



**LEVERAGING THE STORAGE SMARTS TO SIMPLIFY THE DATA MANAGEMENT OF
ORACLE® DATABASES: TR-3426 | September 2005 | Brajesh Goyal, NetApp; Ara Shakian, Oracle**

SNAPMANAGER® FOR ORACLE WITH ORACLE DATABASE 10G GRID

ABSTRACT

IT departments are constantly striving to improve the availability of their data, reduce the cost of administration, and improve the productivity of their staff. NetApp has been constantly striving to deliver technologies that simplify and lower the cost of data management for its customers. Data ONTAP™ 7G provides capabilities to simplify data management and improve productivity for grid environments. While NetApp has focused on the storage, Oracle has been delivering grid technologies with Oracle10g™ to improve availability, increase utilization, and reduce the administration cost for Oracle Databases.

SnapManager for Oracle has been designed to leverage Oracle Database 10g's data management and grid features such as Automatic Storage Management (ASM), Real Application Clusters (RAC), and Recovery Manager (RMAN). It combines these with the NetApp intelligent storage infrastructure to simplify and optimize data management operations. SnapManager for Oracle provides (1) instantaneous, automated, and space-efficient backup; (2) automated and rapid restore and recovery; and (3) automated, fast, and space-efficient clones for Oracle Databases. NetApp with SnapManager for Oracle delivers a unique disk-based backup and granular recovery solution for Oracle customers using the ASM technology.

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EXECUTIVE SUMMARY

With the advent of e-business in the 1990s, information technology (IT) has taken center stage in the operation of business. IT departments responsible for the operation are constantly driven to deliver higher availability at a lower cost. As a result, IT departments are constantly striving to improve the availability of their data, reduce the cost of administration, and improve the productivity of their staff.

NetApp has been constantly striving to deliver technologies that simplify and lower the cost of data management for its customers. NetApp is one of the market leaders in delivering the storage technology for grid deployments. NetApp Data ONTAP 7G provides a highly optimized, scalable, and flexible operating system that provides unified storage access for SAN, IP SAN, and NAS environments. Data ONTAP 7G provides capabilities that simplify data management and improve productivity for grid environments. Enabling technologies include Snapshot™, SnapRestore®, and FlexClone™. Snapshot technology creates extremely fast point-in-time copies that can be used for creating extremely fast and space-efficient backups. SnapRestore technology provides instantaneous restores to older Snapshot copies without any data movement. FlexClone creates writable copies extremely quickly. This technology can be used to create a clone environment extremely quickly.

While NetApp has focused on the storage, Oracle has been delivering grid technologies through Oracle Database 10g to improve availability, increase utilization, and reduce the administration cost for Oracle Databases. Oracle Database 10g ASM is a storage manager that includes volume management, file system, and clustering capabilities designed to manage Oracle Database files. ASM virtualizes the underlying storage used by the Oracle Databases and simplifies the storage management so that DBAs do not need to worry about Oracle Database file layout and management, which typically reside on raw partitions or NAS files. ASM significantly reduces storage management overhead and complexity, improves storage utilization and agility, and reduces total cost of ownership. Oracle RAC provides higher availability, flexible scalability, and increased utilization for the server resources.

SnapManager for Oracle has been designed to leverage Oracle Database 10g's data management and grid features such as ASM, RAC, and RMAN. It combines these with the NetApp intelligent storage infrastructure to simplify and optimize data management operations. It leverages Snapshot technology to provide automated, instantaneous, and space-efficient backups of the Oracle Databases. It utilizes SnapRestore technology to provide automated and rapid restore and recovery of the Oracle Databases. It uses FlexClone technology to provide automated and fast clones of the Oracle Databases. SnapManager for Oracle provides these capabilities for all Oracle Database configurations, including RAC and ASM configurations. NetApp with SnapManager for Oracle is the first to deliver a tightly integrated disk-based backup with granular recovery at the file level for Oracle customers using the ASM technology.

BACKGROUND

The focus of this paper is on how SnapManager for Oracle simplifies and optimizes data management operations for Oracle Databases while leveraging the grid technologies from both Network Appliance and Oracle Database 10g. Let's look at the relevant technology from NetApp and Oracle before getting into SnapManager for Oracle.

NETAPP STORAGE GRID TECHNOLOGY

NetApp delivers storage technology and flexible data management software for dynamic enterprise grid deployments. NetApp offers optimized storage solutions to match the needs of the enterprise. With industry-leading expertise in storage provisioning, clustering, data movement, and mirroring, along with the ability to provide performance and capacity scaling, NetApp is uniquely positioned to deliver next-generation storage

for grid computing. Let's look at some of the technologies that NetApp offers that are useful in simplifying data management for the Oracle Databases.

DATA ONTAP 7G

Data ONTAP 7G—designed for storage grids—is the next step in the continuing evolution toward even greater grid functionality. Data ONTAP 7G integrates seamlessly with all NetApp unified storage products and introduces breakthrough storage management technologies into the enterprise. Data ONTAP 7G provides a highly optimized, scalable, and flexible operating system that provides unified storage access for SAN, IP SAN, and NAS environments. Data ONTAP 7G provides capabilities that simplify data management and improve productivity for grid environments. Key enabling technologies utilized by SnapManager for Oracle include Snapshot, SnapRestore, and FlexClone.

Snapshot

At the highest level, a Snapshot copy can be defined as “a locally retained point-in-time image of data.” NetApp Snapshot technology offers unique advantages. Because a NetApp Snapshot copy does not involve copying of data from one location to another, it is extremely fast and space-efficient. A NetApp Snapshot copy is created in less than a second, regardless of the size of the volume or the level of activity on the NetApp storage system. SnapManager for Oracle utilizes this technology to provide instantaneous and space-efficient backups of Oracle Databases.

SnapRestore

SnapRestore software uses stored Snapshot copies that enable data (a multiterabyte file system, a single file, or a LUN) to be reverted to a previous state and content in a matter of seconds. By not physically relocating any data, SnapRestore can recover entire point-in-time images without impacting system performance. SnapManager for Oracle uses SnapRestore to provide rapid restores of Oracle Databases.

FlexClone

NetApp FlexClone technology enables true cloning—instant replication of data volumes and data sets without doubling the storage requirement. Each cloned volume is a transparent, virtual copy that can be used for essential enterprise operations, such as testing and bug fixing, platform and upgrade checks, multiple simulations against large data sets, remote office testing and staging, and market-specific product variations. NetApp FlexClone provides substantial space savings with minimal overhead. SnapManager for Oracle uses FlexClone to provide fast clones of Oracle Databases.

ORACLE DATABASE 10G

Oracle Database 10g is the industry's first database designed for the grid. Two key grid-enabling capabilities of the Oracle Database are Oracle RAC and Oracle ASM.

Oracle RAC

Oracle RAC virtualizes the servers used by the Oracle Database. Oracle RAC supports the transparent deployment of a single database across a cluster of hardware servers, providing fault tolerance from hardware failures or planned outages. Oracle RAC provides flexibility for scaling applications. When you need more processing power, simply add another server without taking users offline. Oracle RAC provides the highest level of Oracle capability in terms of availability, scalability, and low-cost computing. Oracle RAC enables enterprise grids. Enterprise grids are built from standardized, modular servers, storage, and network components. Nodes, storage, CPUs, and memory can all be dynamically provisioned while the system remains online.

Oracle ASM

ASM is a storage manager with volume management, file system, and clustering capabilities to manage Oracle Database 10g files. ASM is integrated into Oracle Database 10g and offered at no additional cost.

ASM lowers your total cost of ownership and increases storage utilization without compromising performance or availability. With ASM, a fraction of the time is needed to manage your database files.

ASM eliminates overprovisioning and maximizes storage resource utilization, facilitating database consolidation. The ASM self-tuning feature evenly distributes the database files across all underlying provisioned storage. It delivers high performance same as raw, sustained over time, with the ease of use of a file system. ASM's intelligent mirroring technology enables triple data protection, even on non-RAID storage arrays.

SNAPMANAGER FOR ORACLE

SnapManager for Oracle is a management tool with a GUI and command-line interface for Oracle Database administrators that simplifies backup, recovery, and cloning for Oracle Databases. SnapManager for Oracle has been designed to leverage Oracle Database 10g's data management and grid features such as ASM, RAC, and RMAN. It combines these with the NetApp intelligent storage infrastructure to simplify and optimize data management operations. It makes DBAs more productive by providing:

- Instantaneous, automated, and space-efficient backups
- Rapid and automated restores and reduced mean-time-to-recovery
- Fast, automated, and space-efficient clones

Backup

SnapManager for Oracle utilizes NetApp Snapshot technology to create extremely fast and space-efficient backups. Snapshot copies are point-in-time copies of a database that are created nearly instantaneously. These backups can also be registered with Oracle RMAN, which facilitates the use of RMAN to restore and recover the database at finer granularities such as blocks.

To create the backup, the DBA specifies the database that needs to be backed up, and SnapManager identifies the relevant data set that's required for the backup. SnapManager coordinates with the database to create online backups. SnapManager puts the database in "hot backup" mode. Since the entire backup operation is done in a few seconds, the performance of the database is not impacted.

The backups that are created using this technology are extremely space efficient because Snapshot copies consume only enough space to store the differences between the Snapshot copy and the active copy. This feature makes Snapshot copies very economical compared to full copies of the database. This also means that DBAs can create more frequent backups, which reduce recovery times. In addition, as the backups are done directly within the storage appliance, there are no host I/O and no network traffic. Thus this has no performance impact on the database and the network.

Because SnapManager for Oracle automatically identifies the backup set, the DBA does not have to worry about the underlying layout of the database in terms of host file systems, host volumes, raw disks, etc. SnapManager provides these benefits irrespective of the storage networking protocol (NFS, iSCSI, or FCP) used to access the storage.

Another key benefit of SnapManager for Oracle is its ability to verify the backup right after performing the backup. DBAs can defer the verification of the backup to some later point, if they so desire. Consequently, DBAs no longer have to manually mount the backups and verify them manually. Because the backups are verified, DBAs can rest easy knowing that they have good backups for their databases in case of problems.

SnapManager for Oracle provides these capabilities for the Oracle Databases in standalone, ASM, and RAC configurations. ASM configurations combine the benefits of storage virtualization of ASM with the efficient backup capabilities of SnapManager. For the RAC configurations, DBAs can invoke SnapManager for Oracle from any RAC database node to create the backup.

Restore and Recover

SnapManager for Oracle utilizes the unique NetApp SnapRestore technology to efficiently restore the Oracle Database. SnapManager restores the database to the state it was in at the time the last Snapshot copy was created. Because the restore process does not involve data movement, the time to restore a Snapshot copy is a few seconds, regardless of the size of the database. This restore time is significantly less than for traditional recovery methods. Once restored, the logs can be applied and the database rolled forward and recovered. Because backups can now be created more frequently, the amount of logs that need to be applied is drastically reduced, thus reducing the mean-time-to-recovery for a database.

Similar to backups, SnapManager for Oracle relieves the DBA from having to worry about the underlying layout of data in terms of storage subsystems, disks, host volumes, or host file systems. DBAs just choose the backup they want to restore from, and SnapManager does the rest. In addition, DBAs can also specify the date and time or the Database SCN to which they would like the database restored.

DBAs can use SnapManager for Oracle to restore the database at the desired granularity. Using SnapManager, DBAs can choose to recover the full database, a set of tablespaces, or a set of data files. SnapManager is also integrated with Oracle RMAN. Thus DBAs can use RMAN to restore and recover the database at finer granularities such as blocks. This integration provides combines benefits of the speed and space efficiency of NetApp Snapshot copies with the fine level of control for restore of Oracle RMAN.

SnapManager for Oracle also provides this capability for ASM-based databases. NetApp has added unique capabilities to Data ONTAP 7G for restoring partial ASM disks to enable this functionality. NetApp has worked with Oracle to develop this solution. It provides fast and efficient restores for the ASM-based databases. In an ASM configuration, an ASM disk group can be shared by multiple databases. As a result, you cannot simply revert to an older Snapshot copy of the disk group, because it would revert all the databases. Traditional restore solutions would go through the host and would require that all the blocks that constitute the database be moved from the storage system to the host and then back to the storage system. The unique solution provided by SnapManager from Oracle relieves this overhead. SnapManager provides the ability to restore just the required data within the ASM disk group without going through the host for most scenarios.

SnapManager provides these restore and recovery capabilities for the Oracle Databases in both standalone and RAC configurations. DBAs can invoke SnapManager for Oracle from any RAC database node to do the restore and recovery. The RAC node where SnapManager performs the restore and recovery operation need not be the same as the node where the backup was performed.

Cloning

A unique feature of SnapManager is its ability to automate cloning of Oracle Databases. Using the unique NetApp FlexClone capability, SnapManager creates writable clones of the Snapshot copy created during backup. Database clones are created extremely quickly, in a few seconds, and clones only consume enough storage to hold modified blocks. Because the clone is based on a Snapshot copy, modifying a clone has no impact on the source database. As a result, each developer or QA team can be provided with its own personal copy of the database. Developers and QA teams can make any modifications to these personal copies and even destroy them, if needed, without affecting the other users.

Similar to backups and restores, DBAs do not need to worry about the underlying storage layout of the database for cloning. DBAs just need to specify a specific backup or a database that they would like to clone, and SnapManager does the rest.

SnapManager provides these clone capabilities for all configurations of the Oracle Database. This includes both standalone and RAC configurations. Both these configurations can be used along with and without ASM for managing database storage.

HOW TO USE SNAPMANAGER FOR ORACLE WITH ORACLE GRID

Figure 1 illustrates how SnapManager for Oracle works with Oracle ASM. The figure shows two databases—Payroll DB and HR DB—with ASM managed storage. Both these databases use the same disk group, which we call DG1. The ASM disk group, DG1, comprises of three ASM disks, each disk located on a separate NetApp filer. The disk group, DG1, has data from both the databases, Payroll DB and HR DB. SnapManager for Oracle offers both a command line and GUI for its operations. Figure 2 is a screenshot for its GUI. Let's look at how SnapManager for Oracle performs various operations on Payroll DB.

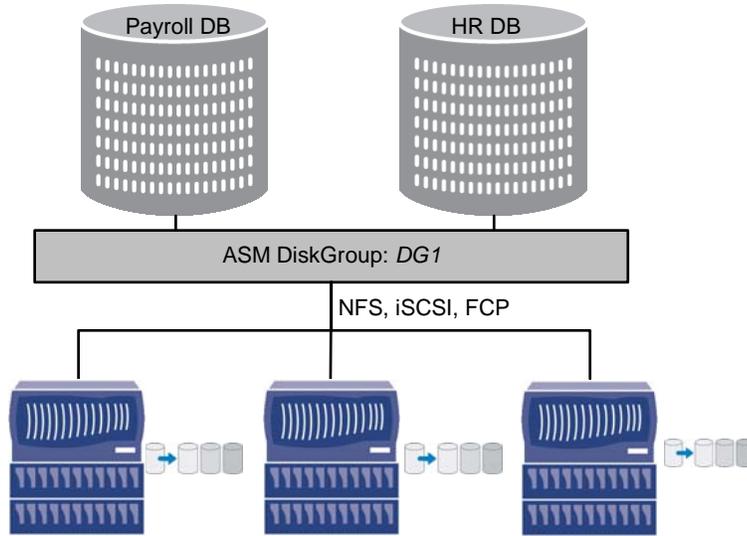


Figure 1) An example of SnapManager for Oracle with Oracle ASM.

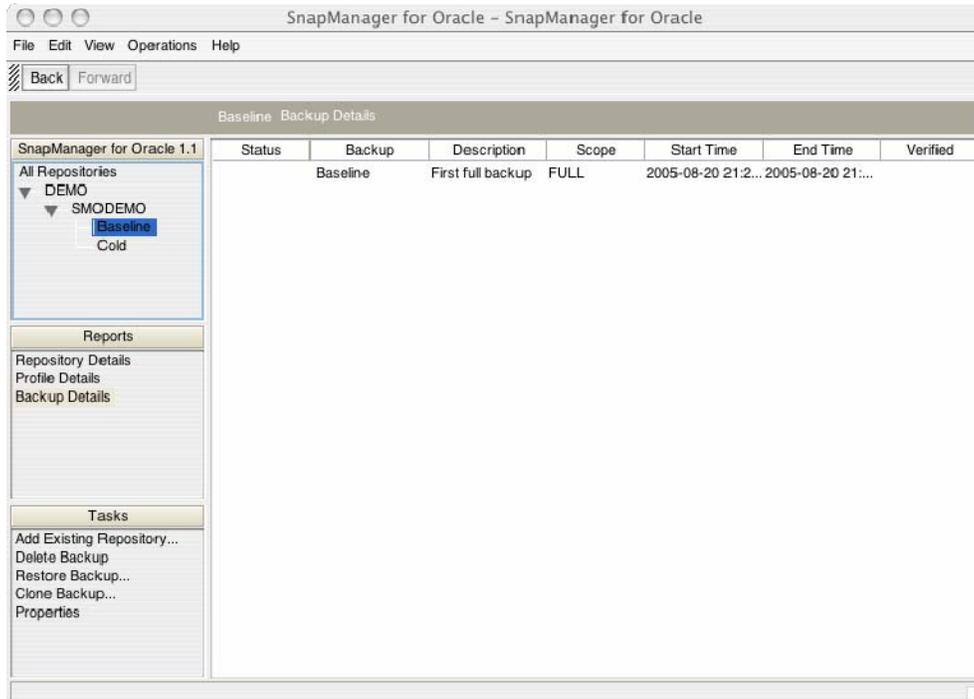


Figure 2) SnapManager for Oracle GUI.

Backup

A DBA can use a wizard-driven GUI or issue the following command to create a backup for Payroll DB:

```
$smo backup -online -profile payrolldb -full -verify -label payrolldb-backup1
```

The above command creates a full backup of Payroll DB while the database is online. The backup is labeled payrolldb-backup1 so that it can be identified in the future. To create a successful backup, SnapManager performs the following operations:

1. Determines the list of data files, control files, and log files that make up the database. These data files, control files, and log files can be located on one or more ASM disk groups.
2. Puts the database in hot backup mode.
3. Creates an atomic Snapshot copy of all the filer volumes that make up the ASM disk group.
4. Ends the hot backup mode.
5. Clones the Snapshot copy and then renames the cloned ASM disk group.
6. Verifies the backup.
7. Registers the cloned ASM disk group and storage information in the RMAN repository.

Restore

SnapManager for Oracle provides GUI wizards for performing restores. Alternatively, a DBA can also issue the following command to restore from Payroll DB from a backup:

```
$smo restore -label payrolldb-backup1 -profile payrolldb -full -recover -when auto
```

The above command restores Payroll DB from the backup labeled payrolldb-backup1. The key step in this operation is to identify the mechanism needed to restore the required data set. SnapManager identifies the most optimal method for restoring the relevant data set. These methods include (1) restoring a single file or a LUN within a volume, (2) partially restoring a LUN or a file within a volume, and (3) externally restoring the file using RMAN or WebDAV. Methods (1) and (2) are the most optimal and fast because these operations are done within the storage appliance and do not require data copy. The majority of the scenarios are covered by these two methods. However, certain scenarios require RMAN or WebDAV to physically copy files from backup to the active system. After the data is restored, the database is recovered using media recovery.

Clone

A DBA can use easy-to-use GUI wizards or directly issue the following command to clone Payroll DB:

```
$smo clone -label payrolldb-backup1 payrolldb-clone1 -profile payrolldb
```

The above clone command uses the payrolldb-backup1 to create the cloned database payrolldb-clone1. The cloned database is also managed by the same ASM instance. The cloned database uses the ASM disk group created at the time of the backup.

CONCLUSION

SnapManager for Oracle combines the database management capabilities of the NetApp storage grid technologies with the Oracle Database 10g grid technologies. SnapManager for Oracle simplifies and optimizes data management operations for Oracle Databases. SnapManager provides automated, fast, and space-efficient backup; automated and rapid restore and recovery; and fast and space-efficient cloning for all Oracle Database configurations. Its unique integration with Oracle ASM provides DBAs with the database storage virtualization and provisioning benefits of ASM along with the ease of data management benefits of the NetApp storage grid technologies.

