

NetBackup™

For Oracle

**Scalable Backup and Recovery for
Critical Oracle Databases**


VERITAS

BUSINESS WITHOUT INTERRUPTION™



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Executive Summary

Oracle database backup and recovery is an inherently challenging process that becomes more difficult as databases grow in size and as increasing demands on database availability limit the time available to perform backups. Many organizations use locally-developed scripts and manual backup methods. However, these methods do not have the reliability required by an enterprise environment, and do little to improve the ongoing availability of critical systems. They are ill-suited to handle today's rapidly growing data environment; according to the Gartner Group, corporate database are doubling in size each year.

VERITAS NetBackup is an enterprise-wide backup and recovery solution. VERITAS Software has worked closely with Oracle Corporation to develop a highly scalable and reliable online backup and recovery solution for Oracle databases. NetBackup *for Oracle* protects both the data itself and the availability of the Oracle applications.

This paper discusses the limitations of manual backup and recovery methods for Oracle databases, and describes how the VERITAS NetBackup solution manages Oracle backups. It explains how using NetBackup *for Oracle* backups and recoveries improves the availability, manageability and reliability of Oracle databases.

Introduction

If you're running critical applications on Oracle databases, then you're already investing in an Oracle backup and recovery solution. For many organizations, this solution is an assortment of scripts and manual processes managed and maintained by in-house database administrators (DBAs). But while you wouldn't dream of running without backups in a critical computing environment, many organizations are using backup schemes that they have outgrown. Often, the problem isn't discovered until a recovery fails, resulting in a costly outage or lost data.

A backup solution that once worked well for smaller or noncritical databases may not address the needs of a larger database, or a large database with growing availability requirements. Symptoms of an inadequate backup/recovery solution include:

- ◆ Excessive DBA time spent maintaining and managing backups, without scheduling integrated with other system operations.
- ◆ Infrequent backups, leading to lengthier recoveries. (The longer it has been since the last backup, the more transaction logs or 'archived redo logs' you have to replay to recover the database. This is an inherently slow process.)
- ◆ Prolonged outages due to data restoration errors or problems finding the right files.
- ◆ Operator support required for changing tapes.

In the enterprise environment, Oracle databases offer unique and specific challenges for backup and recovery. These include:

- ◆ Managing large amounts of data. Database backups tend to be very high volume operations - managing these backups may mean managing tens, hundreds, or even thousands of gigabytes of secondary storage.
- ◆ Maintaining high availability. As databases grow in size, the time spent to take a backup may exceed any designated "backup window."
- ◆ Handling complex recovery scenarios. Recovering an Oracle database is much more than simply restoring a file from tape: it requires identifying the cause of the failure, identifying and restoring the correct set of files and tablespaces, restoring the right archived redo logs, and recovering the database appropriately for the current situation.

It's not enough to have the database expertise in-house - you also need storage management capabilities for handling and managing high volume backups for optimal performance and manageability. VERITAS NetBackup combines enterprise-level storage management capabilities with Oracle-specific database expertise, to provide a highly scalable backup and recovery solution for securing Oracle database data.

Limitations of Manual Backup Methods

Oracle provides a rich variety of backup and recovery options. These are described in greater detail in the Oracle Administration Guide and in a number of third party books on Oracle database administration. This paper presents only the most basic description of these processes to highlight the inherent challenges of manual methods.

Oracle backups can be divided into two categories: cold and hot.

- ◆ *Cold backups*, taken when the database is shut down, create a consistent backup image (the database is in a consistent state).
- ◆ *Hot backups* are taken while the database is online. These may be either full or partial backups. For very large databases it is frequently necessary to back up one tablespace one day, and another the next. Hot backups are not inherently consistent; they must be used in conjunction with archived redo logs and redo logs to bring the database to a consistent state. Performing hot backups requires putting the Oracle database into a special backup mode, in generates some additional redo and rollback information during the backup. This state has implications for database performance.

These two methods may be used in combination, with full cold backups once a week and tablespace-level hot backups on a daily basis. In addition, Oracle is constantly archiving redo logs, which contain the transaction-by-transaction history of the database and are used to bring the database to a consistent state. The database backup must manage all of the files comprising the database, including data files, control files, parameter files and archived redo logs.

Recovering from a failure is a more complex operation, whose exact steps depend on the kind of failure experienced. Basically, there are two phases to database recovery:

1. Data restoration: identifying and restoring the appropriate data files, archived redo logs, and, if necessary, control files and parameter files from secondary media to their appropriate location in primary disk.
2. Database recovery: taking the appropriate steps in Oracle to restore the database, either to a specific point in time or to the most recent point before the failure.

Determining which files to restore can be challenging, particularly if you have been using rolling hot backups. A point-in-time recovery requires different steps than an up-to-the-minute recovery. Restoring the wrong files (for example, restoring the control file when it is not necessary to do so) can actually cause more problems than the original outage. Determining which archive logs are required can also delay recovery.

Many Oracle installations rely on their database administrators (DBAs) to create and run backup scripts to manage regular Oracle backups. These scripts may perform either cold or hot backups, and will automate backups to some degree. However, using home-grown scripts is still primarily a manual approach to Oracle backups because:

- ◆ Maintaining the scripts is a manual, ongoing process. (For example, as new tablespaces and data files are added to the database, the scripts must be updated)
- ◆ The scripts typically lack the robust error management and restartability of commercial software, and as such require ongoing vigilance.
- ◆ Although scripts automate backups, recovery is a manual process, requiring an experienced DBA's presence and guidance.
- ◆ Operators still need to be available to change tapes manually during backups.

Manual methods are adequate for some installations. For example, if the database is small, and if there is an adequate backup window available, then a DBA has the luxury of simply shutting down the database and performing a consistent, "cold" backup. Likewise, if the database does not undergo significant daily changes, then backups do not need to occur as often. And if high availability is not a concern, then a minor delay on recovery is an acceptable risk.

However, as databases grow in size, manual methods become more difficult. A large database may have hundreds of data files; tracking and storing the backup files on secondary media requires excellent organization. Very large backups may need tape changes during the backup, making automation even more difficult.

Most importantly, manual backups still leave organizations vulnerable to errors and delays in the recovery process. Organizations must examine carefully if their backup and recovery solutions protect not only their data but the availability of their critical systems.

3 Steps or 11 Error-Prone Recovery Conditions

The following real-life example illustrates the steps required to restore an entire database that has been lost due to application failure, the most common failure in the database environment. On the left are the steps necessary when using Oracle Recovery Manager in conjunction with VERITAS NetBackup for Oracle. On the right are the steps necessary when using native Oracle utilities and operating system procedures.

Attached as Appendix A is an expanded explanation of both processes with complete descriptions of each step in both scenarios.

Table 1

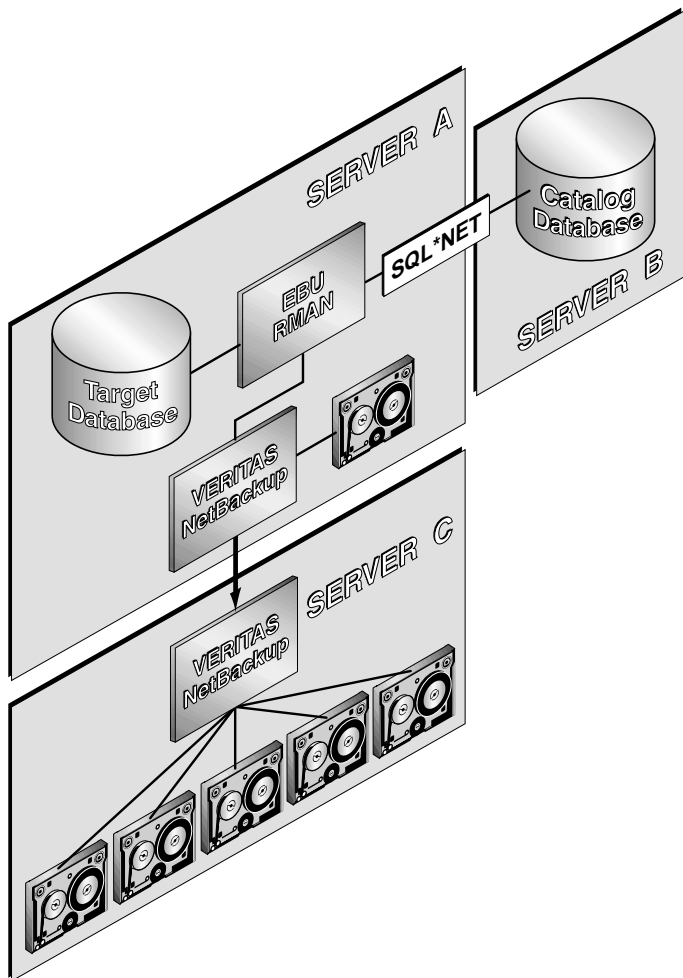
RMAN/NetBackup steps to restore the database	Oracle native utilities and OS commands used to restore the database
1. Start the database in DBA mode.	1. Start the database in DBA mode
2. Issue RMAN 'recover' commands.	2. List files to backup
3. Take database out of DBA mode and open for normal use.	3. Bring the database down
	4. Perform whole database backup
	5. Check control file integrity
	6. Restore the database to a point-in-time
	7. Determine necessary redo logs for recovery
	8. Restore necessary redo logs
	9. Start the database again in DBA only mode
	10. Begin time-based recovery by applying the redo logs
	11. Take database out of DBA mode and open for normal use

Requirements for Oracle Backup and Recovery

A good Oracle backup and recovery solution must be able to meet the following requirements:

- ◆ *High availability of current systems*
If you have a small backup window, or no backup window at all, you need a high-performance solution that supports hot backups and minimizes the impact of backups on running system.
- ◆ *Reliable results*
Oracle recovery can be complex; the backup solution must be inherently reliable and must include the Oracle expertise necessary to recover from a wide variety of failures.
- ◆ *Manageability*
A good backup and recovery solution should completely automate the backup processes, so that backups can take place, unattended, at any time of the day or night. It should allow the DBA to schedule and prioritize backups, so that the most critical information is backed up first. And it must provide end-to-end backup management, from tracking and restoring the right files to expiring old backups.
- ◆ *Flexibility*
An Oracle backup and recovery solution should give you the capability of recovering a single tablespace, performing online recoveries where possible, or recovering to a point in time. To enable this, the backup solution must be closely integrated with the Oracle database itself.

Delivering all of these capabilities in an enterprise environment, with critical data at stake, requires a solution that encompasses both database-specific expertise and enterprise-class storage management capabilities.



VERITAS NetBackup

VERITAS NetBackup is an enterprise backup and recovery solution that provides highly scalable support for a wide variety of servers and clients, together with extensive media management capabilities. NetBackup supports all leading tape vaults and optical disk libraries, and incorporates years of expertise in managing distributed backups, securely and safely, for optimal performance.

As an Oracle Backup Solutions Partner, VERITAS has created database-specific support for Oracle databases using Oracle-supplied interfaces. NetBackup *for Oracle* is tightly integrated with Oracle's Recovery Manager (RMAN) product for Oracle 8.x, and the Enterprise Backup Utility (EBU) for Oracle 7.x databases. These interfaces, created and supported by Oracle Corporation, manage the basic backup and recovery operations, packaging much of the work that the DBA previously performed manually.

The NetBackup server manages backup policies and schedules, and communicates with the storage media. A single NetBackup server can manage multiple Oracle database backups, providing centralized storage management and leveraging high speed or high capacity storage devices.

This solution combines both storage management and Oracle expertise to improve the availability, manageability and reliability of Oracle data and servers.

Improving the Availability of Oracle Databases

VERITAS NetBackup *for Oracle* is a flexible and scalable solution for enterprise database backups. Whether used for a small, critical database or a number of large databases, NetBackup gives DBAs the tools to protect both the data itself and the availability of the database applications.

NetBackup optimizes database availability in two important ways. Superior backup performance and hot backup support minimizes the impact of backups on production systems. Fast data restoration and simplified recovery brings databases back online faster after failures.

Hot backup support

VERITAS NetBackup supports any combination of cold or hot backups, so DBAs can create the backup schedules that best suit their needs and adjust those schedules as the database grows.

Through its integration with Oracle RMAN (or EBU *for Oracle* 7.x), NetBackup *for Oracle* simplifies the process of making and maintaining hot backups. It manages the processes of altering the database state for backups, backing up all of the appropriate files and archived redo logs, and tracking all of the backup information needed for a fast and accurate recovery.

Oracle incremental backups

RMAN supports incremental backups, in which only changed data is written to the backup. During an Oracle incremental backup, RMAN scans the database for changed database blocks. However, with the NetBackup Block Level Incremental Backup Extension, NetBackup *for Oracle* supports an additional kind of incremental backup. NetBackup can write only the changed file system blocks. This kind of backup typically writes smaller block sizes, and does not require scanning the database.

Table 2

Block-Level Incremental Backup/Restore Performance

	Full	Increm 1	Increm 2	Restore
VxFS BLI - tape	138:24	5:01	5:02	16:11
RMAN - tape	103:33	15:10	15:24	34:09
VxFS BLI - disk	31:01	1:42	1:54	1:04
RMAN - disk	25:00	12:17	11:59	4:48

With NetBackup *for Oracle*, you can select the incremental backup methodology that works best for you (database block-level or file system block-level). Depending on the amount of data changed since the last backup, incremental backups can significantly reduce the volume of data backed up and the elapsed time of the backup. A flexible incremental backup structure, including both cumulative and differential incremental backups, lets DBAs create backup schedules that balance backup speed with recoverability time.

High performance backups

Whether you perform cold or hot backups, backup speed is a critical factor, particularly for very large databases. VERITAS NetBackup provides parallel and multiplexed backups. If you have a very high speed tape device, you can keep it running at optimum speeds by streaming multiple backups in parallel to the same device.

Performance measurements at Sun have demonstrated that when streaming data in parallel from several devices, VERITAS NetBackup can sustain online or cold backup rates of approximately 940 GB per hour, with backup rates exceeding one terabyte per hour for raw disk backups.

Table 3

Summary of Performance Statistics for Online, Offline and Raw Device Backups

Benchmark	Sustained Parallel Throughput	Total Data Moved	Time for Test	Overall Average Throughput	CPU Utilization
On-Line Backup	941 GB/hr	271 GB	30 min	580 GB/hr	62%
Off-Line Backup	940 GB/hr	271 GB	27 min	640 GB/hr	60%
Raw Device Backup	1026 GB/hr	291 GB	21 min	831 GB/hr	50%

Off-host backup processing managed by the backup server

Even online backups have a performance impact on the running system. For example, performing an online backup requires putting the database in a special "Backup" mode, which generates more rollback segments (a feature used for backing out changes) than in a non-backup mode. More importantly, the RMAN (or EBU) process runs on the same server as the Oracle database, and therefore competes for the same server resources.

For Oracle 8i installations NetBackup supports a feature called proxy copy, in which the NetBackup server manages reading and writing the backup. This close integration significantly reduces the impact of any backup or restoration activities on the production server. (As of this writing, this feature is supported only for Oracle 8i on Solaris and HP-UX servers running the VERITAS File System; more servers should be added over time.)

Highly Reliable Backups and Recoveries

The greatest danger of using manual backups and recovery methods is that the recovery process is very difficult; the opportunity to make an error during recovery is great, particularly when you consider that recoveries are typically crisis-driven. Your most experienced DBAs may not be immediately available at the critical moment you need them.

Through its integration with Oracle's RMAN and EBU programs, NetBackup reduces the potential for recovery mistakes that delay recovery or result in lost data.

Oracle-managed recovery

VERITAS NetBackup *for Oracle* uses the Oracle RMAN (or EBU) interface to recover the database. It provides a wide variety of recovery alternatives, including point-in-time or partial recoveries. And it reduces the chance of an operator or a DBA making an error during the critical recovery period.

Oracle-VERITAS Partnership

As a member of the Oracle Backup Solution Partner program, VERITAS Software uses application programming interfaces provided and supported by Oracle Corporation. Oracle Corporation uses VERITAS NetBackup for its own internal backups, so you can be sure that the integration is not only tested but proven in the most demanding Oracle environments.

Easier Management of Oracle Backup and Recovery

NetBackup gives DBAs complete control over their backups and recoveries while handling the media management, backup tracking and device support for automated, unattended operations.

Unattended backups

Database administrators use NetBackup to create backup policies and schedules for unattended backups. With NetBackup's extensive tape library and autochanger support, DBAs can schedule backups at any time of the day or night, without operator intervention for tape changes.

Remote backups

NetBackup can perform remote backups of multiple Oracle database servers, even databases using different hardware platforms. This lets you leverage a central repository of secondary media and backup devices to support all of the enterprise's critical data.

Support for disaster recovery

NetBackup's image duplication feature lets an administrator create duplicates of each backup tape, even multiplexed tapes, multiplexed tapes can be de-multiplexed into gnu/tar format for faster recovery of a single file for storage at an off-site location or another facility. NetBackup's BPVault Extension helps administrators manage the off-site archiving of duplicate tapes. Taken together, these features contribute to an enterprise disaster recovery solution. (BPVault Extension is a separately priced option.)

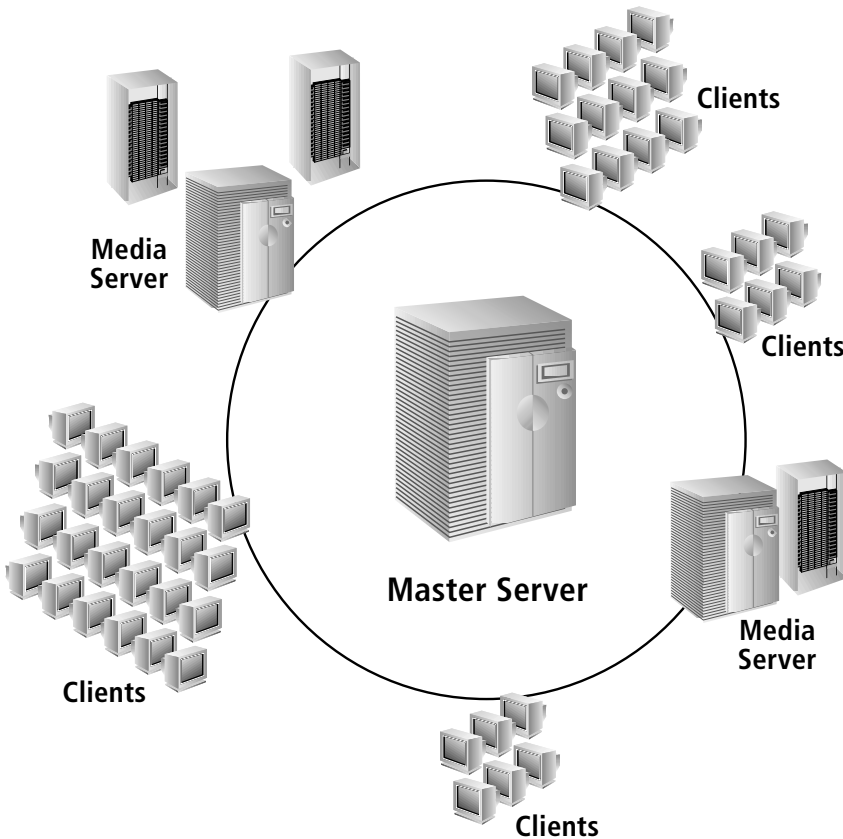
Storage Area Networks

With the Shared Storage Option, you can share storage devices (such as high speed, high capacity tape changers) dynamically in a heterogeneous server environment. For example, you can allocate two drives in a robotic device for a specific database backup; NetBackup dynamically releases those drives once the backup is completed. This feature works in a Storage Area Network (SAN) or a SCSI switched environment. This capability lets organizations use their storage hardware more effectively and efficiently. (The Shared Storage Option is a separately priced option.)

Integration with enterprise backups

NetBackup is a total enterprise backup solution, with file system backups for heterogeneous servers, including Windows NT and most UNIX platforms and Novell NetWare. In addition, NetBackup supports online backups for Sybase, Microsoft SQL Server, Lotus Notes, Microsoft Exchange, and IBM DB2, and specialized support for SAP R/3 on Oracle. All of these backups can be managed centrally via an easy-to-use, Java(tm)-based interface, and all can share the same backup devices and media management.

For large enterprises, NetBackup has a highly scalable architecture with a global server and multiple media servers. This provides nearly unlimited scalability and centralized administration with distributed processing that you can optimize for your particular environment.



Application-Specific Storage Management

VERITAS NetBackup is only one of several Oracle-specific storage management products developed and supported by VERITAS Software. VERITAS Software is working closely with Oracle customers and Oracle Corporation to create application-specific storage management solutions that enhance the performance and availability of Oracle databases. NetBackup is integrated with several of these solutions, described below.

NetBackup Block-Level Incremental Backup Extension for Oracle

This NetBackup extension, offered in conjunction with the VERITAS Database Edition for Oracle, enables a unique, file-system block-level incremental backup (BLIB) capability. A block-level incremental backup only writes changed file system blocks on a backup; information about changed data is

maintained in the file system itself. This lets administrators perform backups more frequently for better recoverability. This technique reduces the CPU and network resources used during backups and improves data availability by virtually eliminating backup windows.

Storage Checkpoints

The Database Edition for Oracle also supports powerful capabilities called Storage Checkpoints and Storage Rollback. Using these features, DBAs can take "snapshots" of their system at any point in time. These Storage Checkpoints are small, disk-resident images and are very fast to perform. DBAs can "roll back" to those database images at any time, quickly and easily.

Support for Off-Host Backups with EMC Storage Arrays

NetBackup lets you create a mirrored image of the database on shared EMC Storage Arrays and take the backup from that mirrored image. NetBackup uses EMC interfaces for mirror synchronization and break-off capabilities. The result is a backup with virtually no impact on the production database server.

Summary

Through its partnership with Oracle Corporation, VERITAS has created a highly scalable backup and recovery solution that protects Oracle data and application availability. NetBackup *for Oracle* optimizes application availability by supporting online backups, optimizing backup performance, and providing fast and accurate recoveries. And with lights-out operations and integration with Oracle-supported interfaces, NetBackup makes Oracle backups more manageable and reliable.

VERITAS Software is committed to providing Oracle sites with superior, database-specific storage management solutions. VERITAS is a member of the Oracle Backup Solutions Partner Program. In fact, Oracle Corporation uses VERITAS NetBackup in-house to support its own critical servers. According to Gary Roberts, Vice President of IT Americas for Oracle, "Due to the size of our IT environment, we needed a true enterprise solution that could provide reliable backup and recovery operations, and we found that with VERITAS NetBackup. Implementing VERITAS' end-to-end storage management product suite helps IT ensure Oracle's business critical data is protected and available."

Appendix

RMAN/NetBackup script for restoring an entire database due to an application error made at a specific time	What's happening	SQL and Operating system procedures for restoring an entire database due to an application error made at a specific time	What's happening
<pre>Run{ startup dba mount; set until time '1999-04-11:11:30:00'; allocate channel t1 type 'SBT_TAPE'; restore database; recover database; sql 'alter database open resetlogs'; shutdown immediate; startup open; }</pre>	<p>Start the database and restrict connections to DBA only users.</p> <p>Make both the restore and recover relative to a point-in-time.</p> <p>Open a data channel between the target database and the NetBackup Media Manager.</p> <p>Recovery Manager queries the Recovery Catalog to determine what the structure of the database was at the correct point-in-time, and requests NetBackup to find and return data files and redo logs so that they can be restored to their original locations.</p> <p>Recover the data files by using a combination of incremental backups and redo logs. The recovery is complete when RMAN reaches the time specified.</p> <p>Open the database with resetlogs to reset the current log sequence number to 1. This effectively discards all changes that are in the redo log, but not in the database.</p> <p>Take the database out of dba mode and open for normal use.</p>	<pre>svrmgrl connect internal startup dba open exit sqlplus select name from v\$datafile; select member from v\$logfile; show parameters control_files; exit; svrmgrl connect internal shutdown immediate exit Use the UNIX cp or tar command to backup, all data files, a control file, and the parameter file that make up the database. Run the Oracle 8 utility DB_VERIFY. Review the list of files that correspond to the current control file and each control file backup to determine the correct control file to use. If necessary, replace all current control files of the database with the correct control file backup. Decide what backup files to use by reviewing the list of files that correspond to the control file being used.</pre>	<p>Run svrmgrl from the command line to start up the database, while restricting access.</p> <p>Run sqlplus to obtain the list of files to backup.</p> <p>Run svrmgrl from the command line to bring down the database before the backup starts.</p> <p>Make a whole backup of the database in case an error is made in this manual procedure.</p> <p>Verify that the backup is valid.</p> <p>If the current control files do not match the physical structure of the database at the intended time of recovery then restore a backup of the control file that reflects the database's physical file structure at the time at which recovery is intended to finish.</p> <p>Restore the database to the correct point-in-time.</p>

RMAN/NetBackup script for restoring an entire database due to an application error made at a specific time	What's happening	SQL and Operating system procedures for restoring an entire database due to an application error made at a specific time	What's happening
		<p>Find where the backup files are located.</p> <p>Use the UNIX cp or tar command to restore backup files of all the data files of the database. All backup files used to replace existing data files must have been taken before the intended time of recovery.</p> <p>Decide what redo log files to use by reviewing the list of files that correspond to the control file being used.</p> <p>Find where the redo log files are located.</p> <p>Use the UNIX cp or tar command to restore the redo logs to their original location.</p> <pre>svrmgrl connect internal startup dba mount; recover database until time '1999-04-11:11:30:00'; alter database open resetlogs; shutdown immediate; startup open; exit;</pre>	<p>Restore the redo logs needed for recovery.</p> <p>Start the database and restrict connections to DBA only users.</p> <p>Begin time-based recovery.</p> <p>Oracle begins the roll forward phase of recovery by applying the necessary redo log files to reconstruct the restored datafiles. If the control file is a backup file, you must supply names of online logs.</p> <p>Oracle continues to apply redo log files until the last required one has been applied. Oracle automatically terminates the recovery when it reaches the correct time.</p> <p>Open the database with resetlogs to reset the current log sequence number to 1. This effectively discards all changes that are in the redo log, but not in the database.</p> <p>Take the database out of dba mode and open for normal use.</p>



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