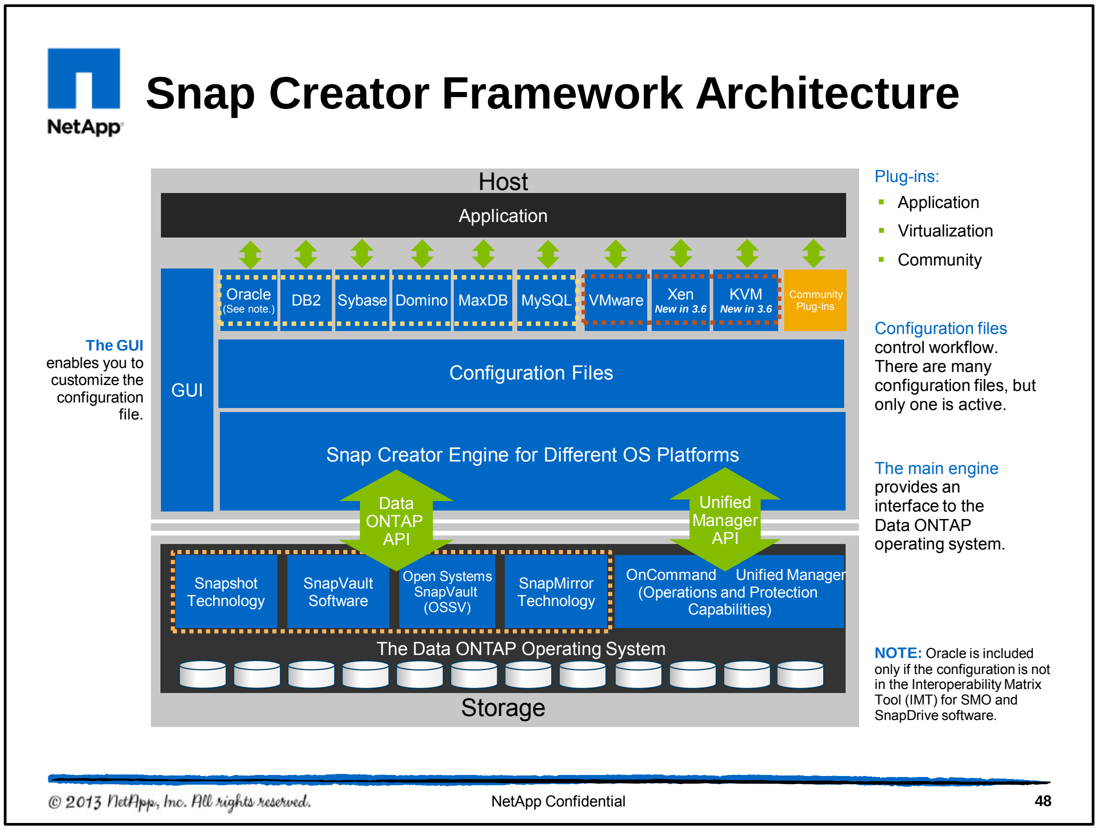
NetApp

Lesson 5

Using Snap Creator Framework

 NetApp Confidential 47

LESSON 5: USING SNAP CREATOR FRAMEWORK



SNAP CREATOR FRAMEWORK ARCHITECTURE

The Snap Creator Framework components are as follows:

Snap Creator Engine (main program):

- Runs on either a central backup server or where the application is installed.
- Uses the Data ONTAP API to communicate with storage systems and other NetApp software products.
- All software products that are listed on the slide are optional
  - (In other words, except for Snapshot, the other products are not required for Snap Creator Framework to function.)
- Communication with OnCommand Unified Manager occurs via the OnCommand Unified Manager API, not the Data ONTAP API.

Optional plug-ins:

- Application
- Virtualization
- Community
  - Supported differently from the built-in plug-ins

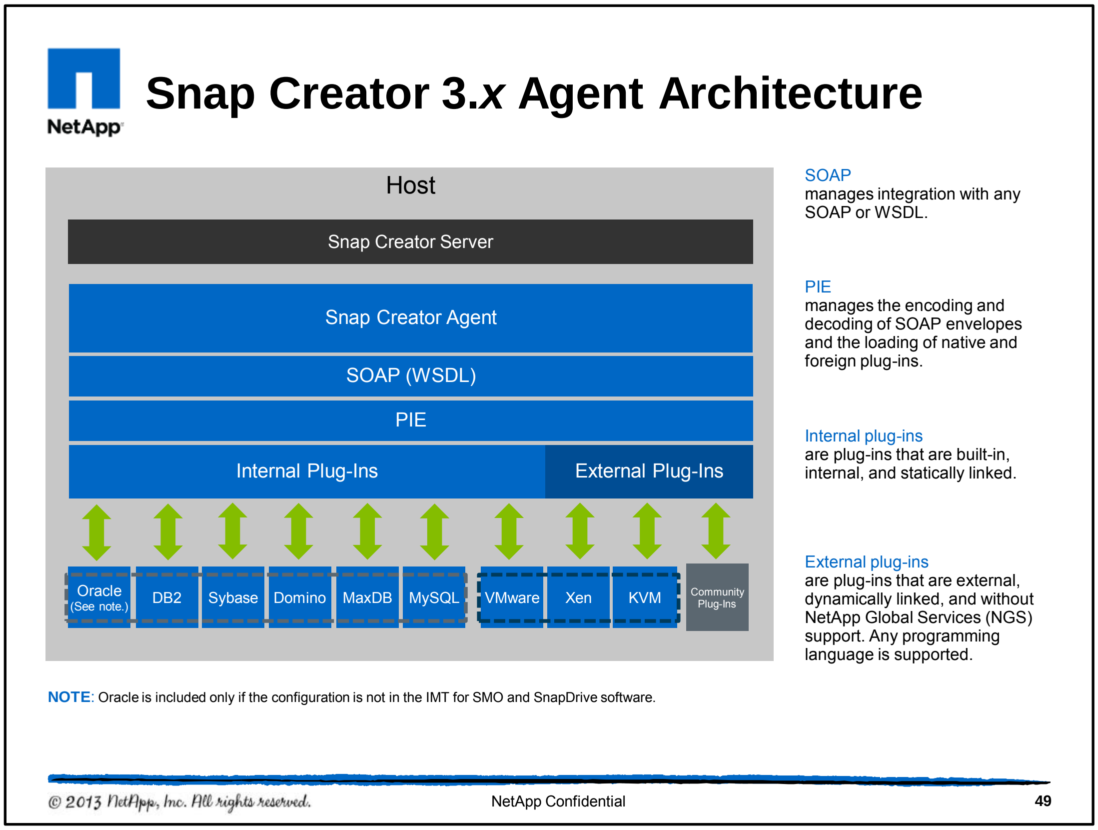
Configuration Files:

- Control what Snap Creator does
- Are available for each system that is backed up
- For example, 10 Sybase servers = 10 configuration files

A default configuration file is installed with Snap Creator, and you can use it as a template.

GUI:

- Is easy to use via a web browser.
- Enables you to easily manage configuration files.
- Enables you to perform Snap Creator actions such as Snapshot or Restore.
- Contains the following:
  - Role-based access control (RBAC) user controls
  - A scheduler
  - A job monitor
  - Detailed data about volumes that are related to configurations and logs



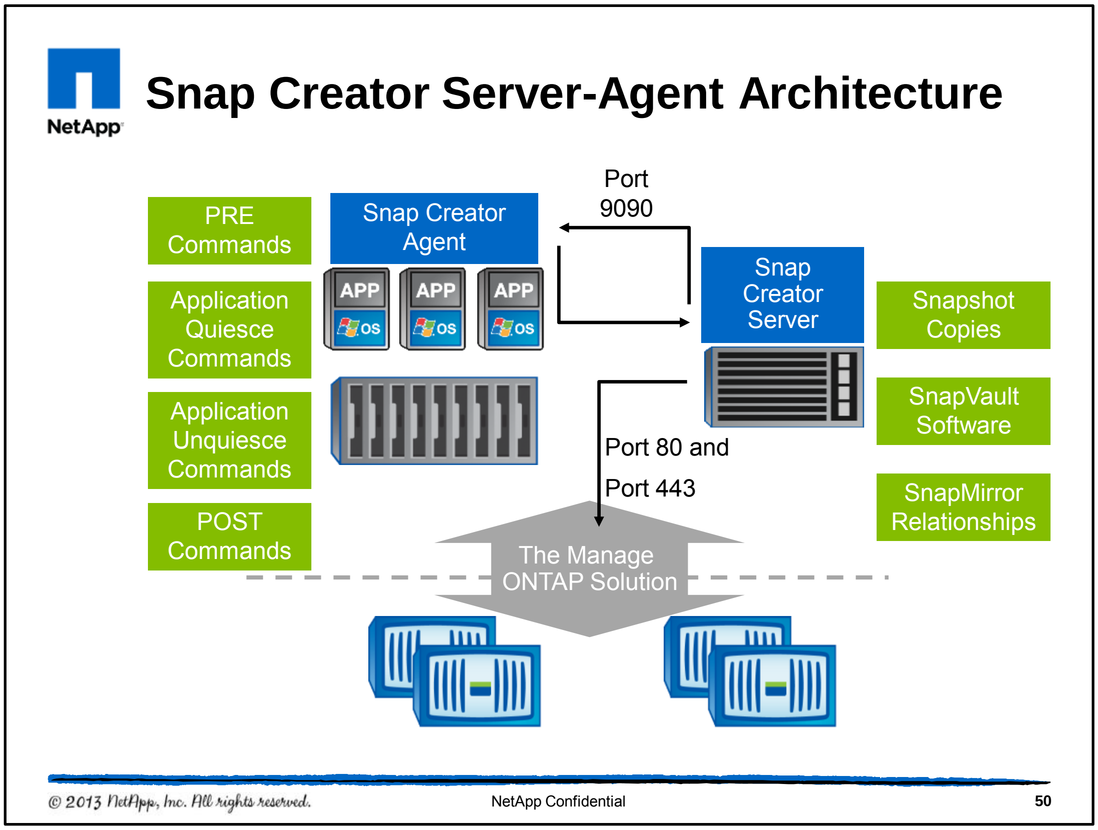
SNAP CREATOR 3.X AGENT ARCHITECTURE

Snap Creator agents:

- Are installed on hosts where applications are installed
- Communicate back to Snap Creator servers
- Use SOAP (Simple Object Access Protocol) or WSDL (Web Service Description Language)

Commands are encoded and decoded through envelopes to internal or external plug-ins (such as Java and PowerShell).
Other commands are passed to and from native applications and OSs (such as Oracle, VMware, Red Hat, and so on).

PIE = Plug-In Integration Engine



SNAP CREATOR SERVER-AGENT ARCHITECTURE

Here is how the Snap Creator server and agent work together:

As mentioned, Snap Creator has a full-featured server/agent architecture.

Snap Creator actions are initiated by the server. Communication to the agent, by default, occurs on port 9090 but this is customizable. The agent handles application quiesce and unquiesce commands, as well as other PRE/POST commands.

ZAPI calls to the storage system occur on the Snap Creator server over port 80 or 443 and handles all Snapshot, SnapVault, SnapMirror type functions before committing changes to storage devices/pools.

Installing and Configuring Snap Creator Framework

1. Extract the zip/tar file for the Snap Creator Framework in the desired directory. In this example, the location is `/home/oracle/SC`.
2. Create a directory for the configuration files.
3. Copy a sample configuration file, and then edit this file for details that are related to your example database.
4. Execute Snap Creator Framework to back up and restore your FlexVol volumes.

   NOTE: Snap Creator Framework does not execute the Oracle recovery.

INSTALLING AND CONFIGURING SNAP CREATOR FRAMEWORK

The Snap Creator Framework CLI

Creating a Configuration

```
########################
### Required Options ###
########################
CONFIG_TYPE=STANDARD
SNAME=
SNAP_TIMESTAMP_ONLY=Y
VOLUMES=
NTAP_SNAPSHOT_RETENTIONS=
NTAP_USERS=
NTAP_PWD_PROTECTION=N
TRANSPORT=HTTP
PORT=80
NTAP_TIMEOUT=60
LOG_NUM=30
LOG_TRACE_ENABLE=Y
SC_TMP_DIR=

##########################
### Connection Options ###
##########################
MANAGEMENT_INTERFACES=
SECONDARY_INTERFACES=
```

```
[root@lyon configs]# pwd
/SC_3.6/scServer3.6.0/configs
[root@lyon configs]# ls
default
[root@lyon configs]# mkdir sctest
```

```
[root@lyon configs]# ls
default  sctest
[root@lyon configs]# cd default/
[root@lyon default]# ls
default.conf
[root@lyon default]# cp default.conf /SC_3.6/scServer3.6.0/configs/sctest/sctest.conf
```

```
[root@lyon default]# cd ..
[root@lyon configs]# cd sctest/
[root@lyon sctest]# ls
sctest.conf
[root@lyon sctest]# vi sctest.conf
```

1. Create a backup profile in the Snap Creator Server configs directory.
2. Copy the default.conf file into the newly created folder, and then select a new name.
3. Edit the new <yourname>.conf file.
4. Edit the parameters in the .conf file. Use comments and the IAG as a guide.

 NetApp Confidential 52

THE SNAP CREATOR FRAMEWORK CLI: CREATING A CONFIGURATION

- Log in to the Snap Creator server, and change to the Snap Creator configs directory.
- Make a new folder in the configs directory, which serves as the backup profile for Snap Creator.
- Copy the default.conf file from the default folder to the newly created folder. Copy it to a new name that is logical for the configuration that you are about to create.
- Using your favorite text editor, edit the file that you just copied.
- Edit the parameters in the configuration file; use the comments and the Installation and Administration Guide (IAG).

The Snap Creator Framework CLI
Defining the Oracle Plug-In

1. Define the application plug-in that you want to use within the file.
2. Define the appropriate Oracle parameters for your database environment for the Oracle plug-in.
3. Use META_DATA_VOLUME to back up archive logs after the database backup.

 NetApp Confidential

THE SNAP CREATOR FRAMEWORK CLI: DEFINING THE ORACLE PLUG-IN

- Log in to the Snap Creator server and change to the Snap Creator configs directory.
- Edit your current configuration file. (Tell SnapCreator to use Oracle as the application.)
- Edit the parameters that are used by the Oracle plug-in: database name and "owner."
- Add the complete path for the SQLPLUS command.
- Identify a location for a pre/post backup of your control file. (Is it an Archive_Log_Only execution? If so, just switch Oracle log files.
- Identify the database as ORACLE_HOME.
- Tell the Snap Creator Framework to export the parameters as it executes. (The parameters might differ from the default parameters for the user account that runs the snapcreator command.)

(The META_DATA_VOLUME parameter enables you to backup a FlexVol after the database has been unquiesced (or taken out of hot backup mode, as in this example). The value in this parameter needs to be in the VOLUMES parameter. Yet, the metadata parameter tells the Snap Creator Framework to back up only that FlexVol after the unquiesce workflow. Thus, you can back up the database and the appropriate archive logs as well.)

- Copy the default.conf file from the default folder to the newly created folder, using a new name that is logical for the configuration that you are about to create.
- Edit the newly copied file.
- Edit the parameters in the configuration file; use the comments and the IAG.

The Snap Creator Framework CLI
Example

```
######################
APP_NAME=oracle
```

```
ORACLE_DATABASES=oranfs:oracle
SQLPLUS_CMD=/u01/app/oracle/product/11.2.0.3/db_1/bin/sqlplus
CNTL_FILE_BACKUP_DIR=/oracle/oranfs/oractl/oranfs
ORA_TEMP=/tmp
ARCHIVE_LOG_ONLY=N
ORACLE_HOME=/u01/app/oracle/product/11.2.0.3/db_1
ORACLE_EXPORT_PARAMETERS=Y
```

```
########################
### Required Options ###
########################
CONFIG_TYPE=STANDARD
SNAME=netappu
SNAP_TIMESTAMP_ONLY=Y
VOLUMES=192.168.81.112:v_oranfs_oractl,v_oranfs_oradata,v_oranfs_oraarch
NTAP_SNAPSHOT_RETENTIONS=daily:3
NTAP_USERS=192.168.81.112:vsadmin/53616c7465645f5fc0664305bd07945629da6649
NTAP_PWD_PROTECTION=Y
TRANSPORT=HTTP
PORT=80
NTAP_TIMEOUT=60
LOG_NUM=30
LOG_TRACE_ENABLE=Y
SC_TMP_DIR=
```

```
META_DATA_VOLUME=192.168.81.112:v_oranfs_oraarch
```

 NetApp Confidential

THE SNAP CREATOR FRAMEWORK CLI: EXAMPLE

The Snap Creator Framework CLI
Defining the Oracle Plug-In: Steps

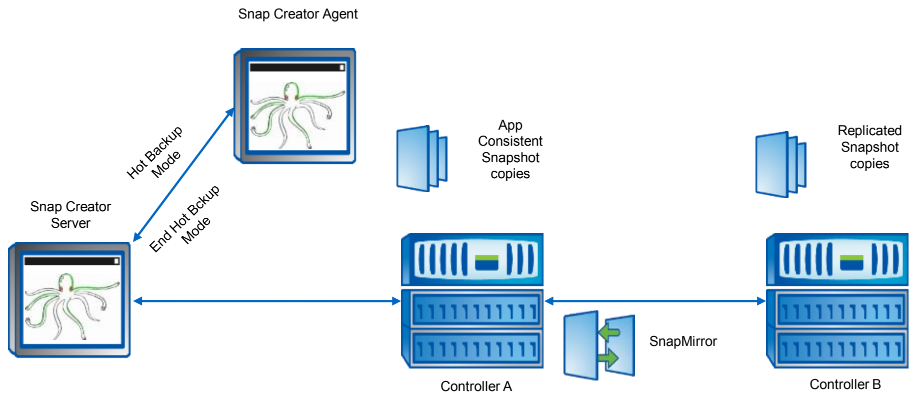
1. Log in to the database with the sqlplus command defined as "sysdba."
2. Verify version of Oracle and type of database (RAC or single instance).
3. Verify that the database is in archive log mode.
4. Create a backup of the control file to trace.
5. Place the database in hot backup mode.
6. Back up FlexVol volumes as defined within your configuration file.
7. Take the database out of hot backup mode.
8. Make the archive logs current.
9. Back up any FlexVol volume that is defined within META_DATA_VOLUME.
10. Create a backup of the control file to trace.

THE SNAP CREATOR FRAMEWORK CLI: DEFINING THE ORACLE PLUG-IN: STEPS

The process in the slide is similar to what SMO does in the background. It is also similar to the process that DBAs would use to script their own backup and recovery.

Deployment
Example

Application-Consistent Snapshot Copy with SnapMirror Update



 NetApp Confidential 56

DEPLOYMENT: EXAMPLE

1. The Snap Creator Server communicates with the Snap Creator Agent (which is installed where the application is installed).
2. Commands are sent to quiesce the application.
3. The scAgent communication line disappears; Controller 1 appears.
4. After the application is quiesced, the Snap Creator Server communicates with the NetApp Controller to create an application-consistent Snapshot copy.
5. The Controller communication line disappears; scAgent line reappears.
6. After the Snapshot copy is created, the Snap Creator Server communicates with the Snap Creator Agent to unquiesce the application.
7. The scAgent line disappears; the controller communication line reappears.
8. Now that the application is running normally, the Snap Creator Server communicates with the NetApp Controller to initiate a SnapMirror update.
9. After the update is complete, Snap Creator completes.

Optionally, you could send a message to Operations Manager, or to any third-party monitoring system using SNMP, to log the success.

Module Summary

Now that you have completed this module, you should be able to:

- Describe specific storage design requirements for the backup and recovery of Oracle databases
- Back up and recover an Oracle database by using SMO
- Back up and recover an Oracle database by using Snap Creator Framework

MODULE SUMMARY

Lab Exercise

During the lab exercise for this module, you will install and configure SnapDrive for UNIX, SMO, and Snap Creator Framework. You will then perform a backup and restore by using each of these tools.

The SMO repository must be created in the existing “orarepo” database. Verify that the database is available and able to accept connections.

You will use the NFS database that you built in an earlier lab as the target database for both tools. You will be asked to create a SMO profile, back up the database by using SMO, verify that the backup exists, and then perform a restore and recovery of the database by using SMO.

You will also create a configuration for your lab database to be used by Snap Creator Framework, use the CLI to back up and restore the database, and then use the Oracle `sqlplus` command to recover and open your database.

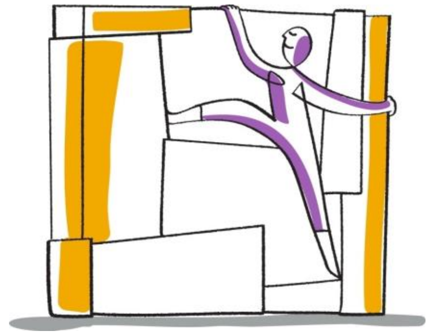
LAB EXERCISE

Our lab exercise for this module will quite involved. But it is not meant to be an exhaustive instruction of SMO or SnapCreator. It will provide you with some basic ways to install, configure and use the products.

![NetApp]

Exercise

Time Estimate: 150 Minutes



 NetApp Confidential

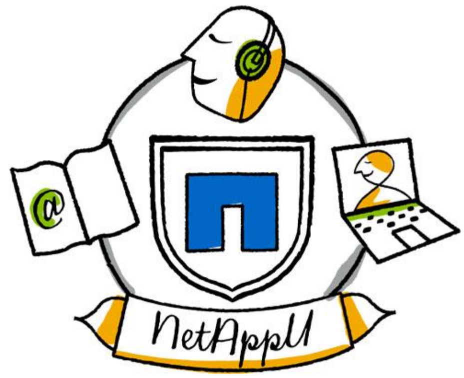
EXERCISE

Please refer to your exercise guide.

NetApp

Module 8

Cloning Oracle Databases



 NetApp Confidential

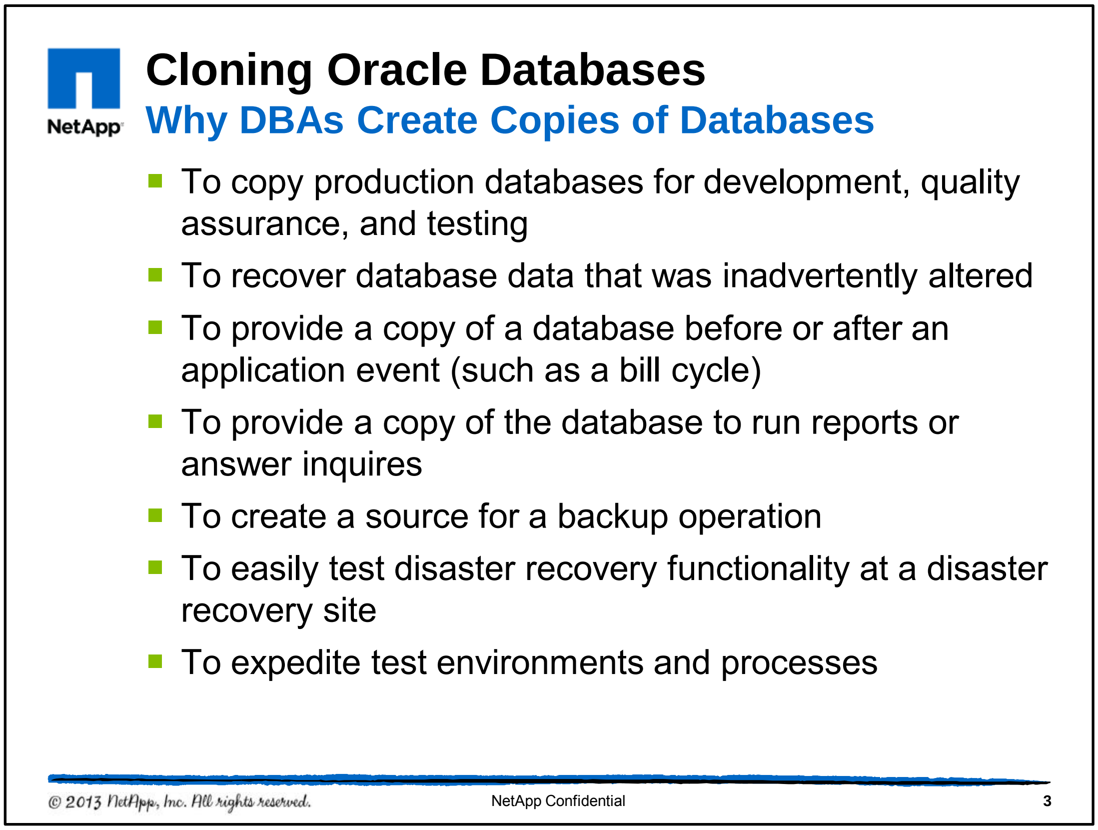
MODULE 8: CLONING ORACLE DATABASES

Module Objectives

After this module, you should be able to:

- Describe use cases for cloning Oracle databases
- Identify the components that are needed for a clone creation
- Identify which objects to clone
- Use NetApp SnapManager for Oracle (SMO) to clone an Oracle database

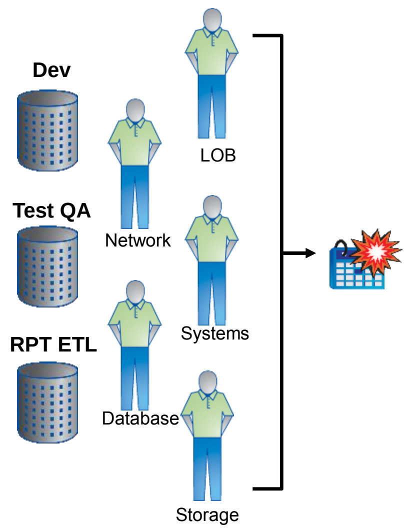
MODULE OBJECTIVES



CLONING ORACLE DATABASES: WHY DBAS CREATE COPIES OF DATABASES

Customers who can quickly and efficiently clone databases differentiate themselves from competitors who use slower traditional cloning methods.

Traditional Approaches to Cloning
Challenges and Pain Points



- Limited storage resources: 100% storage capacity overhead per instance or custom partial extraction scripts
- Long lead-time requirements:
  - Heavy processes (with many required approvals)
  - Storage resource allocation
  - Manual or scripted operations that are subject to human error
- The need for DBAs, developers, testers, and LOB specialists to wait to use limited database copies

TRADITIONAL APPROACHES TO CLONING: CHALLENGES AND PAIN POINTS

LOB = line of business

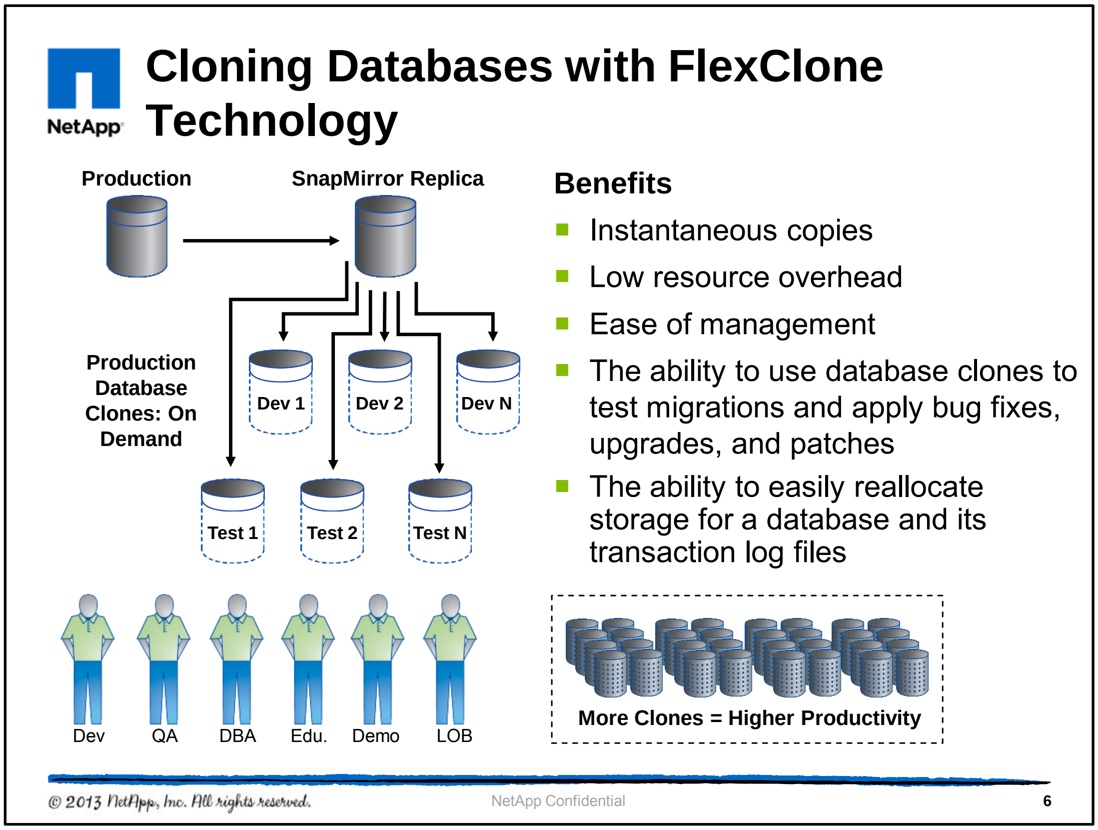
extract, transform, load = ETL

RPT = a report file format

What If?

- Consider the benefits if DBAs and application developers could create (and re-create) a consistent copy of a database application environment with these features:
  – Nearly instantaneously
  – Using negligible incremental storage
  – As needed, even for individual developers
  – With little or no support from a storage administrator
- How would this affect the efficiency of an application development team?

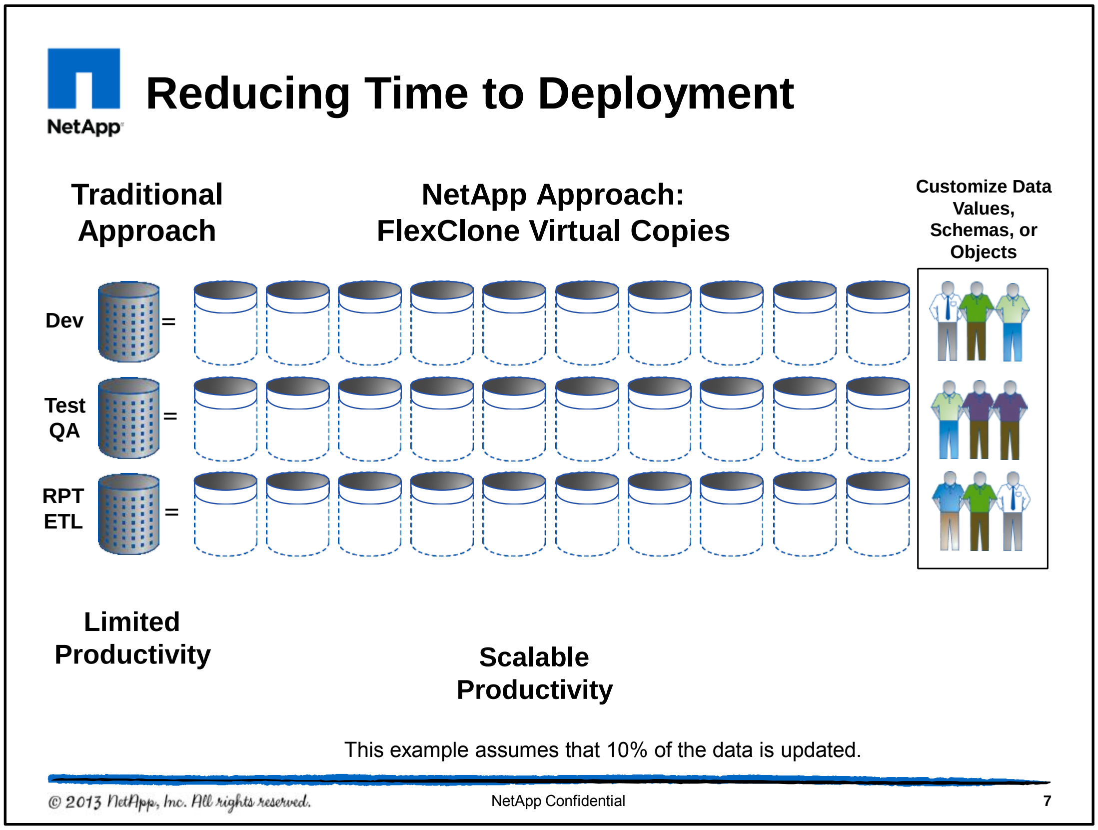
WHAT IF?



CLONING DATABASES WITH FLEXCLONE TECHNOLOGY

Consider this example: You create a volume for a production database. You then create a Snapshot copy of that database, for purposes of instant backup. Recall that, with the exception of a very small amount of metadata, the Snapshot copy does not occupy additional space. New blocks are allocated only as the active file system changes.

You can create a FlexClone volume from that Snapshot copy, without creating any new blocks. Then, another server can start a database instance against the cloned data (perhaps for development purposes). Additional space is consumed only as the FlexClone volume changes. The rate of change of the data within the FlexClone volume is only 5-10%, which offers significant benefit over methods that consume 100% additional storage resources for each clone you create. Therefore, you can create a rapid replica of a production volume using a fraction of the storage.



REDUCING TIME TO DEPLOYMENT

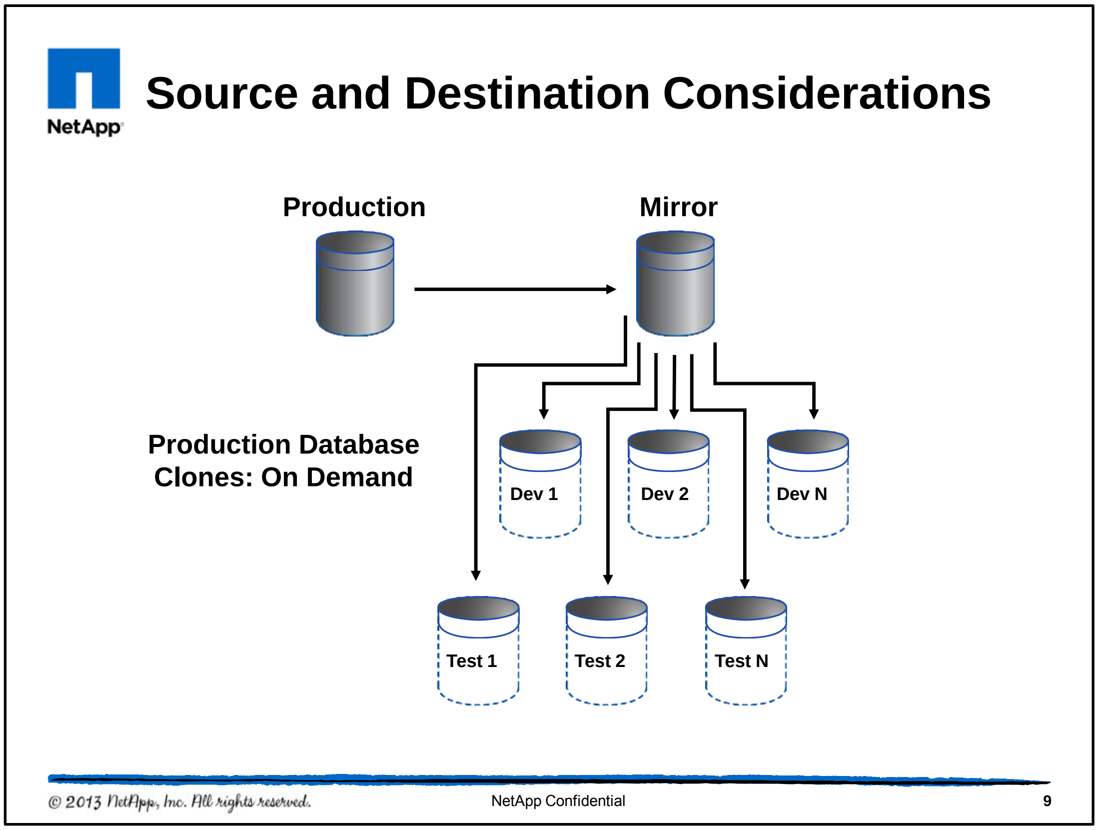
In addition to the storage savings of a FlexClone volume, it can also be much faster to deploy additional clones of your data. FlexClone technology enables DBAs, storage administrators, and application administrators to consume less than a tenth of the storage resources that are used with traditional cloning methods.

Source and Destination Considerations
Source Payload

- Database deployments:
  – Single-instance (SI)
  – Oracle Real Application Clusters (RAC)
- Database editions:
  – Standard
  – Enterprise
- Database options:
  – Any
  – Caveat: Exadata Hybrid Columnar Compression (EHCC) tables must be uncompressed to be accessed.

SOURCE AND DESTINATION CONSIDERATIONS: SOURCE PAYLOAD

Caveat: Some customers use Oracle Data Guard, a disaster recovery tool, to keep a standby database synchronized with NetApp storage. However, if the source database uses Oracle EHCC, that data is uncompressed when the data is accessed. It is not uncompressed on the standby database or if you create a clone.



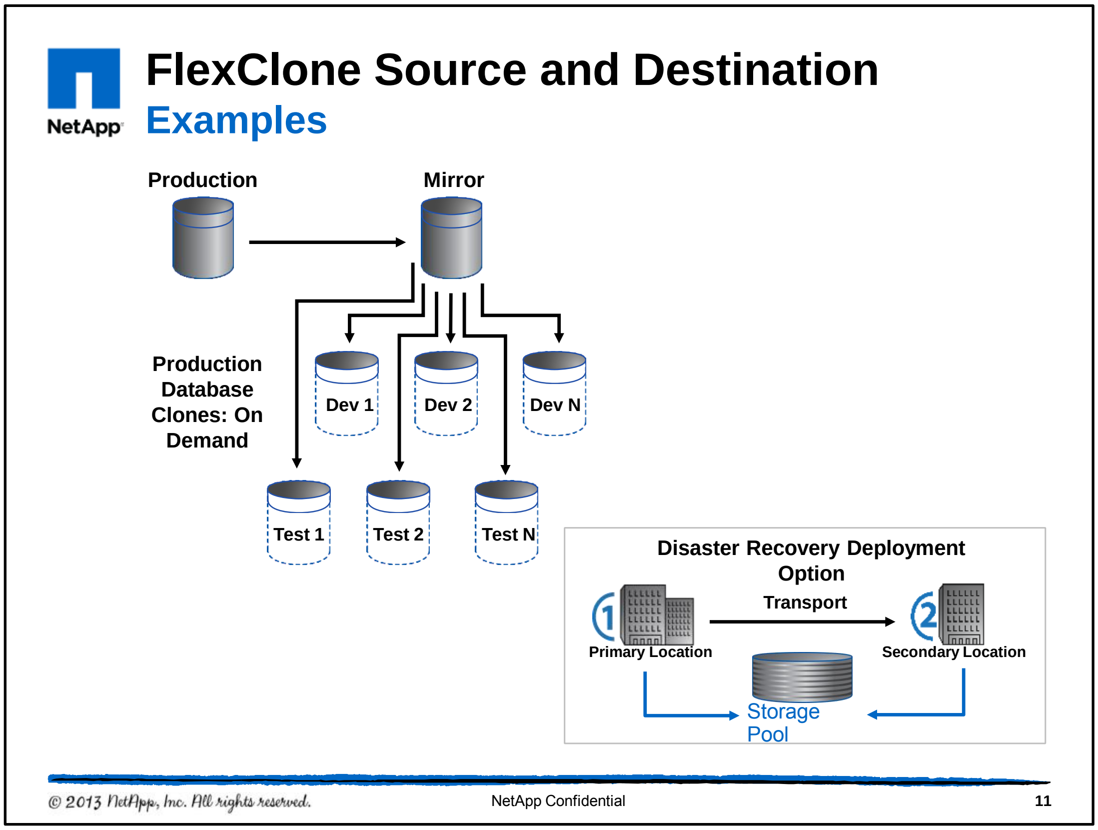
SOURCE AND DESTINATION CONSIDERATIONS

It is acceptable to use different Oracle installation types, such as Standard Edition or Enterprise Edition. You can clone an Oracle RAC database or a Oracle Single Instance database. If you do not need an Oracle RAC environment when you clone multiple databases, then you can still clone the Oracle RAC database as a single-instance database.

FlexClone Source and Destination

- You can create FlexClone copies of databases from different types of destinations:
  - SnapMirror targets
  - SnapVault targets
  - Data Guard targets
- You can also create FlexClone copies of databases locally from the source database.
- Your requirements determine what you choose.

FLEXCLONE SOURCE AND DESTINATION



FLEXCLONE SOURCE AND DESTINATION: EXAMPLES

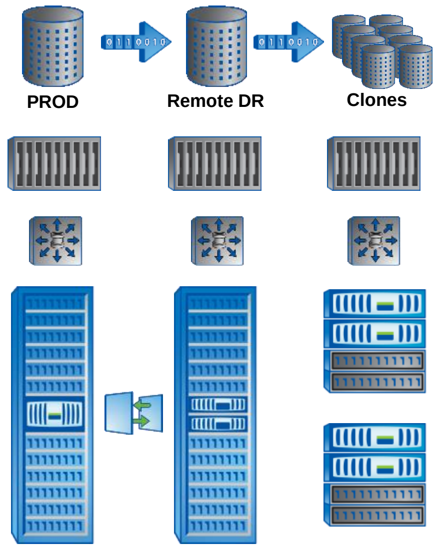
Your requirements determine the location you use to clone a database. Some locations can create a cloned database from a consistent backup that is created by Snapshot technology. Remember that a SnapMirror Snapshot copy is not an application-consistent backup. A SnapVault Snapshot copy is an application-consistent backup, depending on the SnapVault configuration.

New Database Development

- Mirror PROD for initial copy (DR).
- Clone database replicas as needed.
- Create Snapshot copies of replicas for instant SnapRestore of working databases.
- Exploit multiple mirrors to increase fan-out replication and support multiple sites.

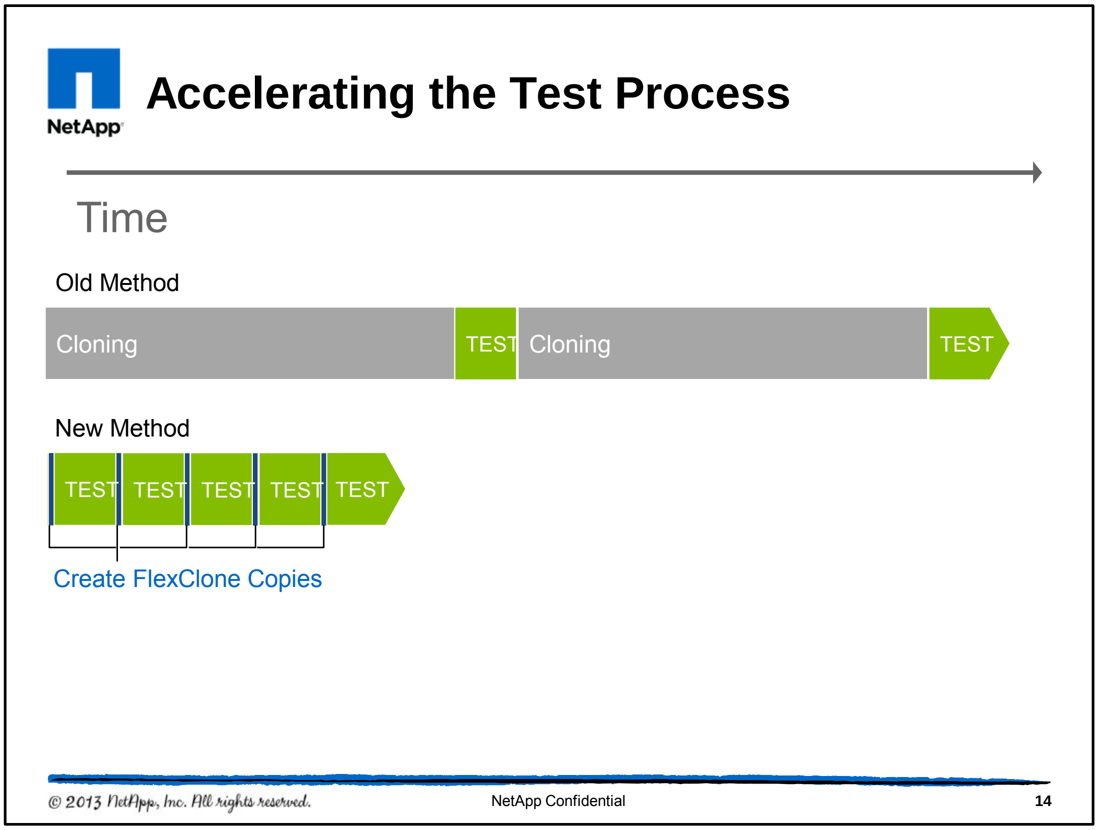
NEW DATABASE DEVELOPMENT

New Database Development Methodology



Develop • Test • Deploy

NEW DATABASE DEVELOPMENT METHODOLOGY



ACCELERATING THE TEST PROCESS

There are some cases where a customer asks for a backup of a test bed at a specific milestone, or the customer wants to execute a new database clone based upon a milestone for other teams. Traditional cloning technology is very time-consuming. NetApp technology enables the development team themselves to clone a database, regardless of size, in minutes. The savings in overall test bed preparation time are tremendous. The team can do more testing over a shorter time frame and shorter overall cycle time. (These benefits apply to other steps in the development and testing cycle also.

Benefits:

Recovery of SAP in about 30 minutes (compared with two days)

Ability to keep multiple Snapshot copies

Ability to replicate data to a DR facility and use the DR environment as a test environment

Ability to create a clone of PRD SAP in 20 minutes (compared with 2 days)

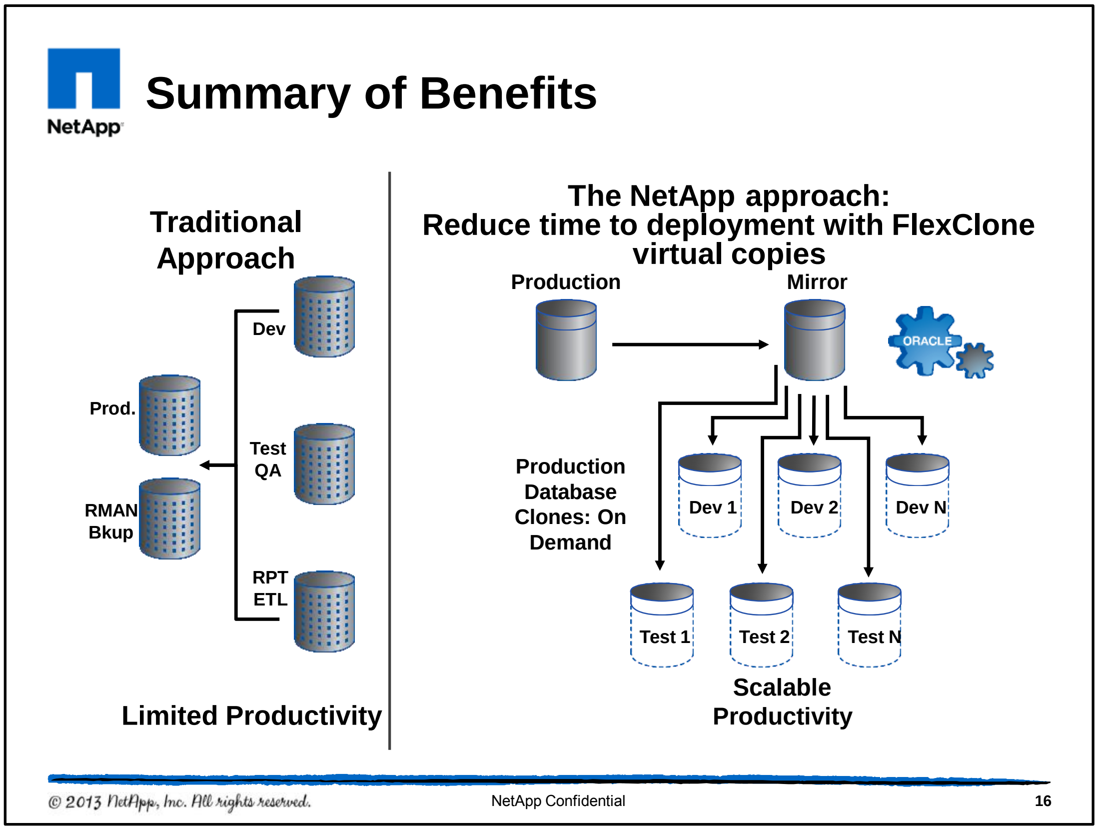
Rapid deployment for testing

Savings of a significant amount of money while increasing functionality and performance

Improving the Test Process

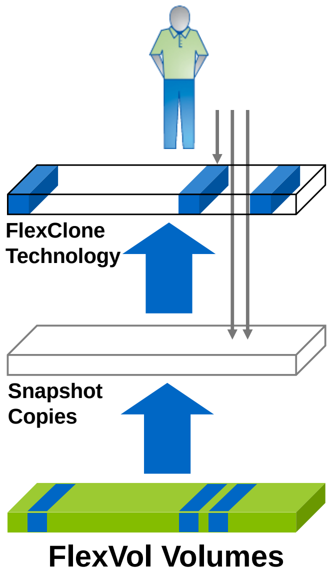
- Speed:
  Database copies that are created in minutes
- Quality
  – More copies to more people
  – Time saved to enable more testing

IMPROVING THE TEST PROCESS



SUMMARY OF BENEFITS

FlexClone Technology
A Quick Technical Review

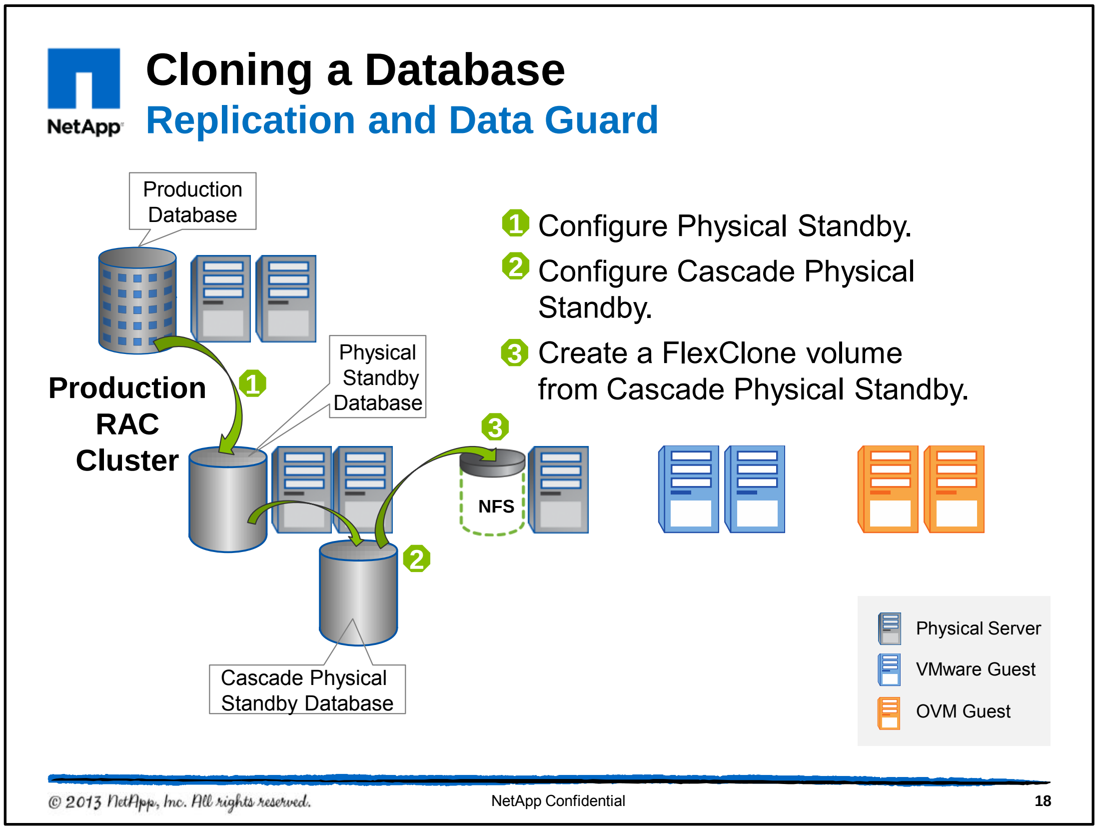


- Test and production copies
  - Database simulations
  - Software testing
- Significant cost savings

FLEXCLONE TECHNOLOGY: A QUICK TECHNICAL REVIEW

A FlexClone volume is a readable and writable Snapshot copy where new blocks (updates to the database) are associated to your FlexClone volume. In the example, a “parent” FlexVol volume is at the bottom, and a backup of that environment was created using Snapshot technology. (Recall that a Snapshot is a “picture” of that FlexVol volume at that exact point in time.)

The FlexClone volume uses the data that is represented by the Snapshot copy, so it points back to the parent FlexVol. When the data is updated, those changes are represented in the FlexClone volume. The FlexClone volume looks, feels, and appears to the OS like a fully populated file system, yet it uses only a small percentage of space.



CLONING A DATABASE: REPLICATION AND DATA GUARD

The production environment to clone from a Data Guard database can be an Oracle RAC or Single-Instance environment. You establish a physical standby database, which is the Data Guard database. You also have a cascading physical standby database (in this example). You then can create a FlexClone database to a different host or the same host, using the physical standby database.

The ability to easily create a FlexClone volume from a DR site without interrupting your DR activity is an advantage.

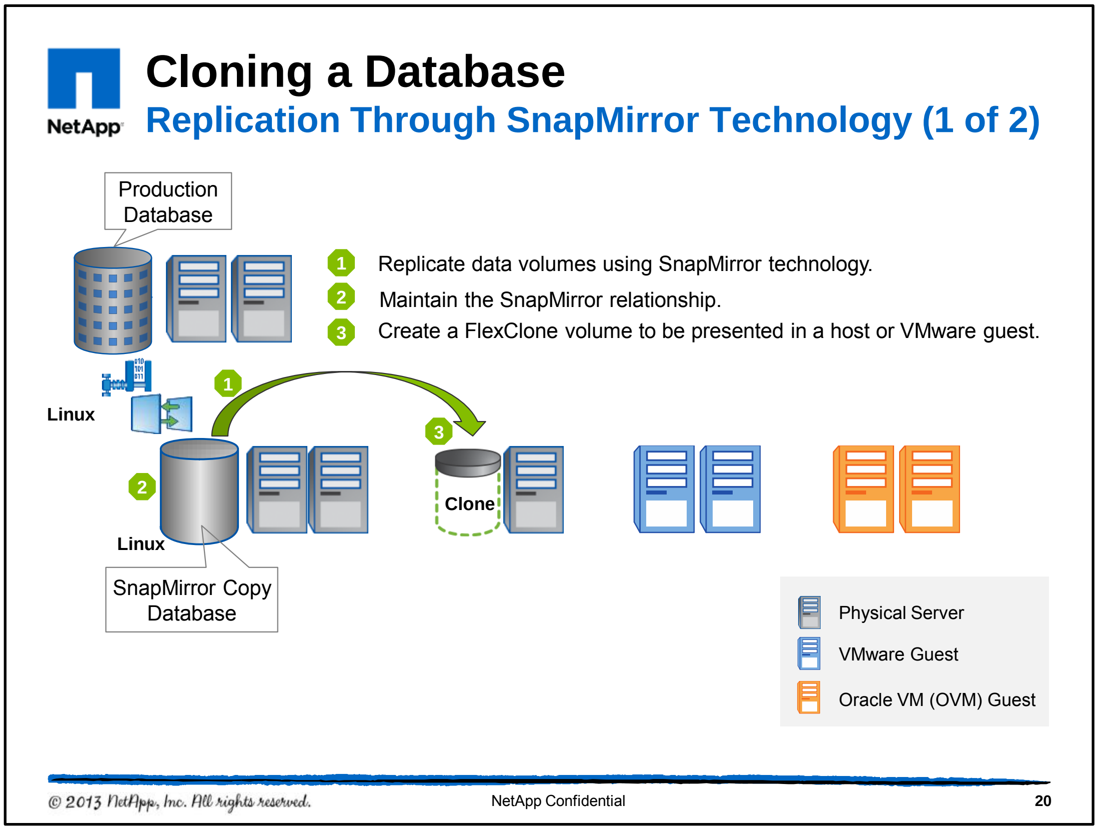
Cloning a Database

Replication Through Data Guard

Issues to consider:

- Production can be on a different OS platform and on storage other than NetApp storage.
- Production can even be a different protocol.
- The file system layout can be different, which means that you can have a different storage design tier for this environment.
- The Data Guard target can become the source for multiple clones.
- The database must be on NetApp storage to use Snapshot copies and FlexClone volumes.

CLONING A DATABASE: REPLICATION THROUGH DATA GUARD



CLONING A DATABASE: REPLICATION THROUGH SNAPMIRROR TECHNOLOGY (1 OF 2)

This example shows how you use NetApp SnapMirror technology to populate a DR or SnapMirror destination. You then can create a FlexClone volume using the SnapMirror destination as your source. You need to use only the application-consistent backup that was created on the production database. SnapMirror is a true mirroring technology. It mirrors at the storage level, which is a physical image of your production environment. Thus, the Snapshot copies that are created on the production database are part of the SnapMirror environment also.

In this example, the FlexClone volume was created on an OVM Guest. You can also use a physical server of a virtualized host, if the storage is visible by the host that you use for the cloned database. Also, when you use SnapMirror technology as your source of data, then the file system layout and host OS need to be the same as the source database.

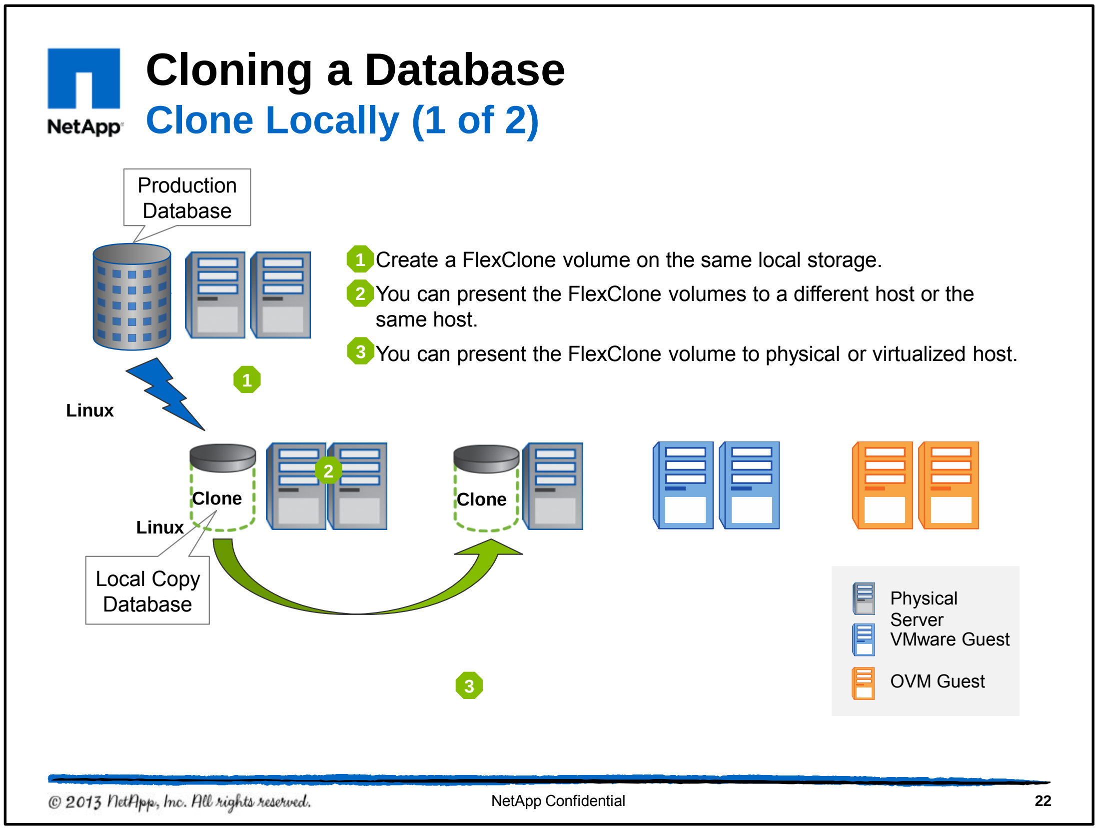
Cloning a Database
Replication Through SnapMirror Technology (2 of 2)

Issues to consider:

- Production must be the same OS.
- Production and the remote site must be NetApp storage.
- Production and the remote site must use the same protocol.
- Refresh the mirror target after each backup.
  - A SnapMirror target is a physical image.
  - If you delete a Snapshot backup on the primary, an update to the SnapMirror relationship tries to delete the backup on the secondary. If the backup is being used, the SnapMirror relationship stops.
- Consider the requirement that the FlexClone volume must be split if its life span is longer than that of the Snapshot copy.

 NetApp Confidential 21

CLONING A DATABASE: REPLICATION THROUGH SNAPMIRROR TECHNOLOGY (2 OF 2)



CLONING A DATABASE: CLONE LOCALLY (1 OF 2)

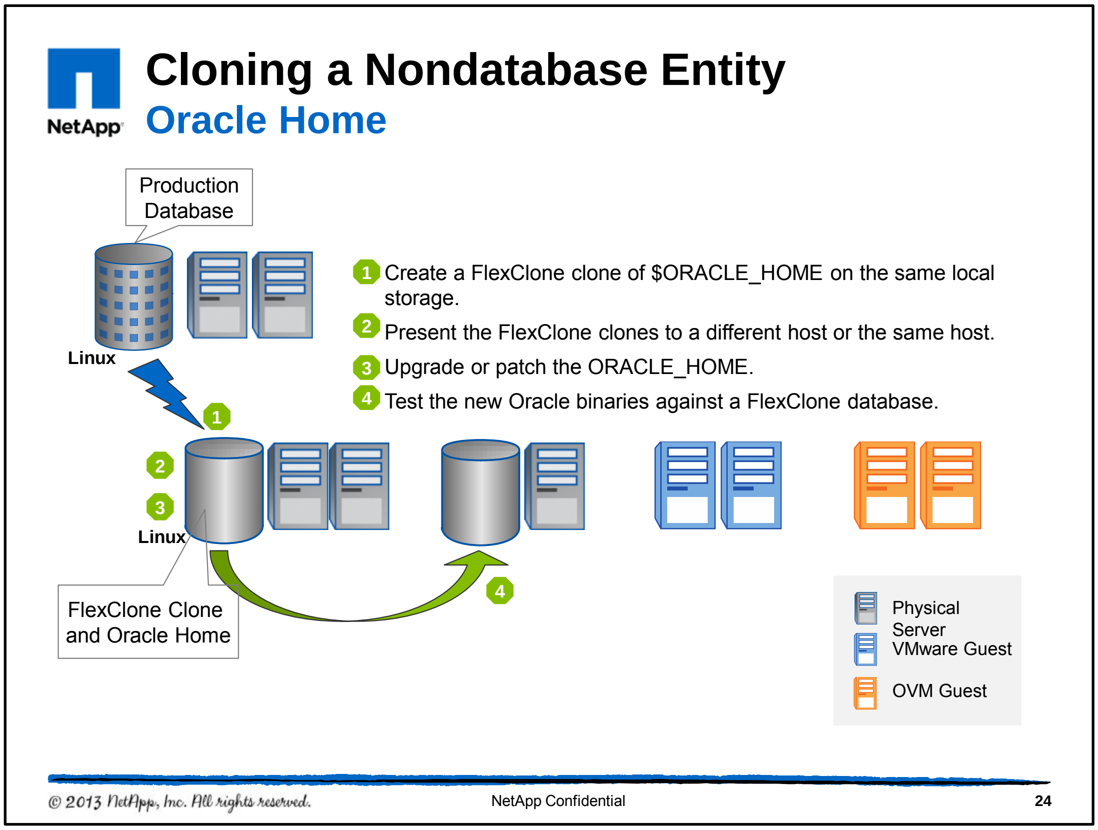
This example shows ho you can clone the database locally. You use the production database backup and then create a FlexClone volume on the same storage. You can present the FlexClone volumes to the same host, a different host, or even an OVM Guest.

Cloning a Database
Clone Locally (2 of 2)

Issues to consider:

- The FlexClone clones are created on the production database FlexVol volumes and are local to the production storage.
- These clones are commonly used on the same host.
- These clones can also be used on a virtualized host.
- This method is often used when business needs require the quick creation of clones.
- What is the impact to the production environment? It depends. (Review the discussion of FlexClone technology for details.)

CLONING A DATABASE: CLONE LOCALLY (2 OF 2)



CLONING A NONDATABASE ENTITY: ORACLE HOME

This example shows how to clone entities outside of an Oracle database. This could be a file system that contains data that is associated to the database or the $ORACLE_HOME installation.

The ability to quickly create a FlexClone volume of Oracle binaries, as well as a database to test against, can dramatically reduce the time it takes to apply patches from Oracle. You can apply a one-time patch to correct a bug, which requires an update to the structures of the database as well as a binary patch. FlexClone technology enables you to accomplish those tasks much faster.

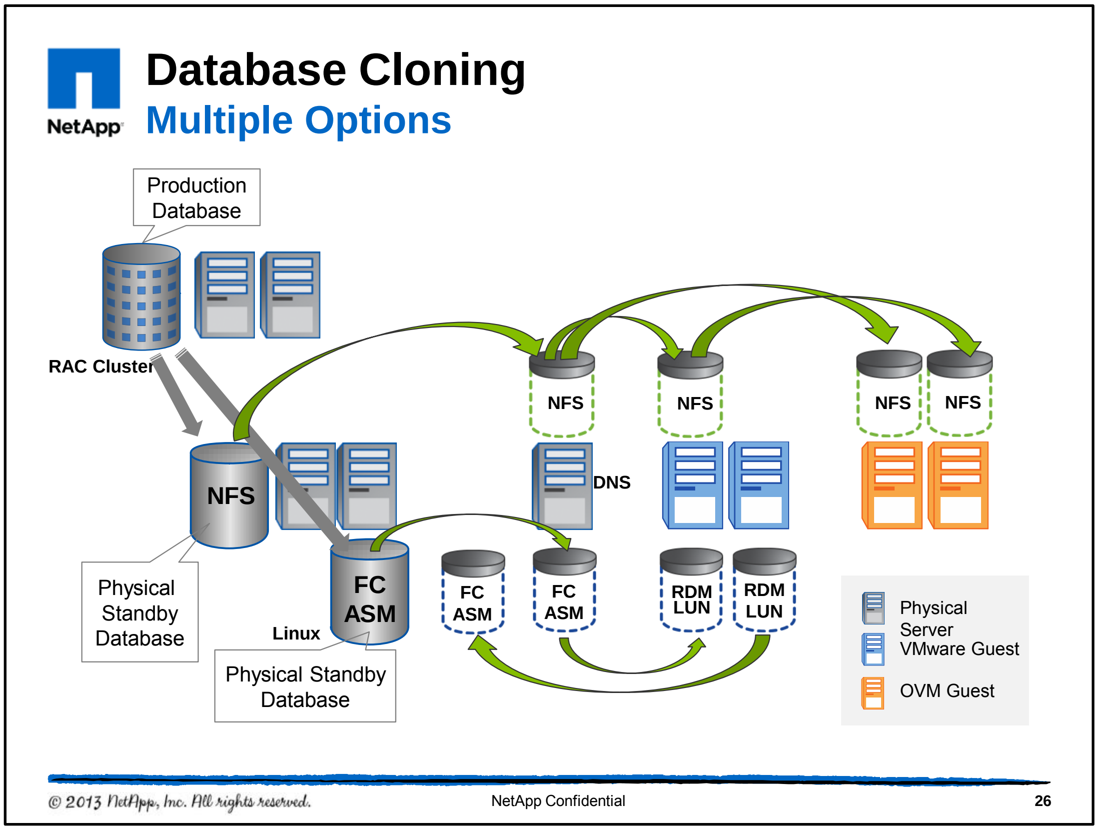
Cloning a Non-Database Entity
Example

What can you clone besides databases?

- You can clone a readily available copy of your Oracle installation.
- You can run various tests for upgrades:
  – Create multiple FlexClone clones of Oracle Home and the database.
  – Refresh the test environment without needing to reapply patches.
- If the upgrade patch is bad, then you can quickly revert the environment back to the time immediately prior to the application of the patch.

 NetApp Confidential 25

CLONING A NON-DATABASE ENTITY: EXAMPLE



DATABASE CLONING: MULTIPLE OPTIONS

FlexClone cloning technology offers multiple new solutions to previously difficult issues in database creation.

FlexClone Volume Clones
Considerations

- FlexClone volume clones provide instant, writable clones of Oracle databases, without doubling disk space utilization.
- You can split FlexClone volume clones into two separate entities (at that point, disk space is used.)
- FlexClone technology provides less time-consuming solutions for test and development engineers.

FLEXCLONE VOLUME CLONES: CONSIDERATIONS

Cloning a Database
Methods for Cloning

Multiple ways to clone a database:

- Use either a script, CLI, or the Data ONTAP API as part of your solution.
- Use NetApp Snap Creator Framework with Linux host commands.
- Use SMO to provide a layer of abstraction for host commands.

NOTE: These methods require knowledge of Oracle and NetApp technology.

 28

CLONING A DATABASE: METHODS FOR CLONING

Cloning a Database
Snap Creator Framework: Steps 1–6

1. Back up and create FlexClone volume clones of database volumes.
2. Create file systems on the new host.
3. Mount FlexVol volumes to the new file systems.
4. Create an init.ora file to suit the needs of the clone database instance.
5. Modify the control file to suit the new clone database instance.
6. Start the clone database image in "nomount" mode.

CLONING A DATABASE – SNAP CREATOR FRAMEWORK: STEPS 1–6

The Snap Creator Framework communicates with the Oracle database when creating a consistent backup. Yet, you need to execute the illustrated steps to ensure that the cloned database is operable.

Cloning a Database

Snap Creator Framework: Steps 7–12

7. Re-create the control file by using the `create controlfile` command.
8. Identify the SCN that is needed to bring the clone database datafiles to consistency.
9. Identify the archived logs from the SCN to enable recovery.
10. Recover the clone database by using the correct archived logs.
11. Open the new database with reset logs without cloning the redo logs.
12. Create a parameter file.

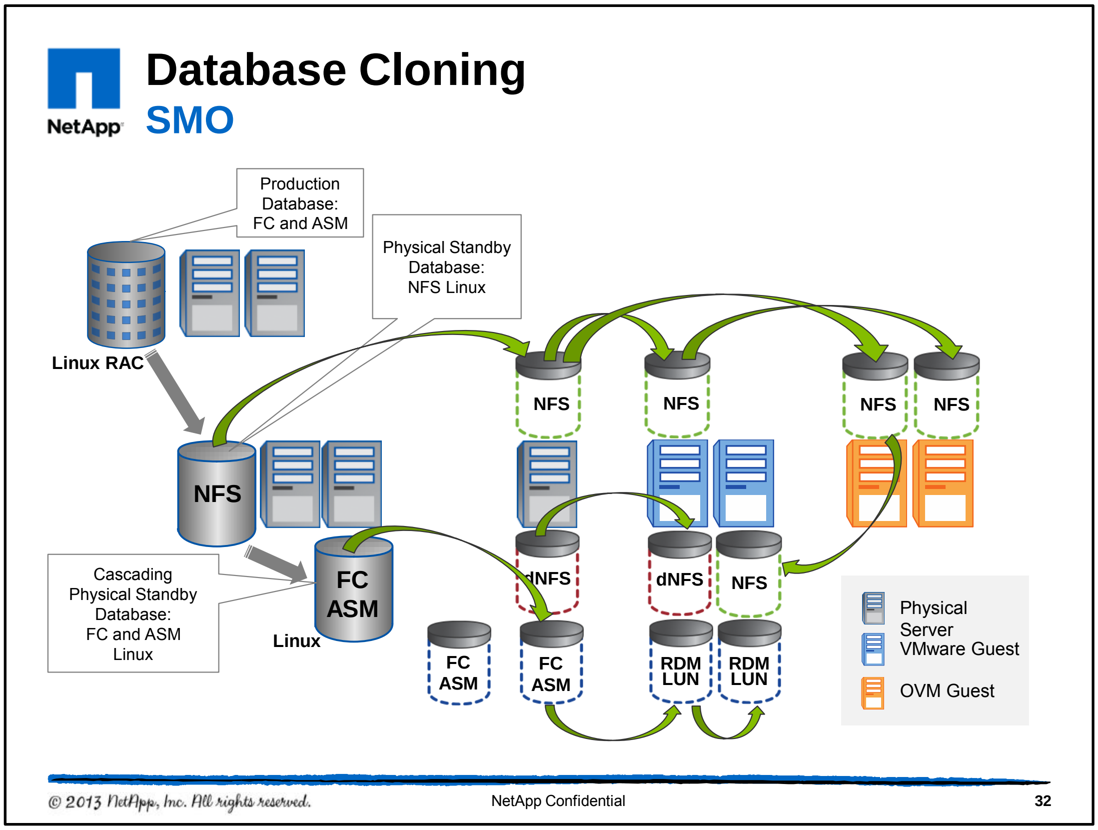
CLONING A DATABASE – SNAP CREATOR FRAMEWORK: STEPS 7–12

Cloning a Database

Snap Creator Framework: Steps 13 –17

13. Shut down the database instance.
14. Execute the `DBNEWID` utility to set the new `DBID` and the new `DBNAME`.
15. Rename the global database with the name of the clone database.
16. Re-create the server parameter file.
17. Restart the clone database.

CLONING A DATABASE – SNAP CREATOR FRAMEWORK: STEPS 13–17



DATABASE CLONING: SMO

You can also use SMO to create a cloned database on your local host or an alternative host. Be sure the Unix host has visibility to the storage where the FlexClone resides.

Cloning a Database

Summary

- You can use local, co-located, or remote (alternate) storage.
- You can use the same host, the co-located host, or the remote host.
- The replication method is needed only for a different location or storage and depends on your expertise and requirements.
- This method might seem labor-intensive, but it is quicker to complete with NetApp technology than with other technologies.

CLONING A DATABASE: SUMMARY

Key Takeaways

- Description of FlexClone clones
- Use cases for cloning a database
- Available tools for cloning a database
- Workflow for cloning a database
- Storage layout impact of cloning a database

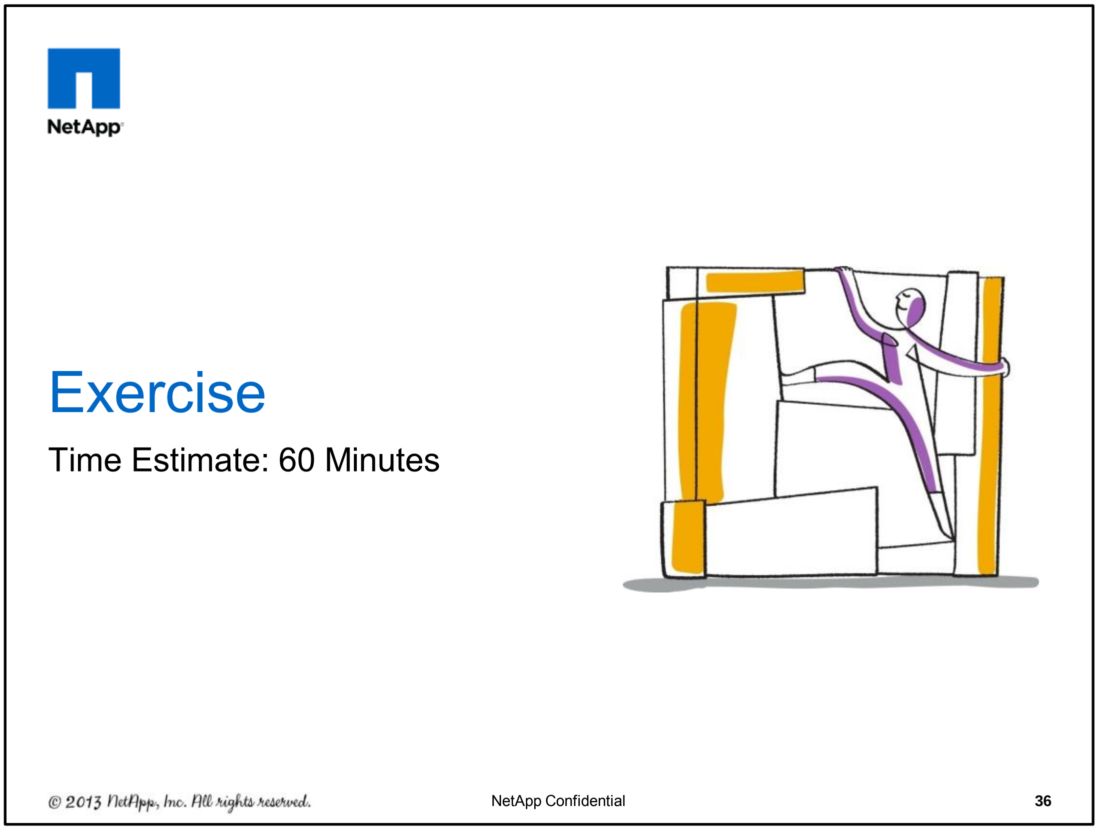
KEY TAKEAWAYS

Module Summary

Now that you have completed this module, you should be able to:

- Describe use cases for cloning Oracle databases
- Identify the components that are needed for a clone creation
- Identify which objects to clone
- Use SMO to clone an Oracle database

MODULE SUMMARY



EXERCISE

Please refer to your exercise guide.

NetApp

Module 9

Disaster Recovery for Oracle Databases

MODULE 9: DISASTER RECOVERY FOR ORACLE DATABASES

Module Objectives

After this module, you should be able to:

- Describe disaster recovery plans and issues for Oracle databases
- Describe NetApp SnapMirror technology for Oracle databases
- Describe a SnapMirror disaster recovery scenario
- Implement recovery options
- Leverage Oracle Data Guard when implementing Oracle on NetApp storage

MODULE OBJECTIVES

Lesson 1

Your Disaster Recovery Plan

 NetApp Confidential 3

LESSON 1: YOUR DISASTER RECOVERY PLAN

Your Disaster Recovery Plan
The Issues

- How much of your organization’s resources can be lost?
- What are the total costs?
- What efforts are required to rebuild?
- How long will it take to recover?
- What is the impact on your overall organization?

 NetApp Confidential 4

YOUR DISASTER RECOVERY PLAN: THE ISSUES

Business Prioritization

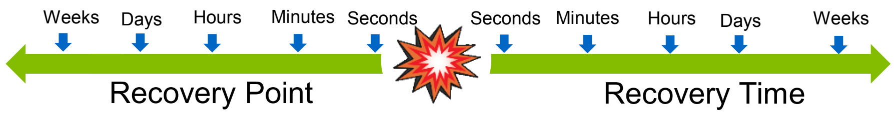
Impact on Business	Typical Business Functions	Application Example
Mission-critical	Customer-facing or revenue-generating	E-commerce, customer support, and stock market
Business-critical	Cross-organization operational	Back office, email, accounting, and manufacturing
Operationally important	Departmental	Human Resources Management System (HRMS) and the file and print server

NOTE: The categories and applications that are listed in the above table are only examples. Data value and application criticality vary from organization to organization.

Business prioritization leads to data value classification, which leads to the disaster recovery plan, which informs your storage design.

BUSINESS PRIORITIZATION

Your Disaster Recovery Plan
Recovery Objective



Business Concerns	Description
Recovery time objective (RTO)	▪ **The point in time by which data must be restored** ▪ **The acceptable time loss**
Recovery point objective (RPO)	▪ **The point to which data must be restored** ▪ **The acceptable data loss (which determines the data currency)**
Type of disaster	**The type and scope of failure that results in data loss**

The nature of the industry, the organization, and the systems in place affect RTO and RPO.

YOUR DISASTER RECOVERY PLAN: RECOVERY OBJECTIVE

Consider these scenarios that illustrate the concepts of RTO and RPO:

Example 1: A law firm with 50 attorneys determines that, if there is a system failure, it is acceptable for client files to be inaccessible for 48 hours (RTO). But, since the attorneys input data directly into the systems rather than on paper first, near zero data loss is acceptable (RPO).

Example 2: A $50 million insurance agency, whose business is dependent on being available to its customers when a disaster strikes, experiences a flood that causes widespread damage. The agency must be back online processing customer claims in four hours (RTO). However, the agency's client interactions have a front-end paper trail, so reentry of a small amount of data prior to the failure is acceptable: a two-hour RPO.

NetApp

Your Disaster Recovery Plan

Gartner Sample: Availability, RTO, and RPO

Class	Business Process Service	Service Level				
		Scheduled Hours and Days	Availability		RTO	RPO
			Per-cent-age	Down-time		
1	▪ Customer- and partner-facing ▪ Functionally critical to revenue generation	24 x 7	99.99%	52.5 minutes annually	30 minutes	0 minutes
2	▪ Less critical but revenue-generation-functional ▪ Supply-chain-related	24 x 6.75	99.5%	8.7 hours annually	8–24 hours	4 hours
3	▪ Enterprise back-office-functional	18 x 7	99%	Less than 5.5 hours monthly	3 days	1 day
4	▪ Department-functional	24 x 6.5	98%	Less than 13.5 hours monthly	5 days	1 day

YOUR DISASTER RECOVERY PLAN – GARTNER SAMPLE: AVAILABILITY, RTO, AND RPO

<u>**Availability Target**</u>	<u>**Amount of Downtime per Year**</u>
99.999%	5 minutes
99.99%	52 minutes
99.9%	525 minutes (8.7 hours)
99%	87 hours (1.7 hours per week)
98%	3 hours 18 minutes per week
95%	8 hours per week (1 hour 12 min per night)

Key Disaster Recovery Requirements

- Survive a disaster and preserve data consistency.
- Produce an I/O-consistent copy of data at the secondary location.
- Provide emergency restart capability.
- Provide asynchronous schedule flexibility.
- Provide synchronous capability.
- Provide the ability to re-establish application connectivity.

KEY DISASTER RECOVERY REQUIREMENTS

Your Disaster Recovery Solution

- Local:
  – Disk protection and RAID
  – Snapshot copies for file recovery
  – SnapRestore software for volume recovery
  – Oracle Data Guard
- Remote:
  – Replication without read access on the destination
  – Replication with read access on the destination
  – Replication with failover recovery
  – Oracle Data Guard

 NetApp Confidential 9

YOUR DISASTER RECOVERY SOLUTION

Disaster Recovery Solutions and Protection

Solution	Protection
NetApp Snapshot technology	▪ Provides a point-in-time version of the file system
NetApp SnapRestore technology	▪ Recovers a file system from Snapshot copies
NetApp SnapMirror technology	▪ Provides disaster recovery locally, remotely, or both
Oracle Data Guard	▪ Provides different configurations for different needs ▪ Provides host-based disaster recovery at the database level

DISASTER RECOVERY SOLUTIONS AND PROTECTION

Lesson 2

NetApp SnapMirror Basics

 NetApp Confidential 11

LESSON 2: NETAPP SNAPMIRROR BASICS

SnapMirror Technology
Definition

SnapMirror technology is a thin replication solution that is based on Data ONTAP Snapshot technology.

SNAPMIRROR TECHNOLOGY: DEFINITION

What SnapMirror Does

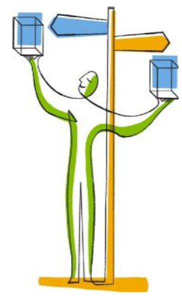
- Replicates volumes from source to destination NetApp storage systems
- Supports synchronous, semi-synchronous, and asynchronous modes
- Transfers only changed unique blocks in 4-KB increments
- Reduces bandwidth requirements by 70% with native network compression
- Provides a block level image of the source data

WHAT SNAPMIRROR DOES

Consistent Snapshot Copies and Oracle

Application-coordinated Snapshot copies do the following:

- Create backups in database hot backup mode
- Meet the requirements of Oracle for third-party Snapshot copies as a backup
- Use data protection and application-coordinated Snapshot copies



CONSISTENT SNAPSHOT COPIES AND ORACLE

Lesson 3

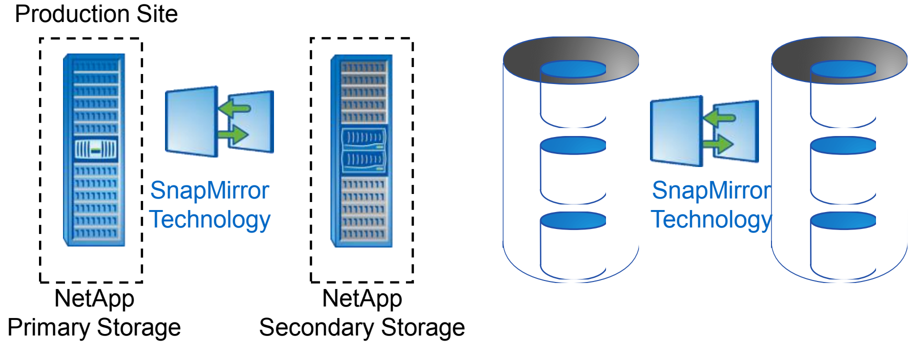
A SnapMirror and Oracle Disaster Recovery Scenario

 NetApp Confidential 15

LESSON 3: A SNAPMIRROR AND ORACLE DISASTER RECOVERY SCENARIO

Disaster Recovery Scenario

Database Recovery with SnapMirror Technology



FlexVol Volume	SnapMirror Copy	Application Snapshot Copy
oradata	1 hour	1 hour
oractl	1 hour	1 hour
oraarch	Every 10 minutes	Every 10 minutes

 NetApp Confidential 16

DISASTER RECOVERY SCENARIO: DATABASE RECOVERY WITH SNAPMIRROR TECHNOLOGY

Consider the elements of a database that you need in order to reduce the amount of data loss at the disaster recovery site.

Description of the Database Environment
The Database Server

- Oracle Home on the local host: /u01/app/oracle/product/11.2.0/db_1
- init.ora on the local host: $ORACLE_HOME/dbs/initoraclass.ora

DESCRIPTION OF THE DATABASE ENVIRONMENT: THE DATABASE SERVER

Description of the Database Environment
The Database Layout

Flexible Volumes	Database Data Files
oradata	/oracle/oraclass/oradata/oraclass/*.dbf
oractl	/oracle/oraclass/oractl/oraclass/control01.ctl /oracle/oraclass/oractl/oraclass/control02.ctl
oraarch	/oracle/oraclass/oraarch/oraclass/*.dbf
oraredo	/oracle/oraclass/oraarch/oraclass/redo_01.log /oracle/oraclass/oraarch/oraclass/redo_02.log /oracle/oraclass/oraarch/oraclass/redo_03.log
oratemp	/oracle/oraclass/oratemp/oraclass/temp*.dbf

DESCRIPTION OF THE DATABASE ENVIRONMENT: THE DATABASE LAYOUT

SnapMirror Use Case Example

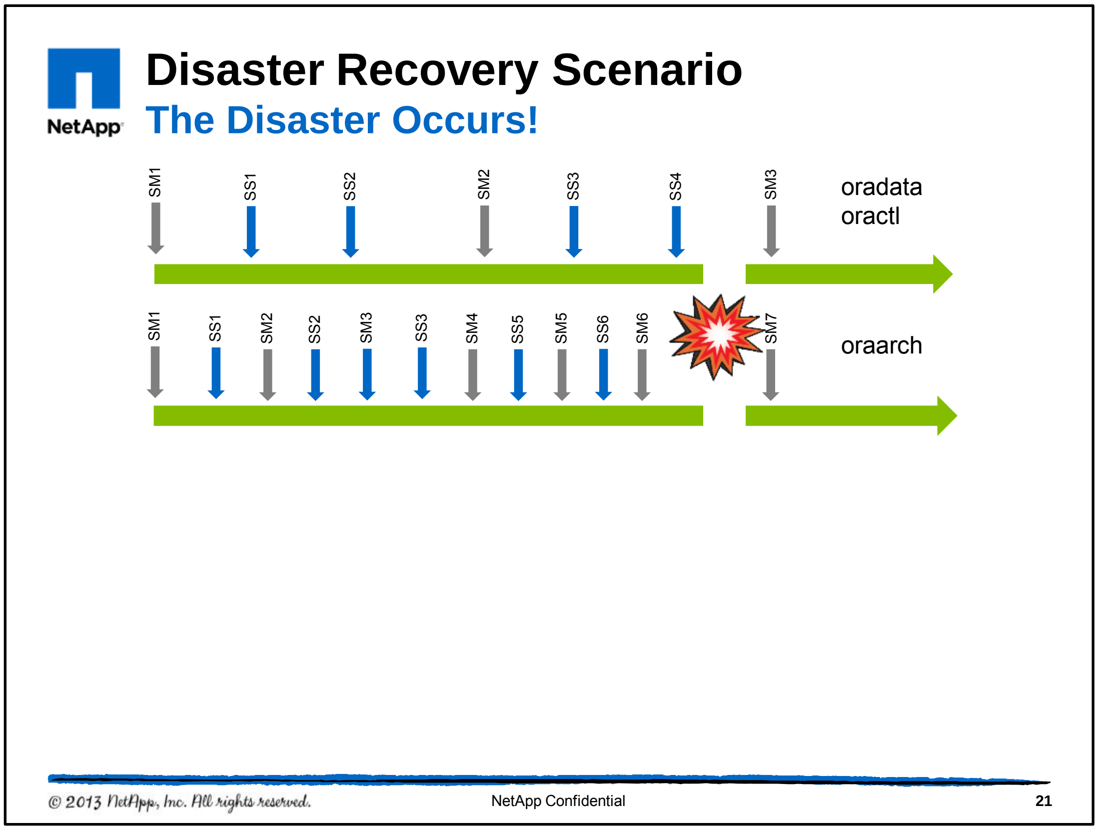
- Create a SnapMirror copy of the Oracle archive logs every 10 minutes (frequency depends on RPO and RTO).
- Coordinate the Oracle backup schedule and SnapMirror updates every hour.
- Create the backup copy, and then update the SnapMirror replica.

SNAPMIRROR USE CASE EXAMPLE

Setting Up SnapMirror Disaster Recovery

1. Ensure that you have an established SnapMirror relationship: oradata, oraarch, and oractl.
2. Create a backup of the Oracle database.
3. Execute the SnapMirror update for the data files and the control files.
4. Execute a SnapMirror update for the Oracle archive logs every 10 minutes.

SETTING UP SNAPMIRROR DISASTER RECOVERY



DISASTER RECOVERY SCENARIO: THE DISASTER OCCURS!

To use the SnapMirror target for disaster recovery, you have to make your FlexVol volumes available to a Linux host.

Use the application-consistent Snapshot copies to restore the data components to the disaster recovery site.

Consider the timeline in this example. Use the SS2 Snapshot copy for the oradata and oractl FlexVol volumes. You do not need to do any restores for the archive log data.

Why do you go back to SS2 instead of SS3 or SS4?
Because the Snapshot copies were created after the last SnapMirror volume and prior to the next one.

Now, the disaster recovery site looks like it did at the time of the SS$ snapshot, with the exception of the archive logs.

Disaster Recovery Scenario
Using Snapshot Copies

Use application-coordinated Snapshot copies to recover the database:

1. Make database volumes writable.
2. Break the SnapMirror relationships.
3. Execute a SnapRestore update to the latest application-coordinated Snapshot copy for oradata and oractl.

DISASTER RECOVERY SCENARIO: USING SNAPSHOT COPIES

Disaster Recovery Scenario
Steps to Recover the Database

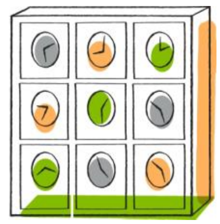
1. Prepare the host discontinue use of the FlexVol volumes are unavailable.
2. Mount the SnapMirror replicas of the database data files.
3. If necessary, regenerate your control file from a “backup to trace” SQL.
4. Follow the process to clone a database.
5. Apply all available logs.
6. Open the database with the Oracle resetlogs option.

DISASTER RECOVERY SCENARIO: STEPS TO RECOVER THE DATABASE

Disaster Recovery Scenario
RPO and the Redo Logs

RPO is defined as the data that is lost in a window of time that involves the following:

- The last successful SnapMirror update
- The latest archive log that was created
- Any transactions within the online redo buffer

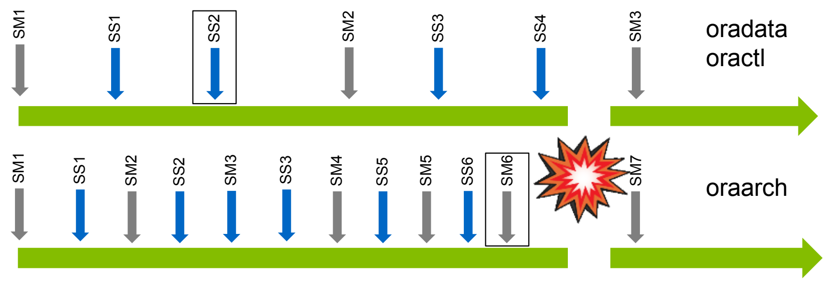


 NetApp Confidential

DISASTER RECOVERY SCENARIO: RPO AND THE REDO LOGS

Disaster Recovery Scenario
Considerations

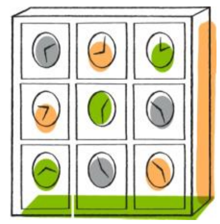
- A disaster occurred prior to the third SnapMirror copy of oradata and oractl FlexVol volumes and after the sixth SnapMirror copy of the oraarch FlexVol volume.
- Which Snapshot copies do you use?
  – Use SS2 for oradata and oractl, the last application-coordinated Snapshot copy on the disaster recovery site.
  – The data that was mirrored from SM6 is used for oraarch. It is not necessary to create a SnapRestore copy.



DISASTER RECOVERY SCENARIO: CONSIDERATIONS

Oracle Data Guard Disaster Recovery

- Oracle Data Guard provides data availability and protection and disaster recovery for production databases.
- Data Guard provides the management, monitoring, and automation software to create and maintain one or more standby databases to protect Oracle databases.



ORACLE DATA GUARD DISASTER RECOVERY

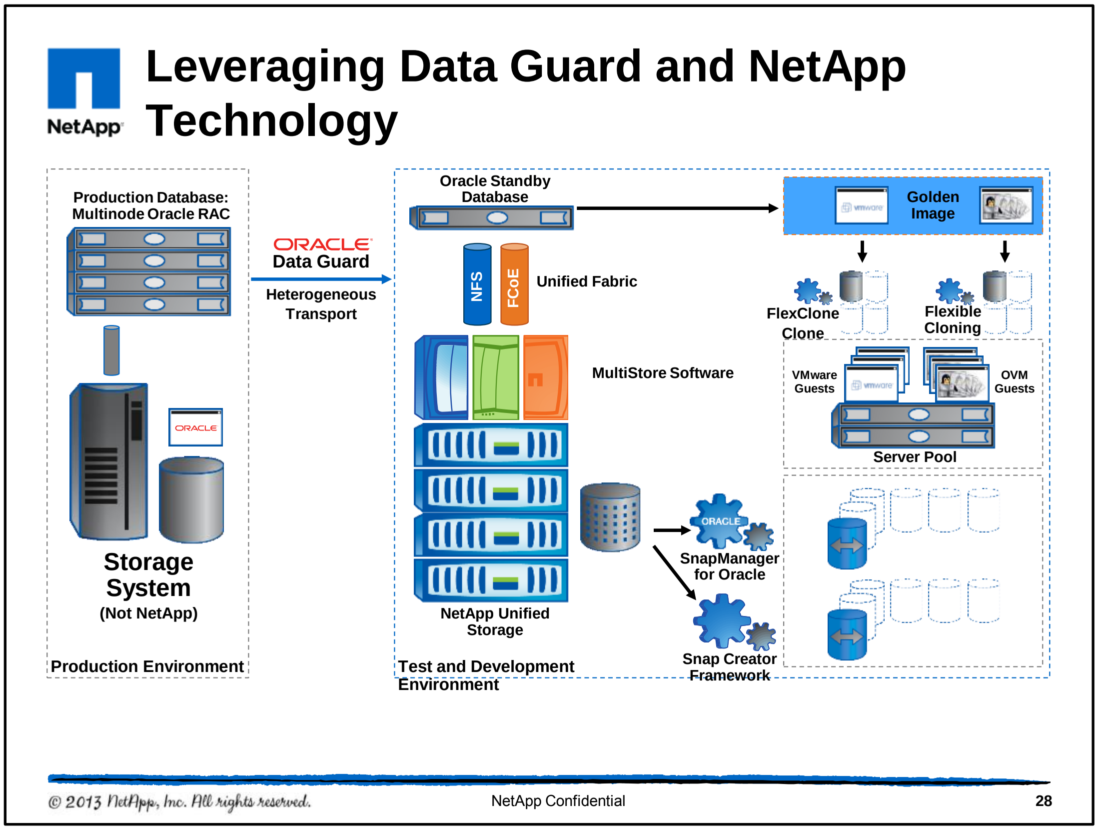
Data Guard Modes of Operation

- Maximum protection:

  Data protection is the highest priority.
- Maximum availability:
  - Availability is the highest priority.
  - Zero data loss is the second-highest priority.
  - If a communication error occurs, the primary starts to save the data until issues are resolved.
- Maximum performance:

  Primary database performance is the highest priority.

DATA GUARD MODES OF OPERATION



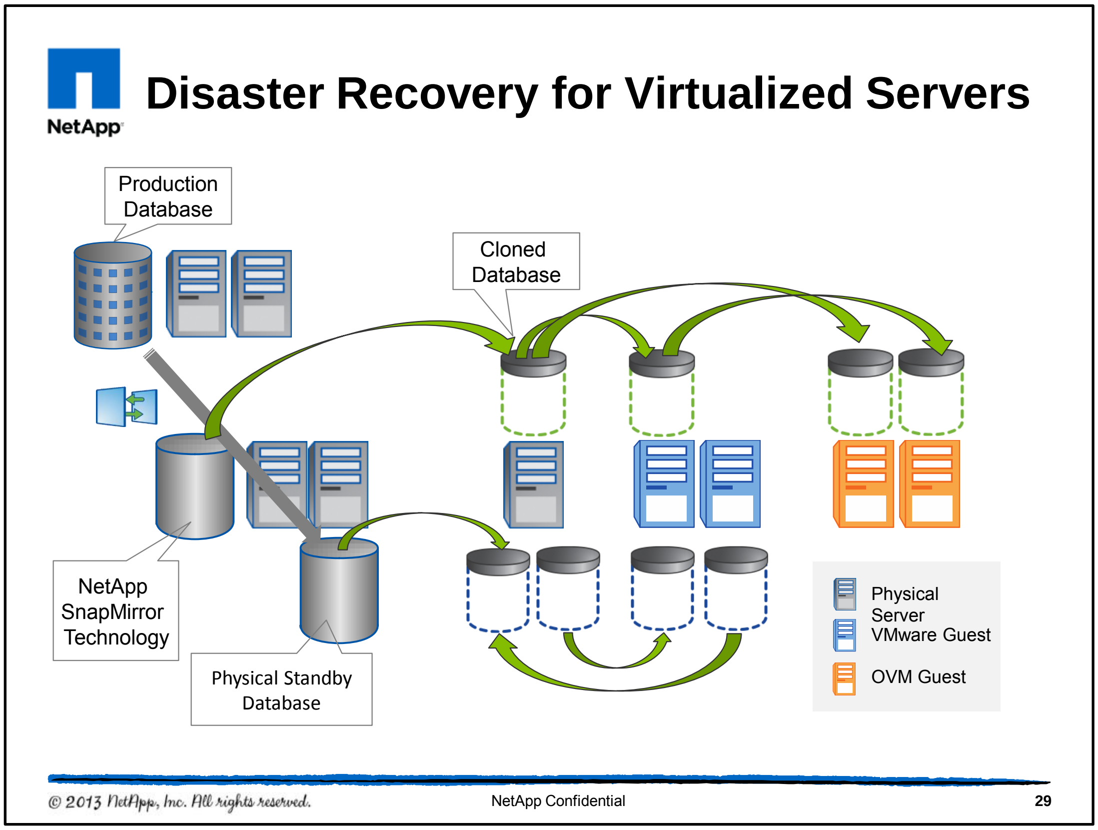
LEVERAGING DATA GUARD AND NETAPP TECHNOLOGY

You can use Data Guard to create a copy of production database within a development and test environment that uses NetApp storage. A database administrator can use NetApp FlexClone technology to make many copies of the Data Guard database. The physical standby database serves as a “golden image”—a source for all development and test environments.

Data Guard can help you transition data for a database. It provides a complete development and test solution that leverages a disaster recovery infrastructure.

Many customers use Netapp SnapMirror technology to instantiate the data for the Data Guard database, which offers the advantages of both tools.

Also consider how a Data Guard environment at a disaster recovery site enables you to use FlexClone technology as a golden image.



DISASTER RECOVERY FOR VIRTUALIZED SERVERS

Module Summary

Now that you have completed this module, you should be able to:

- Describe disaster recovery plans and issues for Oracle databases
- Describe NetApp SnapMirror for Oracle databases
- Describe a SnapMirror disaster recovery scenario
- Recall recovery options
- Recall tips on leveraging Oracle Data Guard when implementing Oracle on NetApp storage

MODULE SUMMARY

Course Summary

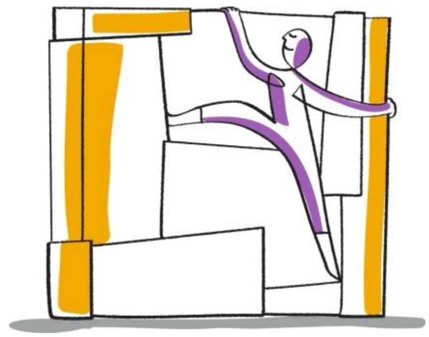
Now that you have completed this course, you should be able to:

- Describe key issues that occur with Oracle database deployments
- Describe key architecture decisions for deploying Oracle on NetApp storage systems
- Provision storage on NetApp systems for Oracle databases
- Configure Oracle databases to use NetApp storage systems
- Use NetApp data management solutions to back up, recover, and clone Oracle databases

COURSE SUMMARY

Exercise

Time Estimate: 60 Minutes



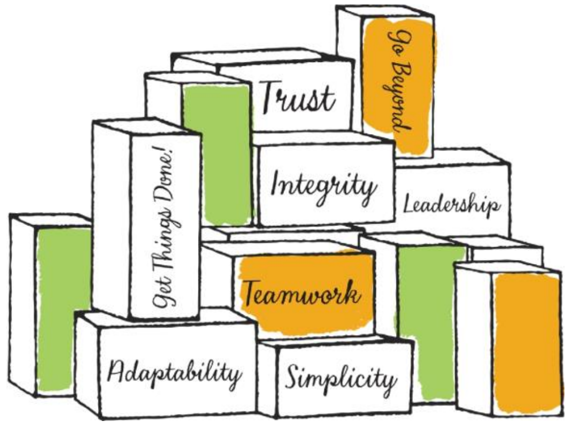
 NetApp Confidential 32

EXERCISE

Please refer to your exercise guide.

NetApp

Thank you



 NetApp Confidential 33

THANK YOU