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Integrating NetApp™ Snapshot™ and SnapRestore® with VERITAS NetBackup™ in an Oracle® Backup Environment

NetApp Inc. and VERITAS | Bill May and Don Peterson | TR-3394

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Introduction

The Snapshot function of a NetApp storage system provides a fast and completely stable point-in-time copy of files, directory hierarchies, and LUNs. Snapshot copies give administrators near-instantaneous access to previous versions of data, without the bulk and complexity of maintaining completely separate backup copies.

The NetApp Snapshot feature can be used to quickly and reliably create online backups of Oracle databases and, when combined with SnapRestore, allows rapid restore of the database to an earlier point in time. The one downside to using NetApp Snapshot is that the graphical user interface (GUI) and command line interface (CLI) do not lend themselves to operation by inexperienced users, and the process of determining exactly which Oracle files must be snapped, and then placing those files in backup mode while the snapshot takes place, is cumbersome. Fortunately there is a much easier and more effective method of performing a NetApp Snapshot operation.

Leveraging NetApp storage system support for the NDMP V4 snapshot extension, VERITAS NetBackup for Oracle software is able to trigger a NetApp Snapshot operation through the NAS Snapshot option of the VERITAS NetBackup Advanced Client software (Figure 1). NetBackup software is fully integrated with the Oracle Recovery Manager (RMAN) and an administrator performing a snapshot of an Oracle database on a NetApp storage system need only create and schedule a NetBackup policy to automate the otherwise manual process of determining which Oracle files to back up, placing database objects in backup mode, and then running the snapshot operation. Allowing NetBackup software to orchestrate the efforts of Oracle RMAN and NetApp Snapshot makes the backup process effortless.

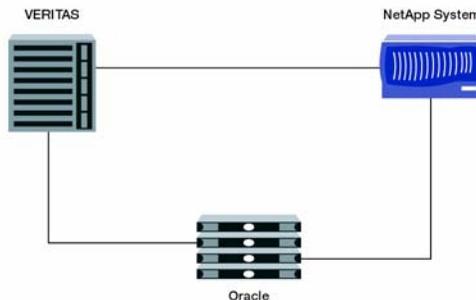


Figure 1) Overview of VERITAS, NetApp, and Oracle configuration.

NetBackup for Oracle software also simplifies restoring a NetApp Snapshot copy of an Oracle database by automating the recovery process. The restore of the NetApp Snapshot copy and the recovery of log information by Oracle RMAN is coordinated, and administrators need only specify the desired point in time for the recovery. Unlike the native NetApp SnapRestore functionality, NetBackup software does not require a user to have root privileges in order to perform a SnapRestore operation. This can free up significant time for the NetApp storage system administrator, who no longer needs to be involved in every SnapRestore operation on every storage system.

Using the intuitive interface provided by NetBackup for Oracle software, Oracle administrators with data on a NetApp storage system gain significantly enhanced ease of use, without giving up any of the functionality on which they rely.

Backup and Restore of Oracle Databases

As reliable and effective as modern database technology has become, it is still impossible to safeguard corporate data assets from error. Implementing a rigorous backup and recovery procedure is essential to ensure the continuing health of a database environment. Administrators have traditionally relied on tape-based backup solutions to guarantee business continuity. As a backup medium, tape offers permanence, portability, and cost benefits that cannot be matched by other long-term storage media. But tape-based backup and recovery also tend to be slow. Increased demand for round-the-clock access to application data and near-instantaneous recovery from database corruptions is placing a strain on tape-based backup and recovery processing.

For Oracle databases operating in ARCHIVELOG mode—the predominant mode of operation for mission-critical corporate databases—the ability to perform hot backups helps to alleviate the deficiencies of tape-based backup. Rather than shutting down the entire database during the backup window—as is the case when performing cold backups—hot backups of the Oracle database allow applications and end users to continue accessing data while a backup is running, albeit with degraded performance. If a recovery is necessary, the database can be returned to a consistent state by restoring data from the backup tape and then rolling forward the transactions in the redo logs.

When operating in ARCHIVELOG mode, the Oracle redo and archive logs are critical to database recovery. The hot backup image of a database will likely contain transactions that are partially complete. To return the database to a consistent state, these incomplete transactions must be rolled back using information from the redo and archive logs. It is advisable to locate redo and archive logs, along with essential Oracle control files, on volumes and LUNs independent of the database data. This will ensure that a catastrophic failure affecting the volumes containing the data files will not corrupt the log and control files, and the database will be able to use the log information to recover data up to a point immediately prior to the failure.

The downside to performing Oracle hot backups is the inevitable impact on application performance. During a hot backup, additional redo log information is recorded to ensure data integrity during a recovery. Write operations against the database are particularly hard hit. To minimize the disruption to business applications, it is essential that the database backup process be completed as quickly as possible.

NetApp Data ONTAP™ Snapshot Technology

Although hot backups do away with downtime during the backup process, applications and end users are still affected by degraded performance while Oracle data is being written to tape. This impact can be significant for large, frequently accessed databases. NetApp storage systems eliminate this problem.

The Data ONTAP microkernel operating system powering every NetApp storage system features an innovative point-in-time Snapshot capability. NetApp Snapshot technology allows an administrator to create an instantaneous frozen image of the Oracle database data on a storage system volume. Snapshot is effective for databases running on file systems and raw devices.

The NetApp Snapshot feature provides a fast and effective backup, without moving any database data. Snapshot creates a consistency point within the storage system, copying the master inode of the NetApp WAFL® file system to a new partition on the volume. Any data blocks modified after the Snapshot operation is performed will be written to the Snapshot partition, leaving the original blocks unchanged. The storage system volume, and database files on the volume, can be returned to the consistency point at any time by running the NetApp SnapRestore command. SnapRestore alters the pointers of data blocks modified since the Snapshot copy to point back to their original location. A NetApp storage system is able to maintain up to 255 Snapshot copies per volume concurrently.

A Snapshot command takes only a few seconds to complete, regardless of how much data is contained on a volume. And, because SnapRestore changes pointers rather than moving data blocks, even very large databases can be recovered quickly to minimize disruption to end users.

Hot Backups with NetApp Snapshot

Backing up Oracle databases using NetApp Snapshot technology takes only a few seconds while the consistency point is created. And because the time it takes to run Snapshot is not affected by the amount of data on a volume, it is possible to create an effective backup of very large Oracle databases with negligible impact on application performance. With the Snapshot copy to guarantee data consistency, the storage system volume, containing both the Snapshot copies and the Oracle tablespace data, can be backed up to a persistent storage medium, such as tape, without placing a load on the Oracle database server.

While NetApp Snapshot limits the impact of hot backups on Oracle database users, the process of performing a Snapshot operation is complex and manually intensive for administrators. Whether using the NetApp GUI or running scripts from the command line, the administrator must perform all tasks by hand, and a recovery requires root authorization to initiate the SnapRestore commands. Fortunately there is a more efficient method of performing the NetApp Snapshot and SnapRestore processes using the sophisticated scheduling, policy, and user interface features of VERITAS NetBackup software.

VERITAS NetBackup for Oracle and the NetBackup Advanced Client

VERITAS NetBackup for Oracle is the cornerstone of many successful Oracle database backup and recovery environments. Tightly integrated with Oracle RMAN, the NetBackup for Oracle scheduling, policy, and media management capabilities give administrators essential tools for efficient day-to-day management of Oracle database backup and recovery operations.

The NetBackup administration console provides administrators with a sophisticated user interface for creating Oracle database backup policies. A NetBackup policy defines the criteria that govern the storage units and media used for a backup. The administration console also provides backup scheduling information, the location of the NetBackup clients to be backed up, and the template or script files that will be executed on the client to identify specific databases and database objects being backed up. Wizards guide administrators through the process of creating backup policies and templates, and many default values are automatically selected based on a configuration that works for most instances.

The Backup Selections list of a NetBackup policy holds the templates and Oracle RMAN scripts that initiate the backup process. When using NetBackup for Oracle in a standalone implementation, RMAN performs the physical extraction of data from database objects and NetBackup captures the backup stream and moves the data to persistent media. Adding VERITAS NetBackup Advanced Client software to this configuration allows RMAN to delegate all data movement to NetBackup.

Oracle Proxy Copy

Leveraging the Oracle Media Management API proxy copy extension, the NetBackup Advanced Client software takes integration between NetBackup for Oracle and RMAN one step further. Using the proxy copy API, NetBackup Advanced Client relieves RMAN of responsibility for the physical movement of data during a backup operation. Instead of performing stream-based backups—capturing the data stream as RMAN produces it—NetBackup Advanced Client allows NetBackup for Oracle to perform file-based backups.

When performing a proxy copy backup, NetBackup for Oracle provides RMAN with a script listing all of the database objects to be backed up. RMAN records information about these objects in the RMAN repository and returns a list of file names to NetBackup. NetBackup then performs file-based backup of the Oracle files, using the NetBackup Advanced Client to manage the physical movement of data blocks. When data movement is complete, NetBackup signals RMAN that the backup is finished.

The proxy copy API currently supports the backup of Oracle databases, tablespaces, and data files using file-based data movement. Although control files and archived redo logs require conventional NetBackup stream-based backup methods, these files can be included in a policy that uses NetBackup Advanced Client. Proxy copy allows advanced third-party file-based backup techniques, such as snapshot and block-level incremental copies, to be used on Oracle database objects. The NetApp storage system's support for the Network Data Management Protocol (NDMP) enables Data ONTAP Snapshot functionality to be fully integrated into a NetBackup Advanced Client proxy copy backup process.

Integrating the NetApp Snapshot Feature

Combining the NetApp Snapshot feature with the VERITAS NetBackup Advanced Client, NDMP, and Oracle agent options, provides a complete solution (Figure 2).

NetBackup policy executes RMAN script(s) on Oracle server.

- RMAN places datafiles in backup mode and returns list of files to NetBackup.
- NetBackup issues NDMP commands to initiate Snapshot on NetApp storage system.
- NetBackup requests RMAN to remove backup mode from datafiles.

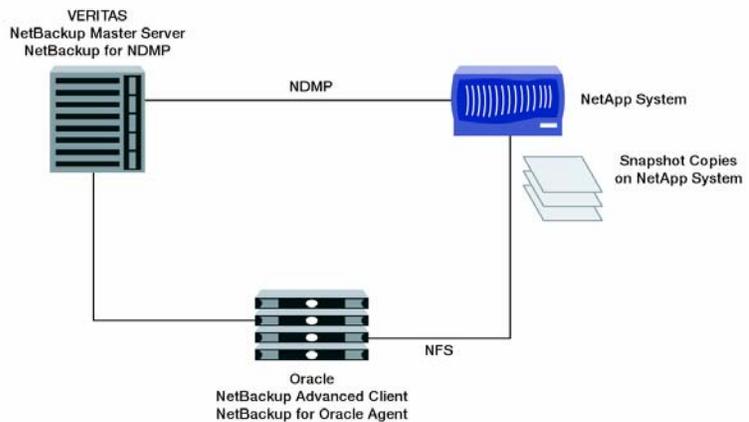


Figure 2) VERITAS NetBackup for Oracle with NetApp Snapshot.

NetBackup for NDMP is an essential component of the configuration that allows NetBackup Advanced Client to perform Snapshot copies of a NetApp storage system. When NetBackup for Oracle performs a proxy copy backup, the NetBackup policy checks the Advanced Client attributes to determine the data movement configuration. Data movement specifies how the Oracle files are going to be copied from disk to a backup medium. If NAS Snapshot is selected as the data mover, NetBackup Advanced Client uses NDMP V4 snapshot extension commands to communicate with the NetApp storage system and initiate the Data ONTAP Snapshot functionality.

NetBackup software determines the location of the NetApp NAS device and the mount point to receive the Snapshot command from the path and file names returned to it by RMAN. Once the storage system has successfully completed the Snapshot copy, control is returned to NetBackup software.

By incorporating NetApp Snapshot functionality into the arsenal of backup methods deployed by NetBackup for Oracle, administrators of NetApp storage systems are able to make full use of the scheduling, media management, and sophisticated user interface features of the VERITAS NetBackup product suite when backing up Oracle databases.

Snapshot Copies and Persistent Storage

Performing a Data ONTAP Snapshot backup of the Oracle database objects on a NetApp storage system volume is a fast and efficient means of backing up data, but it is not the end of the road if the data is to be fully protected. To safeguard data against a storage system failure, and to provide offsite copies for business continuity purposes, it is essential to back up the volumes of the storage system, and all Snapshot copies, to persistent storage.

Snapshot copies are stored in a separate partition on the same NetApp volume as the primary data, with typically 20% of the volume being allocated for Snapshot contents. A backup of the volume mount point to a persistent storage medium automatically safeguards both the original data and the modified blocks in the Snapshot copies.

Although NetBackup Instant Recovery backups include an option to back up the Snapshot copy to persistent storage in the same policy that creates the Snapshot copy, this option is not available for NAS Snapshots. A separate NetBackup schedule must be created to ensure that the primary data and Snapshot copies are copied to a long-term storage medium.

Restoring a NetApp Snapshot Copy

Oracle database recovery is traditionally performed by the DBA from backup tapes and often takes a prohibitively long time. The process involves manually shutting down the Oracle database, restoring selected data files, mounting the database, recovering transactions from the archived and online redo log files, and finally opening the database for user access.

NetBackup for Oracle coordinates and speeds the process of recovering an Oracle database using the contents of a NetApp Snapshot copy, but the task remains complex and should be attempted only by a knowledgeable administrator. However, one significant advantage of using the automated processing of NetBackup for Oracle is that the user does not require root privileges to perform the restore.

NetBackup for Oracle Recovery Wizard

Restoring a NetApp Snapshot through the NetBackup administration console is straightforward and requires no special advanced configuration. The NetBackup for Oracle Recovery wizard, initiated from the Backup, Archive, and Restore (BAR) user interface, prompts the administrator for information about the databases and tablespaces to be recovered. The administrator can choose to restore to the last Snapshot copy, the default action, or choose a specific time to force selection of an earlier Snapshot copy. NetBackup also supports using RMAN scripts, giving the database administrator greater control over the recovery process.

Point-in-time rollback, also referred to as Snapshot rollback, restores the entire NetApp storage system volume. The process wipes out all subsequent Snapshot copies from the volume's Snapshot partition. Before performing a Snapshot rollback, NetBackup software attempts file verification, checking to ensure that file numbers and names on the Snapshot copy and primary volume are identical and that no files have been added to the volume since the Snapshot operation. If verification fails, the restore aborts.

The Oracle RMAN catalog contains detailed information about each proxy copy backup. At run time, the template created by the NetBackup recovery wizard, or the database administrator's RMAN script, issues recovery commands to RMAN, and RMAN, in turn, requests that NetBackup software perform file restores. NetBackup software communicates with the NetApp storage system using the NDMP V4 snapshot extension to initiate a SnapRestore recovery of the chosen files. The restore can process a single file or a tablespace or return an entire database back to a specific point in time.

Requirements and Assumptions

Familiarity with Oracle database administration, the operation of VERITAS NetBackup 5.1 software, and administration of NetApp storage systems is assumed in the following discussion of how to perform backup and recovery of Oracle databases using NetBackup for Oracle and the NetApp Snapshot option.

Software Version Prerequisites

- NetBackup 5.1 Enterprise Server
- NetBackup 5.1 for Oracle
- NetBackup 5.1 Advanced Client, UNIX®
- NetBackup for NDMP
- Data ONTAP 6.5.3 or later, including SnapRestore option
- Oracle8i™ or later
- NFS v3 and v4
- Sun™ Solaris™ 7, 8, and 9 (Oracle Server)

The NetApp storage system volumes must be mounted on the Oracle server using NFS.

Additional Reading

Information about the components comprising this solution can be found in the following VERITAS documentation:

- VERITAS NetBackup 5.1 for Oracle System Administrator's Guide*
- VERITAS NetBackup 5.1 for NDMP System Administrator's Guide*
- VERITAS NetBackup Advanced Client 5.1 Systems Administrator's Guide*

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Backup

VERITAS NetBackup software coordinates the activities of Oracle RMAN and the NetApp Snapshot functionality to create snapshot copies of user-specified Oracle database data. Snapshot policies are configured from the NetBackup administration console.

Creating a NetBackup Policy

Before executing a Snapshot copy of a NetApp storage system, it is necessary to create a NetBackup policy specifying the attributes that differentiate this backup from other types of NetBackup activity. Once a policy has been created, it can be executed manually or scheduled to run at a predefined time. Policies are created from the NetBackup administration console, started on the NetBackup master server, and require the user to log on as an administrator.

The new policy dialog is started by choosing a master server from the list of servers displayed in the administration console and selecting New from the All Policies panel. After entering a policy name, the Change Policy dialog box (Figure 3) allows specific policy attributes to be selected.

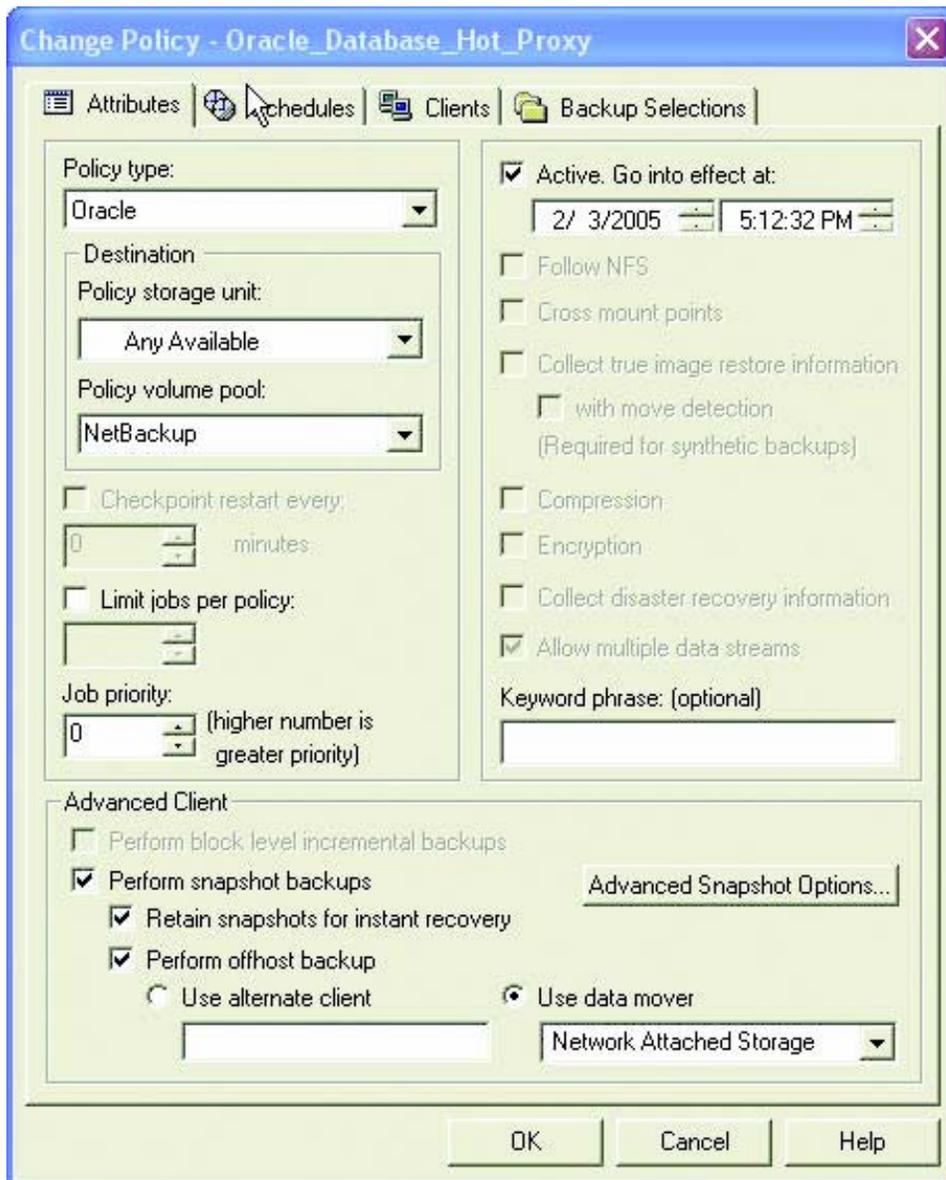


Figure 3) VERITAS NetBackup Change Policy dialog box Attributes tab.

When creating a new policy, or when editing an existing policy, the Change Policy dialog box allows the administrator to enter the following attributes:

“Oracle” must be selected in the Policy Type box.

Note: Oracle shows in the pull-down display only if a NetBackup for Oracle license key has been obtained.

“Any Available” must be selected for Storage Unit.

The Snapshot copy is created on the disk of the NetApp storage system regardless of what is specified in the Storage Unit attribute.

Select “Perform snapshot backups.”

Select “Retain snapshots for instant recovery,” “Perform offhost backup,” and “Use data mover.”

In the pull-down box under “Use data mover,” select “Network Attached Storage” as the specified method.

Click the Advanced Snapshot Options button to verify that the NAS_Snapshot method is selected and to configure the Maximum Snapshots parameter.

After configuring policy attributes, a new schedule must be created to initiate the Snapshot backup. In the Schedule tab, select “Instant recovery backups to disk only.” For more information about configuring schedules, including how to incorporate stream-based backup of control and archive redo logs into a Snapshot policy, refer to the *VERITAS NetBackup for Oracle System Administrator’s Guide for UNIX*.

Each NetBackup policy must contain at least one client, specified via the Clients tab of the Change Policy dialog box. The name of the Oracle server can be manually entered, or you can browse to choose a client on the network. Note that if Oracle is installed in a cluster, the virtual server name must be specified as the Client name.

NetBackup software will attempt to run templates and scripts specified in the Backup Selections tab on each client specified on the Clients tab. The Backup Selection tab (Figure 4) of the Change Policy dialog box contains a list of templates or scripts defining the RMAN commands issued by NetBackup for Oracle.

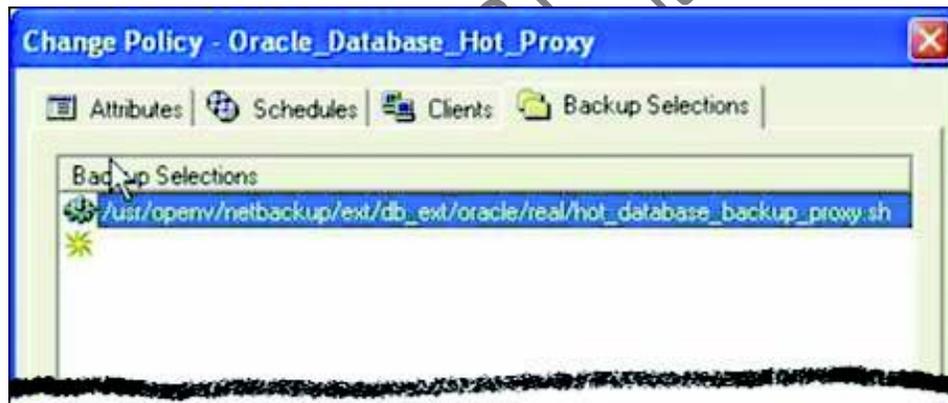


Figure 4) Change Policy dialog box Backup Selections tab showing Oracle RMAN script.

Scripts are created manually, usually by the database administrator, and must be located on each Oracle server being backed up by the policy. The script must include the Oracle `backup proxy` command to enable a NetBackup Advanced Client backup. Sample scripts are included with each NetBackup for Oracle installation, and more information can be found in the Oracle Server Backup and Recovery Guide.

NetBackup for Oracle RMAN Template Generation Wizard

Typically Oracle database administrators specify their own RMAN scripts in the Backup Selections tab. However, NetBackup software also provides an Oracle RMAN Template Generation wizard that allows database administrators to easily create templates for Oracle backups. These templates are located on the NetBackup for Oracle master server and at run time are converted to scripts and executed on the Oracle server.

The NetBackup for Oracle RMAN Template Generation wizard is started from the NetBackup BAR interface. If Oracle is installed, the wizard displays Oracle nodes in the left pane of the screen. Selecting the Backup Files tab and expanding the Oracle instance hierarchy displays the database objects that can be backed up. For NAS Snapshot, only database, tablespace, and data file objects can be selected.

After selecting the Oracle objects to be backed up, clicking the Backup button, on the lower right of the display, initiates the Template Generation wizard. The wizard prompts the administrator for information about the type of backup to perform, including the following data:

- Target Database Logon Credentials
- Recovery Catalog Logon Credentials
- Archived Redo Logs
- Configuration Options
- Backup Options
- Database State
- NetBackup Configuration Variables

Note that Backup Limits does not apply to NAS Snapshot backups. After completing the template wizard a summary screen is displayed showing all selections made. The template can then be executed immediately or saved for scheduled execution at a later time.

Restore

The process for restoring a NetApp Snapshot copy using NetBackup for Oracle and NetBackup Advanced Client is the same as for non-Snapshot Oracle backups. Administrators use the NetBackup for Oracle Recovery wizard (Figure 5) to specify whether individual tablespaces or entire databases are being recovered, and to select a specific point in time for the recovery or opt for restoring to the latest Snapshot copy. Oracle RMAN scripts can be written by the database administrator to drive the recovery process. Direct command line interaction with RMAN can also be used.

The NetBackup for Oracle Recovery Wizard is launched from the BAR interface, which is accessed from the NetBackup administration console.

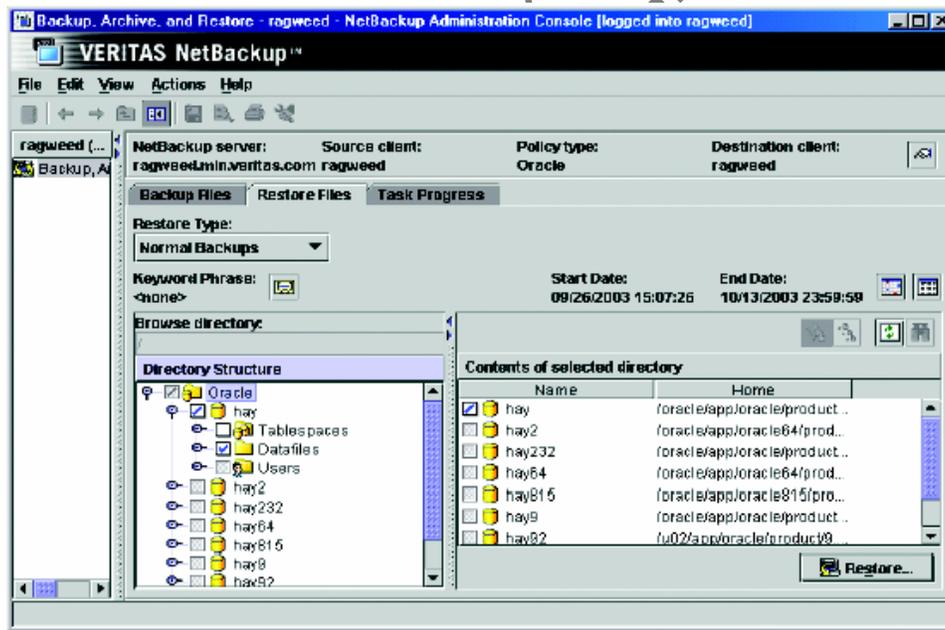


Figure 5) NetBackup Backup, Archive, and Restore interface.

Selecting the Restore Files tab from the NetBackup BAR interface allows the administrator to choose individual database objects to be restored from the expanded Oracle instance in the left panel of the display. Selecting the instance will recover the entire Oracle database.

With Oracle specified as the Policy Type, Restore Type set to either Normal Backups, for individual data file recovery, or Point In Time Rollback, to recover the entire NetApp volume, and the appropriate Oracle instance objects selected for restore, the administrator clicks the Restore button in the lower right corner of the BAR interface to initiate the NetBackup for Oracle Recovery wizard. The wizard prompts the administrator to fill in several panels of data that must be completed before the restore takes place. The information required includes:

- Target Database Logon Credentials
- Recovery Catalog Logon Credentials
- Recovery Options
- Restore Options
- Recover Limits
- Database State

The NetBackup for Oracle help files contain additional information for each of these items.

After completing the wizard, the selection summary screen is displayed showing all details chosen for inclusion in the recovery template. The template can be executed immediately, saved and executed, or simply saved to be executed at a later time.

A saved Recovery wizard template can be executed by issuing the `bpdbsbor.a` command from the command line of the NetBackup for Oracle master server.

RMAN Recovery Scripts

The NetBackup and NetApp integrated solution also supports script-driven restores, giving the administrator greater control over the recovery process. RMAN scripts can be initiated from the NetBackup master server or run manually on the Oracle server. The following shell script example uses the NetBackup `NB_PC_ORA_RESTORE` variable to indicate that a Snapshot rollback is being performed.

```

RUN {
  allocate channel t1 'sbt_tape';
  send 'NB_ORA_PC_RESTORE=rollback';
  sql 'alter tablespace TEST offline immediate';
  restore tablespace TEST;
  recover tablespace TEST;
  release channel t1;
}

```

Conclusion

NetApp Snapshot functionality provides quick and reliable online backups of Oracle databases. The integration of this capability with VERITAS NetBackup software and the Oracle agent provides a solution that augments the existing NetApp functionality. Policy configuration, Snapshot scheduling, and cataloging of the Snapshot copies are managed by the NetBackup software. The NetBackup Backup, Archive, and Restore interface takes advantage of NetApp SnapRestore functionality to quickly recover the database or specific parts of it. For administrators, this is a win-win combination.

As application service level demands increase, pushing at the limits of the existing backup and recovery environment, the productivity benefits of combining the proven functionality of NetApp with NetBackup software's management capabilities and its integration with the Oracle database are compelling. This integrated solution significantly enhances the administrator's ability to effectively manage the Oracle backup and recovery infrastructure.

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