



Technical Report

Using Oracle Database 10g/11g Automatic Storage Management with NetApp Storage

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1 INTRODUCTION

This technical report shares best practices for using the new Oracle® Database 10g/11g Automatic Storage Management (ASM) feature in conjunction with NetApp® NFS NAS, Fibre Channel, and iSCSI SAN storage products. It also shares information on the best configurations for the combined technology. The partnership between Oracle Database 10g/11g ASM and NetApp storage products is one more example in a long-standing technology relationship that has helped our joint customers realize solutions that leverage technology from both companies.

ASM offers a new way to manage the storage that underlies the database. Built into the Oracle Database kernel, it provides an integrated file system and volume manager for the database files. Starting with 11gR2, ASM is extended to provide the ASM Cluster File System and ASM Dynamic Volume Manager. With this capability, ASM offers an alternative to some third-party file-system and volume management solutions for database and application storage management tasks, such as creating and laying out databases, managing the use of disk space, and hosting application executables and other general-purpose application file data. NetApp storage systems simplify the deployment and management of enterprise data. Both ASM and NetApp storage lower the total cost of ownership and complement each other to offer increased cost savings.

In this technical report, the Oracle DBA can learn about the combined benefits of using NetApp storage for Oracle databases and database layered applications. Like Oracle on NetApp NAS storage, Oracle ASM on NetApp SAN and iSAN storage gives customers an alternative capability for volume management on the Oracle server host, using familiar create/alter/drop SQL statements. This simplifies database storage provisioning for the DBA.

The following topics summarize how the combined features of ASM and NetApp storage complement one another:

- I/O Load Balancing
- Adding and Removing Storage Capacity
- Data Protection and Availability
- Shared Storage for RAC Clustered Nodes

1.1 I/O LOAD BALANCING

Load balancing avoids performance bottlenecks by making sure that the I/O workload uses all available disk drive resources. ASM and NetApp storage accomplish I/O load balancing in the following ways:

- Based on a 1MB stripe size, ASM provides load-balanced I/O across all LUNs or files (see “APPENDIX 1: IMPLEMENTING ASM ON NFS-BASED STORAGE”) in an ASM disk group by distributing the contents of each data file evenly across the entire pool of storage in the disk group.
- NetApp storage automatically load balances I/O across all the disk drives in a WAFL® (Write Anywhere File Layout) aggregate (see Figure 1). Each WAFL flexible volume in an aggregate has access to all the disks in that aggregate. As a result, workloads using LUNs created in a flexible volume are balanced across all disk drives in the containing aggregate.

When NetApp storage and ASM are used in combination, NetApp load balancing allows multiple LUNs and file-system data to share common disk drives, improving manageability by reducing the number of LUNs per ASM disk group. ASM further allows load balancing across multiple WAFL aggregates or storage systems. The WAFL file system and RAID 4 are optimized for random small I/O. WAFL makes sure that the data is evenly spread across all the disk drives of a RAID group in an aggregate. This results in optimal read/write performance in high-transaction database environments.

Figure 1 shows NetApp WAFL flexible volumes, each residing in an aggregate that is made up of a distinct set of physical disk drives. The volumes contain files and LUNs, which are distributed across all the disk drives in the aggregate. NetApp aggregates can be configured from a pool of available physical disk drives—Fibre Channel, SAS, or SATA disks—in one or more software RAID groups in a RAID 4 or RAID-DP® configuration.

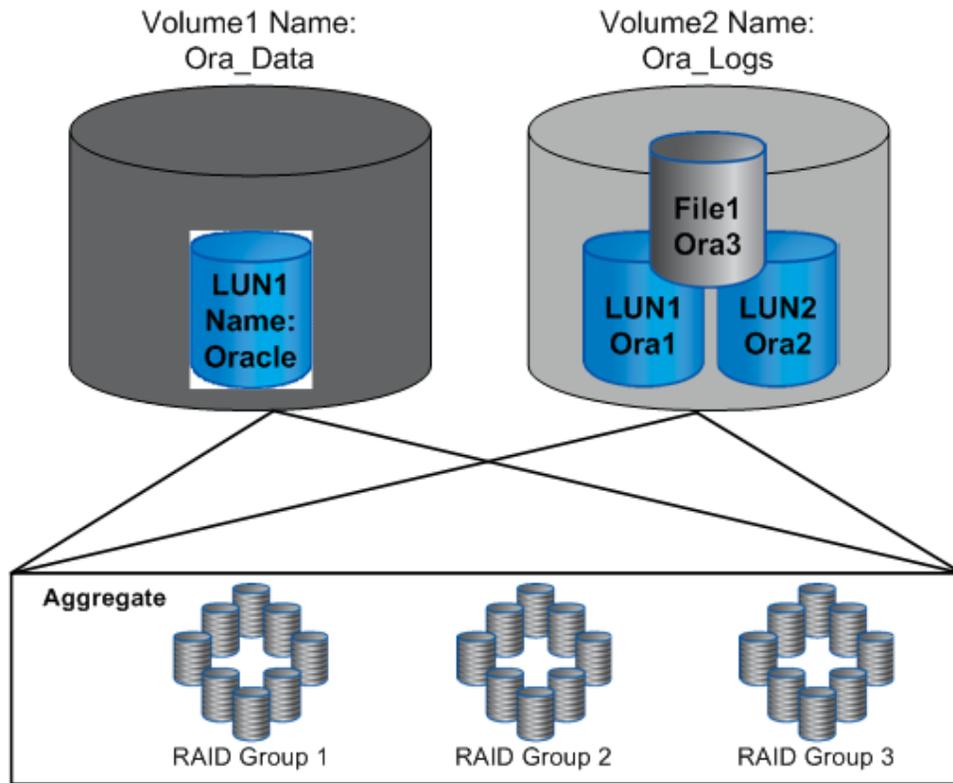


Figure 1) NetApp storage overview.

1.2 ADDING AND REMOVING STORAGE CAPACITY

Support for online addition and removal of storage capacity maximizes data availability when making necessary storage configuration changes. Figure 1 illustrates these principles.

ASM and NetApp storage provide the following functionality pertaining to the addition and removal of storage capacity:

- ASM allows online resizing, adding, and removing LUNs or files within each ASM disk group, as well as automatically rebalancing data distribution for new configurations. Entire disk groups can be migrated from one set of LUNs or files to another (for example, on different volumes or storage systems) by adding and then removing LUNs or files from a disk group without database downtime.
- NetApp storage allows online addition and replacement of disk drives within each WAFL aggregate and rebalances the load to use new disk drives as writes occur.

NetApp I/O rebalancing across physical disk drives occurs only when disk drives are added to expand a NetApp aggregate nondestructively. Adding LUNs or files to a volume does not cause any additional I/O rebalancing to occur as long as there is enough space in the volume to add a new LUN or file, or to grow an existing LUN or file. For information about NetApp architecture basics, see [TR 3001](#), [TR 3002](#), and other introductory material listed in "APPENDIX 3: TECHNICAL REFERENCES". The key benefit to aggregate, volume and LUN, or file resizing is that it is a nondestructive process that is rapid and easy to accomplish. This allows you to grow your ASM disk group easily and rapidly with no downtime, so that you can provision storage dynamically in sync with your database growth needs.

1.3 DATA PROTECTION AND AVAILABILITY

Enterprises require very high levels of data protection and availability, regardless of faults or component failures in storage subsystems. ASM and NetApp storage provide the following data protection and availability technologies:

- ASM optionally implements two-way or three-way extent-based mirroring, offering an additional means for protection against storage failures. It also provides the ability to mirror between sets of ASM disks (implemented as LUNs or files on NetApp storage) called *failure groups*. ASM can keep data available after a component failure causes all storage in one of those failure groups to become unavailable.
- NetApp storage implements RAID 4 or RAID-DP protection on all WAFL volumes and aggregates. RAID 4 assures full data availability despite the loss of any given disk drive in a RAID group. RAID-DP implements double-parity protection to guard against the loss of any two disk drives. The WAFL write-anywhere data layout gives excellent RAID write efficiency without incurring the storage costs implied by full mirroring. NetApp controller failover protects against failure of other storage system hardware components, such as failure within the controller head itself. Additionally, NetApp mirroring solutions can be implemented for additional protection for business continuance and disaster recovery requirements.

Combining the data protection technologies from NetApp and Oracle offers customers several ways to address their data protection requirements. Table 1 compares Oracle, NetApp, and combined Oracle and NetApp data protection technologies.

Table 1) Oracle ASM, NetApp, and Oracle ASM plus NetApp data protection technologies.

	Oracle ASM	NetApp	Oracle ASM + NetApp
Data Resilience			
Protect against single disk failure	Yes	Yes	Yes
Protect against double disk failure	No	Yes	Yes
Passive block corruption detection	Yes	Yes	Yes
Active block corruption detection	Yes	Yes	Yes
Lost disk write detection	No	Yes	Yes
Performance			
Stripe data across ASM disks	Yes	No	Yes
Balance I/O across ASM disks	Yes	No	Yes
Stripe data across physical disks	No	Yes	Yes
Balance I/O across physical disks	No	Yes	Yes
I/O prioritization	No	Yes	Yes
Storage Usage			
Free space management across physical disks	No	Yes	Yes
Thin provisioning of ASM disks	No	Yes	Yes
Space-efficient cloning	No	Yes	Yes
Data Protection			
Storage Snapshot based backups	No	Yes	Yes
Storage Snapshot based restores	No	Yes	Yes

1.4 SHARED STORAGE FOR RAC CLUSTERED NODES

Oracle Database 10g/11g Real Application Clusters (RAC) provides high availability and scalability for Oracle databases implemented across clustered database servers. RAC requires that all servers have full, direct read/write access to the database files. NetApp storage and ASM provide the following functionality concerning shared storage for RAC clustered nodes:

- ASM implements simple and Oracle RAC-optimized Cluster File System and Dynamic Volume Manager functionality for shared storage. In SAN and NAS environments, ASM provides the cluster-capable file system and volume management for Oracle database and RAC data files. Starting in 11gR2, ASM Cluster File System (ACFS) and ASM Dynamic Volume Manager with third-party file systems can be used to host application data and unstructured data.
- NetApp networked storage also provides the shared access that RAC requires. Like ASM, NetApp's NAS storage systems deliver shared and cluster-capable file systems, which can be used to store both database data files and unstructured data.

ASM and NetApp unified storage (SAN/NAS) combine to create a simple and scalable storage facility for Oracle 10g/11g RAC.

Together, NetApp and Oracle toolsets offer a rich assortment of data management options for use separately or in combination. Customers' selection of techniques depends on their unique requirements and the context of their enterprise's data infrastructure.

2 BEST PRACTICE RECOMMENDATIONS

This section contains:

- Guidelines for configuring ASM disks
- Guidelines for creating ASM disk groups
- Guidelines for creating databases within ASM
- Discussion of best practices

In subsequent sections, Figure 2, Figure 3, and Figure 6 illustrate some of the best practices concepts and proposed recommendations.

The use of ASM Cluster File System (ACFS) and ASM Dynamic Volume Manager (DVM) with third-party file systems to store nondatabase files is not discussed. Rather, the focus is on configuring storage and ASM for databases.

2.1 COMMON RECOMMENDATIONS

The following recommendations apply regardless of which high-level deployment model you select:

- Use host file systems or NFS to store Oracle binaries and other non-ASM-enabled files. In Oracle 10g/11g RAC environments, NFS can be used to simplify deployment by using a shared Oracle Home.
- Use NetApp unified storage protocols (Fibre Channel, iSCSI SANs, or NFS/TCPIP NAS) to access the storage for ASM disk groups.
- Combine each storage system's disk drives into a limited number of large WAFL aggregates and volumes to minimize administrative overhead.
- Make sure that the LUNs or files within each disk group are balanced in terms of throughput per capacity, making the I/O throughput available to a disk group from each LUN or file proportional to the size of the LUN or file. In other words, all LUNs and files within the disk group should supply roughly equivalent I/O operations per second per gigabyte. Generally, best practice is to use disk drives with very similar capacity and performance properties throughout the underlying WAFL volumes.

Configure several (for example, four) LUNs or files per ASM disk group per WAFL volume. Configuring multiple LUNs or files can maximize I/O concurrency to the disk group, which overcomes any per-LUN limits of the host driver stack (operating system, host bus adapter driver, and/or multipath driver). Even if initially unnecessary, this provisioning can avoid unneeded data movement that occurs if LUNs within the same volume are later added to the disk group.

3 DEPLOYMENT MODELS

Either of the following high-level deployment models may be appropriate for ASM on NetApp, depending on the intended use of data management facilities at the storage subsystem (controller) level:

- Shared disk groups
- Separate disk groups

When deciding which deployment model to use, consider the following factors:

- **Shared disk groups.** If controller-based data management is not used, it is simpler to group multiple databases into shared disk groups.
- **Separate disk groups.** If the ASM deployment uses controller-based features for data management (such as controller-based facilities to implement full database backup and restore, cloning, mirroring, and/or migration), separate ASM disk groups should be established for each database deployed and each disk group should be stored within a single WAFL volume.

The following sections give detailed information about these two deployment models.

3.1 SHARED DISK GROUPS

When all data management methods are based exclusively on Oracle tools, the easiest deployment model groups multiple databases into shared disk groups, which provide a common shared pool of storage for several databases. The following additional recommendations are specific to the shared disk group model. Figure 2 illustrates these recommendations.

- Use two or more Oracle ASM disk groups to store the databases. The database work areas should be stored in separate disk groups from their respective flashback recovery areas. For databases that may require independent control over the underlying storage resources (for example, to assure quality of service or independent data migration capabilities), consider assigning them to distinct ASM disk groups.
- Each ASM disk group may include storage from one or more WAFL flexible volumes, aggregates, or storage systems. With flexible volumes, the workload for a single volume is spread across all the disks in the containing aggregate. Therefore, volumes can be sized based on the combined size requirements of LUNs and/or files and still provide the performance benefits of the I/O being balanced across all the disks in an aggregate that has been sized for maximum performance.
- When adding disk drives to existing aggregates for greater capacity or throughput, expand the pertinent WAFL aggregates, volumes and disk group's LUNs, or files within them to maintain uniform throughput-per-capacity ratios and to minimize unneeded data movement due to load balancing.
- When adding storage from a new controller within a disk group, configure the new controller's LUNs or files with similar throughput-per-capacity properties to those already in the disk group. If the new storage system contains multiple LUNs or files for host I/O concurrency, then all LUNs or files should be added to the disk group at once to limit ASM's load-balancing movement.

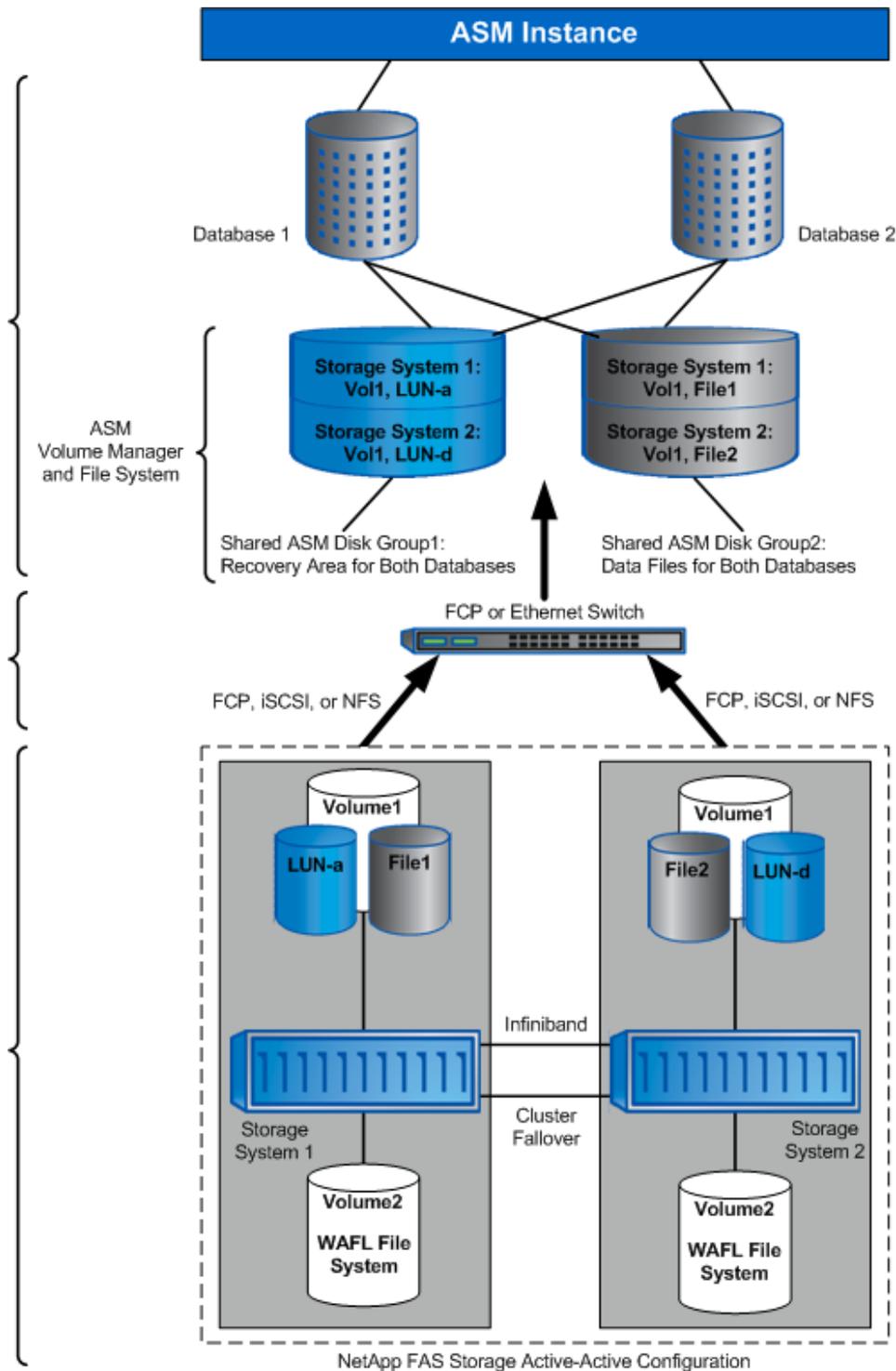


Figure 2) Multiple Oracle databases running on shared ASM disk groups that are distributed across multiple NetApp storage systems.

3.2 SEPARATE DISK GROUPS

To leverage the storage system's ability to implement data management, each database should be stored in a distinct ASM disk group, with each ASM disk group stored in a single WAFL volume. For ASM metadata

consistency among the NetApp Snapshot™ copies, the disk group must be unmounted when creating Snapshot copies if an ASM disk group spans WAFL volumes.

The following additional recommendations are specific to the separate disk group model. Figure 3 illustrates these recommendations.

- Use two Oracle ASM disk groups per database, one containing database work area data files and the other containing the flash recovery area.
- Place all LUNs within a given disk group in a separate WAFL qtree (quota tree directory) to maximize data management flexibility.
- When adding disk drives for greater capacity or throughput, expand the WAFL aggregate. Then resize the volumes and LUNs on the storage system, in the host operating system, and finally in ASM to expand the ASM disk groups. Set the power limit parameter to 0 and then perform all the ASM `add disk` and `drop disk` commands. This pauses the rebalance process until you are ready to increase the power limit and complete the rebalance in one pass.

Also note:

- The RAID-protected WAFL volume load balances across all spindles that make up the containing aggregate, thus optimizing performance for both databases on their respective ASM disk groups.
- Each database gets two disk groups (work area and recovery area), for a total of four disk groups. This allows the use of Snapshot and NetApp SnapRestore® to back up and recover the entire database.

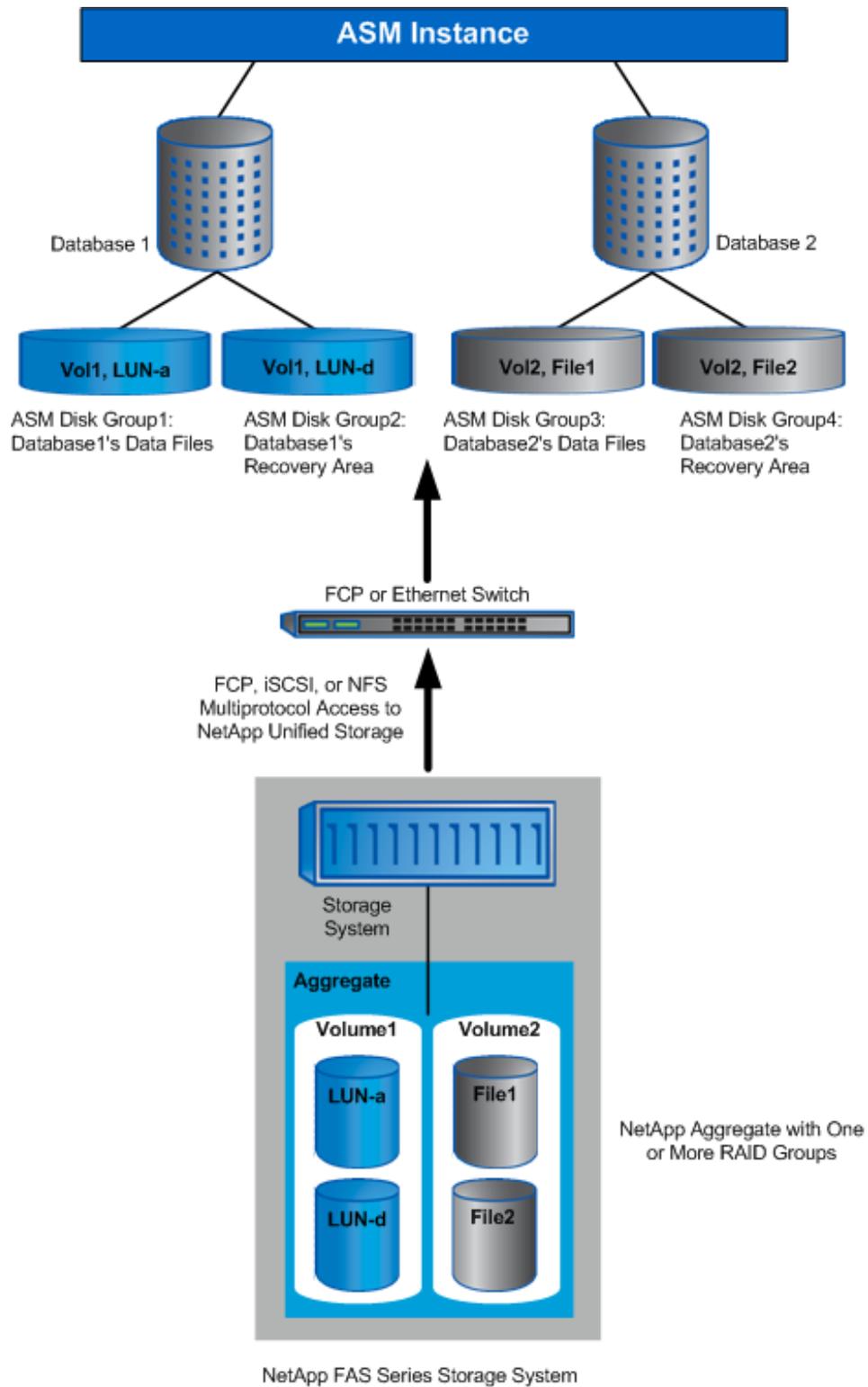


Figure 3) Multiple Oracle databases running on separate ASM disk groups that map to separate NetApp WAFL file-system volumes.

3.3 EXAMPLE OF ASM DEPLOYMENT ON NETAPP

Regardless of whether the shared or separate disk group model is used, a typical ASM environment may consist of multiple ASM disk groups where each disk group corresponds to data, redo logs, and temp and flash recovery archive.

Each ASM disk group is made up of one or more ASM disks, where an ASM disk maps directly to a LUN or a file on the underlying NetApp storage system. The LUN or file on NetApp is constructed from a volume that resides in an aggregate spanning one or more RAID groups. Figure 4 is an example of ASM deployment on NetApp showing a direct relationship between ASM disk groups and disks, and NetApp LUNs, volumes, and aggregates.

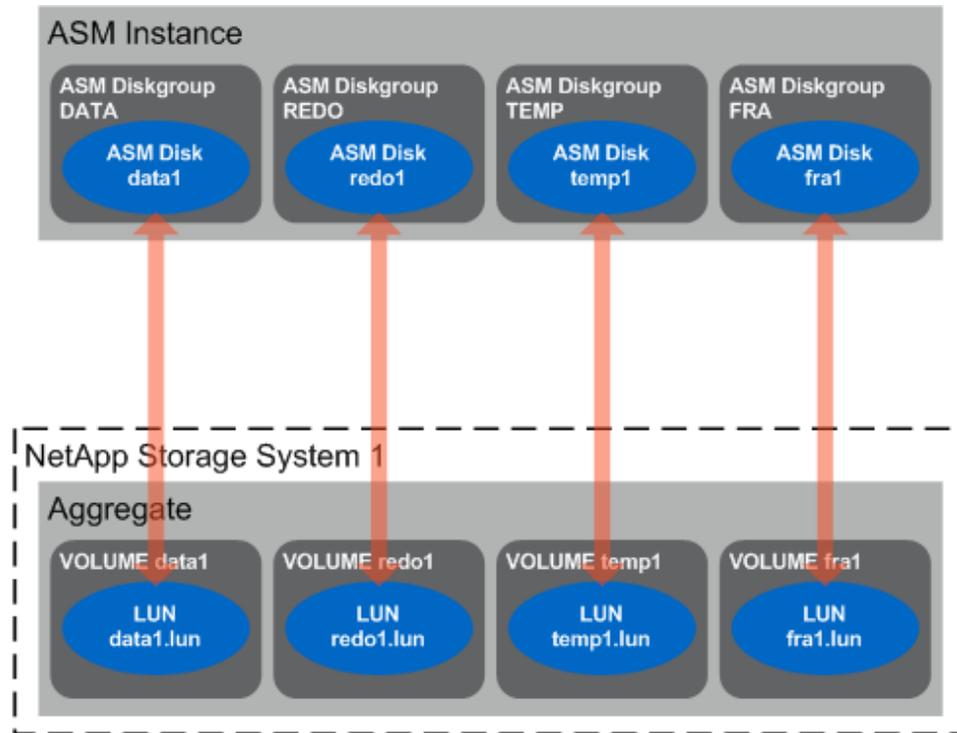


Figure 4) Typical ASM deployment on NetApp.

As the demand on databases increases or additional databases are deployed, new ASM disks can be added to an existing ASM environment to achieve increased capacity and throughput. The operation of adding ASM disks to ASM disk groups is seamless and nondisruptive to the database and applications. This enables customers to scale their database storage on demand.

Figure 5 illustrates an example of scaling ASM storage on demand with NetApp. Additional NetApp storage systems can be deployed to provide more LUNs, which then can be added to the ASM disk groups as ASM disks. Through the automatic rebalancing feature, ASM can take advantage of new LUNs to provide increased capacity and higher throughput.

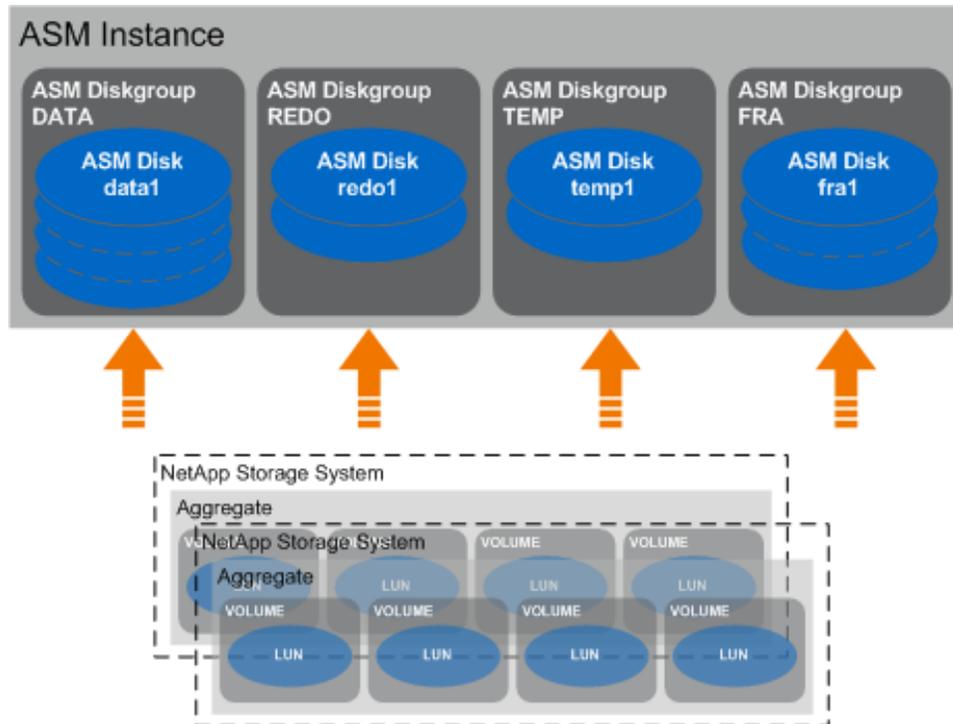


Figure 5) Scaling capacity and throughput of ASM environment with NetApp.

4 FAILURE GROUPS AND REDUNDANCY

Generally, ASM's external redundancy option should be configured for ASM disk groups on NetApp storage. This choice minimizes the amount of storage hardware required to realize data protection for a given level of database capacity and throughput. With external redundancy, the NetApp LUNs that comprise the ASM disk groups can be RAID parity protected. Standard RAID 4 parity protection allows continued operation with a single disk drive failure in a RAID group. NetApp double-parity protection (RAID-DP) allows continued operation even after a simultaneous double disk drive failure in a RAID group, dramatically reducing the risk of data loss due to simultaneous double disk drive failure.

The NetApp controller failover (CFO) option should generally be configured to improve availability in case of unscheduled storage system downtime. As an alternative to using CFO, ASM disk groups can be configured with two-way mirroring; that is, without the external redundancy option. Two-way mirroring also improves availability in case of unscheduled storage system downtime, at a cost of up to double the required disk drive hardware. If ASM mirroring is used to protect against storage system failure, all LUNs in a disk group hosted by one storage system should be placed within the same failure group.

5 ASM DISKS

NetApp LUNs have the same semantics on the host side as any other LUNs; therefore, they are incorporated into ASM disk groups as described in the 10g/11g ASM documentation. The best practice recommendation is to use LUNs or files of the same size and performance capacity when configuring an ASM disk group. In order to achieve good load balancing for a disk group stored on multiple WAFL volumes, the total capacity from each WAFL volume should be proportional to the throughput available to the disk group from that volume.

5.1 RUNNING 10G/11G RAC ON ASM DISK GROUPS DERIVED FROM NETAPP

When Oracle RAC is deployed with ASM on storage derived from NetApp, NetApp recommends placing the shared Oracle Home on a NetApp NFS volume for ease of manageability. Follow the directions in the

product documentation to install and enable cluster synchronization services in Oracle 10g/11g. Alternatively, some clustered host file systems can support a shared Oracle Home on SAN storage, or each node can have its own Oracle Home on a private host file system. See Figure 6.

With the release of Oracle 10g/11g RAC, Oracle has made it easier to share a single Oracle Home on a NAS volume among multiple nodes of an Oracle RAC cluster. The ability to share the Oracle Home binaries and configuration files between multiple RAC instances adds tremendous benefits to manageability and administration of a multinode Oracle RAC cluster. The shared instance-specific admin and configuration files (`TNSnames.ora`, `initSID.ora`, and so on) have separate parameter entries for each cluster node. When deploying ASM on NetApp SAN storage, it is preferable as well to implement the Oracle RAC CRS files (voting disk and OCR device) on SAN storage. Consult the configuration details for the applicable Oracle RAC validation. **Note:** Starting with 11gR2 for new installations, OCR and voting disk files can be placed either on ASM or on a cluster file system or NFS system. Installing Oracle Clusterware files on raw or block devices is no longer supported unless an existing system is being upgraded.

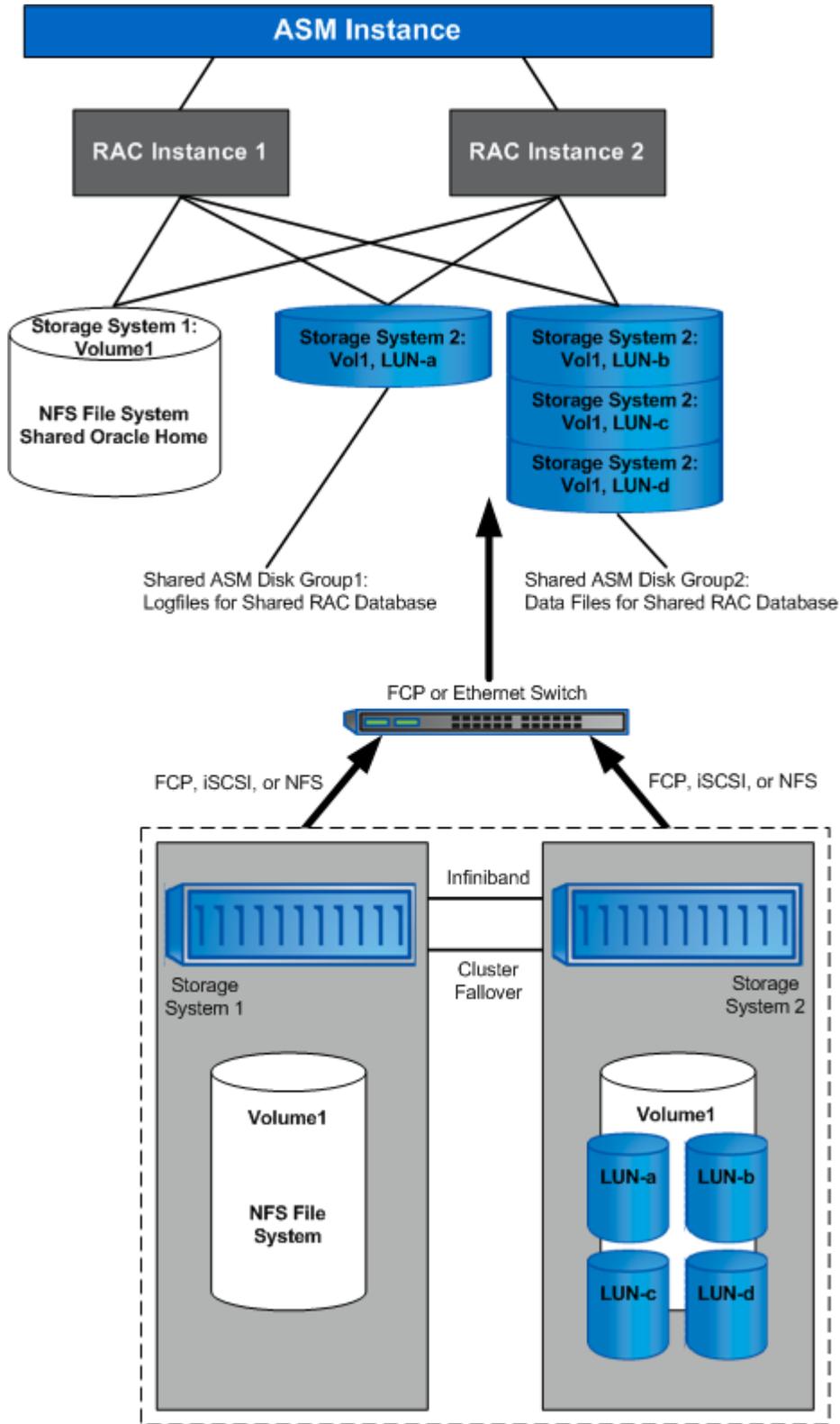


Figure 6) Multiple Oracle RAC instances running on shared ASM disk groups.

6 CONCLUSION

Automatic Storage Management simplifies the configuration and administration of storage management for the Oracle10g and Oracle11g database data files. ASM complements NetApp Fibre Channel and iSCSI SAN storage products. Oracle Database 10g and 11g ASM and NetApp storage products can be combined in ways that deliver the full value of both sets of technologies.

Although several possible combinations of redundancy protection and data management options exist, the partnership between NetApp and Oracle provides best practices for how these options can be combined to meet the business requirements of our joint customers. Depending on the high-availability and performance requirements, there are powerful combinations of our joint technology that meet those requirements. Although the increased number of combinations may seem complex, this technical report outlines the criteria to help choose the most cost-effective solution that fits the specific requirements. This is another example of how the partnership between Oracle and NetApp delivers unique value for our joint customers. Together, we are helping to reduce the complexity and cost of achieving high-performance and high-availability business systems while reducing management overhead.

7 SUMMARY OF BEST PRACTICES

The following list summarizes the best practices for combining Oracle Database 10g ASM and NetApp storage products:

- ASM is the recommended file system and volume management solution in a NetApp NAS or SAN/iSAN unified storage environment for Oracle databases.
- Configure ASM disk groups with external redundancy for use with controllers.
- Use NetApp controller failover to prevent a single point of failure.
- Use ASM to manage Oracle Database files.
- Use the NetApp clustered file system for shared Oracle Home.
- Build ASM disk groups with LUNs or files of similar performance and capacity properties.
- Distributing I/O across the front end with ASM and striping within the storage system are complementary procedures that can further simplify the combined configuration as compared to using either approach by itself.

APPENDIX 1: IMPLEMENTING ASM ON NFS-BASED STORAGE

ASM can be configured with NFS-based files as ASM disks. When used in this manner, a large file is configured to be a storage container for this ASM disk. When using ASM on top of NFS, the NFS files are used as ASM disks; therefore the provisioning and data management model is similar to that for ASM on SAN storage, while NFS is used to perform I/O. ASM on NetApp NFS can be used to load balance across multiple storage systems, just as with ASM on NetApp SAN (FCP, iSCSI). This is easily achieved by building an ASM disk group with ASM disks located on volumes from multiple storage systems, as seen in Figure 2.

There may be situations in which ASM on NFS is applicable, either for uniformity of operating procedures or to satisfy product, host OS, or other environmental constraints. The following list provides more detail on the ASM-on-NFS configuration:

- NFS-based storage from NetApp and ASM provides some common functions.
- Oracle DBAs can directly employ the NFS-based file system functionality to implement simple, scalable, RAC-ready file storage.
- Oracle DBAs can directly provision storage from a NetApp storage system using NFS storage and the familiar create/alter/drop SQL statements.
- ASM on NFS similarly implements scalable, RAC-ready storage and further extends scalability at the high end. However, provisioning additional controller storage to Oracle files within Oracle requires additional steps when using ASM on NFS storage.

For a detailed explanation of the installation of ASM on NFS, see TR 3572. For a detailed explanation of the installation of ASM on iSCSI, see TR 3349. When implementing ASM on NFS, you should combine the

guidelines for deploying Oracle directly on NFS with those for implementing ASM on NetApp SAN storage. The following list provides details:

- Use NFS mount options as recommended for non-ASM Oracle files on NAS. See the applicable NetApp technical reports, listed in Appendix 3, for guidance on configuring specific NFS clients for use with Oracle. Specifically, see TR 3183, "Using the Linux NFS Client with Network Appliance Storage Systems."
- Create NFS-based files according to the guidelines for LUNs discussed in section 3, "Deployment Models." Follow the appropriate model, either the shared disk groups model or the separate disk groups model. Multiple files and mount points from a single WAFL volume can be used to overcome I/O concurrency limits, just as multiple LUNs were discussed for this purpose in section 2 "BEST PRACTICE RECOMMENDATIONS."
- Use `mkfile` on UNIX[®] platforms or `dd` on Linux[®] platforms to size the files to be incorporated into the ASM disk groups (as if they were LUNs). If later resizing is required, establish up-to-date backups. Then alter the sizes of the files as required without truncating or overwriting any live data. The tools needed to do this vary among host environments.
- Set the permissions on the files to allow `oracle:dba` read/write access.
- Use an ASM disk string that allows the ASM instance to find the file; for example, `/nfs/<host>/oradata/<db_name>/*.` Symbolic links can be used to make such a disk string work for files spread across multiple NFS mount points.

APPENDIX 2: USING NETAPP SNAPSHOT COPIES WITH ASM-BASED DATA

Backup and recovery methods are critical elements of any Oracle production deployment. Figure 7 and Figure 8 illustrate the concepts presented in this section.

NetApp Snapshot copies implement inexpensive point-in-time copies that can be used to accelerate media recovery, making them a very popular feature for Oracle environments. Snapshot copies also provide the basis for various other backup and recovery methods and can be used to clone databases nearly instantaneously. To apply Snapshot copies with ASM-based Oracle data effectively, it is important to focus on the ASM disk group as the unit of Snapshot copy-based recovery, copying, or cloning.

ASM also works with the full suite of Oracle data management tools, including RMAN, Data Guard, Flash recovery, and Flashback queries. You can use these technologies when databases span multiple WAFL volumes or more than one storage system.

RMAN is the only interface that is able to take hot and cold backups of Oracle databases on ASM disk groups. More importantly, RMAN is the only interface for single file restore capability from a backup set. However, you can also do hot and cold backups of Oracle by using the NetApp volume-level point-in-time Snapshot copy and SnapRestore to back up and restore entire LUNs. Therefore, you can back up and restore entire ASM disk groups to a point in time. To preserve ASM disk group integrity, all disks within the ASM disk group must be snapped atomically with the current NetApp technology. This implies following the separate disk group recommendations discussed in this technical report, including placement of all LUNs for a given disk group into a single WAFL volume.

ASM maintains all disk group metadata within the disk group itself, so a disk group can be restored to a previous state by dismounting, restoring, and remounting the disk group. A disk group's metadata is fully consistent for any atomic point-in-time copy of the disk group, so there is no need for flushing and freezing the metadata, as is required prior to creating Snapshot copies of some traditional host file systems. A hot backup requires only putting the individual tablespaces of the database in online or hot backup mode and then creating a Snapshot copy of the volume containing the LUN or LUNs.

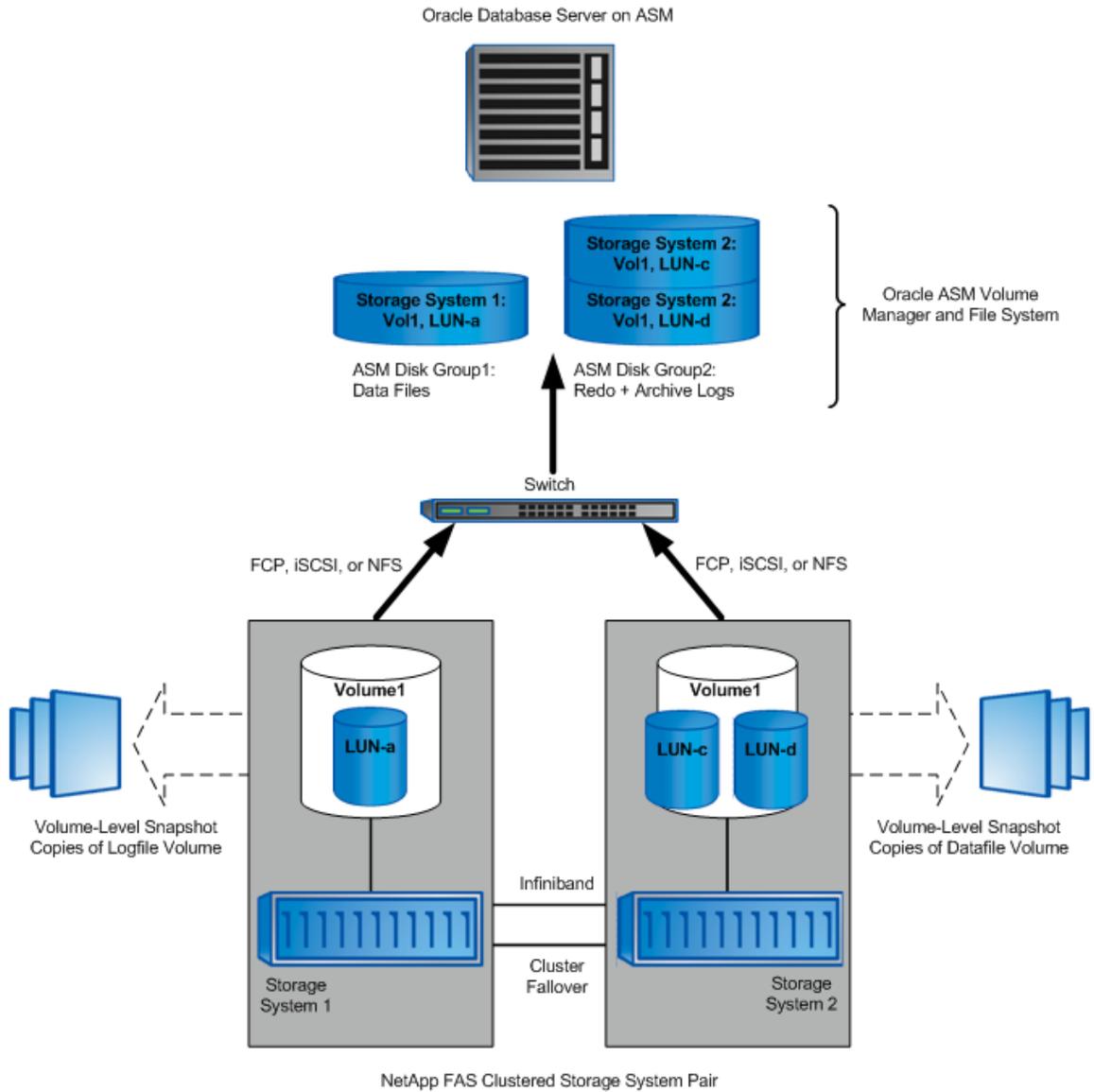


Figure 7) Overview—backing up an Oracle Database on ASM with NetApp storage.

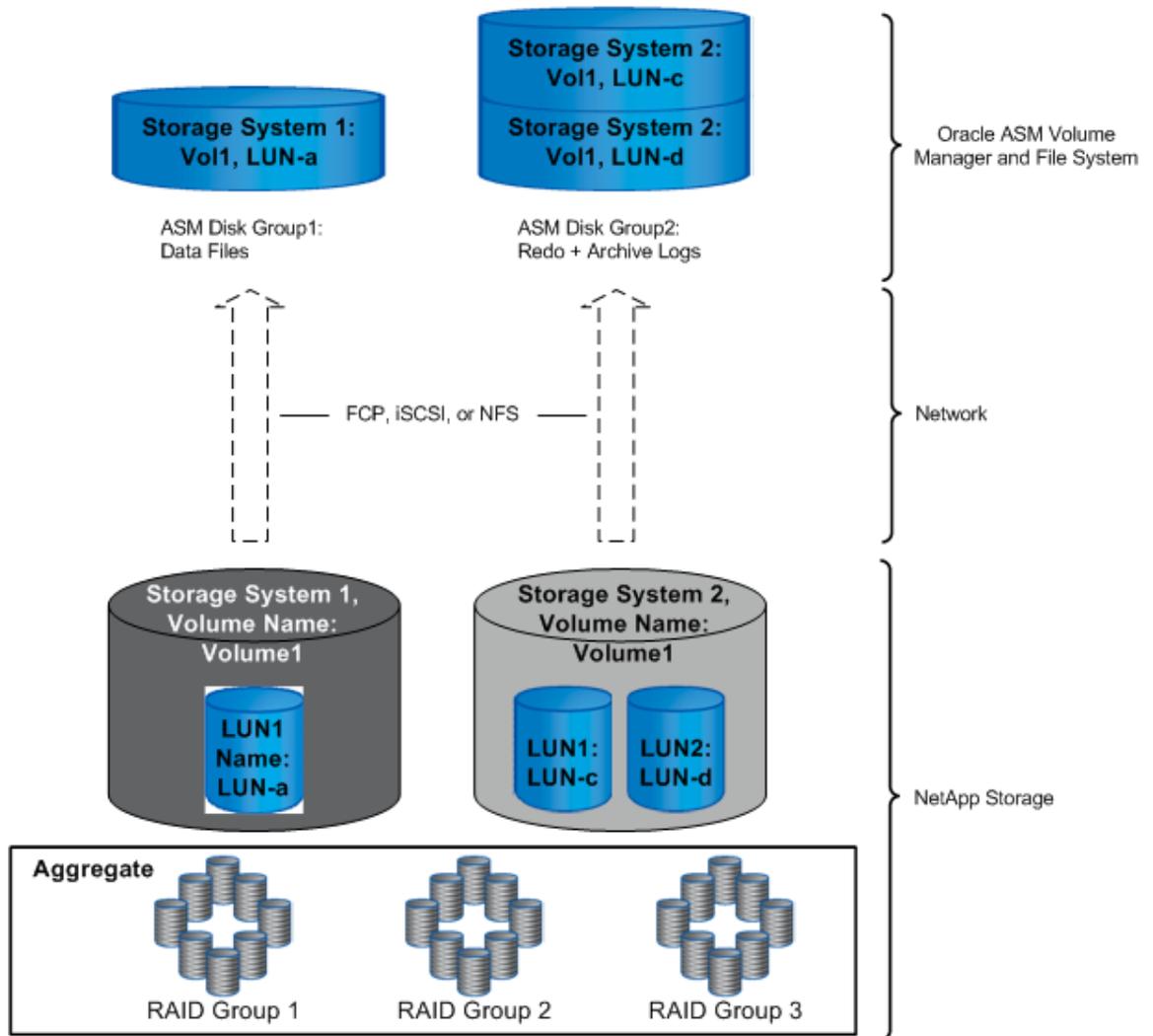


Figure 8) Backing up an Oracle Database on ASM with NetApp storage.

NetApp Snapshot and SnapRestore technology can be used for an Oracle ASM environment similarly to the way it is used for a non-ASM environment. The only constraint is that to back up Oracle ASM disk groups by using Snapshot copies, the entire ASM disk group must be contained within a NetApp WAFL file-system volume boundary.

APPENDIX 3: TECHNICAL REFERENCES

The following technical documents contain introductory material on NetApp technology. Web sites with additional details are also listed.

Table 2) Introduction to NetApp technology.

TR Number	Technical Report Name	URL
TR 3001	A Storage Networking Appliance	http://www.netapp.com/library/tr/3001.pdf
TR 3002	File System Design for an NFS File Server Appliance	http://www.netapp.com/library/tr/3002.pdf

TR Number	Technical Report Name	URL
TR 3014	Multiprotocol Data Access: NFS, CIFS, and HTTP	http://www.netapp.com/library/tr/3014.pdf
TR 3241	iSCSI: Accelerating the Transition to Network Storage	http://www.netapp.com/library/tr/3241.pdf
TR 3183	Using the Linux NFS Client with Network Appliance Storage	http://www.netapp.com/library/tr/3183.pdf
TR 3298	RAID-DP: Network Appliance Implementation of RAID Double Parity for Data Protection	http://www.netapp.com/library/tr/3298.pdf
TR 3131	Data Protection Solutions Overview	http://www.netapp.com/library/tr/3131.pdf
TR 3194	Rapid Recovery with Network Appliance Storage Solutions	http://www.netapp.com/library/tr/3194.pdf
TR 3202	Best Practices Guide for Data Protection with Controllers Running FCP	http://www.netapp.com/library/tr/3202.pdf
TR 3633	NetApp Best Practice Guidelines for Oracle Database 11g	http://www.netapp.com/library/tr/3633.pdf

Table 3) NetApp technical white papers on Oracle Database 10g and automatic storage management.

	NetApp Technical White Paper	URL
TR 3572	Setting Up Oracle Database 10gR2 with RAC with ASM over NFS on NetApp Storage	http://www.netapp.com/library/tr/3572.pdf
TR 3349	Oracle 10gR1 RAC: Installation with a NetApp Filer in an RHEL 3.0 Environment Using Oracle ASM and iSCSI Devices	http://www.netapp.com/library/tr/3349.pdf

Table 4) Oracle technical white papers on Oracle Database 10g and automatic storage management.

Oracle Technical White Papers and PowerPoint Presentations	URL
Oracle Database 10g—Automatic Storage Management	http://otn.oracle.com/products/manageability/database/pdf/asmov.pdf
Automatic Storage Management Technical Overview	http://otn.oracle.com/products/manageability/database/pdf/asmwp.pdf
Automatic Storage Management: The New Best Practice	http://otn.oracle.com/products/database/asm/pdf/40288_asm_fnl.pdf
Simplify Your Job—Automatic Storage Management	http://otn.oracle.com/products/database/asm/pdf/40140_asm_fnl.pdf
Oracle Database 10g: A Revolution in Database Technology	http://otn.oracle.com/products/database/oracle10g/pdf/oracle_database_10g_revolution.pdf

WEB SITES WITH MORE DETAILS ABOUT ORACLE DATABASE10G AND ASM

<http://otn.oracle.com/products/database/asm/index.html>

<http://otn.oracle.com/tech/linux/asmlib/index.html>

<http://otn.oracle.com/tech/linux/asmlib/install.html>

<http://www.oracle.com/technology/products/database/oracle10g/index.html>

REVISION HISTORY

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