

Oracle Database 11g Data Repair Technologies

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Oracle Database 11g Data Repair Technologies

Oracle Database 11g

Data Repair Technologies Highlights

Data Recovery Advisor

- Automatically diagnoses data failures
- Reports feasible recovery options
- Executes recovery procedures
- Intuitive EM wizard, or scriptable via RMAN commands

Recovery Manager

- Intrafile parallel processing, improving backup and restore performance
- Faster binary compression for backups
- Eliminate undo for committed transactions, improving full backup performance
- Virtual private catalog allows catalog administrator to define access to registered databases for certain backup operators.
- Network-enabled DUPLICATE to create clone or standby database, without need for backups.
- Improved manageability in Data Guard environment
- Integrated with Microsoft Volume Shadow Copy Services (VSS)

Flashback Technologies

- Flashback Transaction backs out changes of a transaction and optionally, its dependent transactions.
- Flashback Data Archive tracks all changes for the lifetime of a table, applicable for ILM, auditing, and compliance applications.

INTRODUCTION

In today's knowledge-based economy, business critical information must be continuously available, from internal IT systems that manage company-wide sensitive data such as HR and financials, to applications that manage crucial partner and customer relationships. When disaster, error, or corruption strikes, data has to be quickly and accurately restored and recovered.

A pillar stone for ensuring information vitality is a comprehensive and reliable database backup and recovery strategy, to address media loss or corruption. In addition and just as important, are focused repair procedures to combat logical data issues, e.g. human or application operations that erroneously delete or modify data. These types of problems can be potentially more difficult to isolate, as the database may continue to run without any alerts or errors, in contrast to physical media corruption, and can be just as destructive to business operations. Stringent analysis and repair strategies for logical errors must be considered in enterprise-wide data recovery procedures. Finally, while recovering the good data is the ultimate goal, any downtime to accomplish this task must be mitigated – this takes into account how long and what portions of data are inaccessible during problem identification, analysis, and recovery.

Oracle Database 11g provides all the tools needed to implement the most reliable, flexible, performant, and cost-effective data recovery strategies in the face of hardware or human mishaps. The Oracle database repair technologies consist of:

- Data Recovery Advisor – recovery-intelligent tool that automatically diagnoses data failures, presents recovery options, and executes recovery at the user's request.
- Recovery Manager (RMAN) – native database backup and recovery tool, providing Oracle-only features such as block corruption detection, unused block compression and undo optimization during full backups, fast incremental backups (where only changed blocks are read and written to the backup), and incrementally updated backups (where on-disk image copy backups are rolled forward in-place using incremental backups).
- Flashback Technologies – a suite of logical recovery features, including a fast database point-in-time 'rewind' capability (Flashback Database), as well as

historical viewing and quick recovery at the row, transaction, and table level (Flashback Query, Flashback Transaction, Flashback Table).

- Logminer - powerful auditing tool for the Oracle database, allowing users to easily locate changes in the database, enabling sophisticated data analyses, and providing undo capabilities to rollback logical data corruptions or user errors.
- Oracle Secure Backup (OSB) - tape data protection for the Oracle database and file systems in distributed UNIX, Linux, Windows and Network Attached Storage (NAS) environments, and fully integrated with RMAN for exclusive features such as backup encryption, unused block compression, and undo optimization.

This paper focuses on the new Data Recovery Advisor, in addition to the rich enhancements to RMAN and Flashback Technologies, with Oracle Database 11g. All of these features are included with the Oracle Database and integrated with Enterprise Manager as the centralized management console, lowering overall cost and complexity of deployment.

Note: more information on [Logminer](#) and [Oracle Secure Backup](#) can be found on [OTN High Availability](#).

DATA RECOVERY ADVISOR (DRA)

As gatekeepers of a company's most valuable assets, database administrators understand that any type of database failure is unacceptable, whether it is physical data corruption or loss/inaccessibility of critical files. Symptoms of these problems range from unavailability of portions of the data, to a database not able to be opened properly. [Oracle Data Guard](#) is a key solution to preserving database availability, with only a few seconds of downtime, by utilizing a standby database to quickly takeover the primary database role. However, the failure on the old primary database must still be properly analyzed and repaired – most frequently, the time for isolating the root cause represents the majority of the total recovery time. Furthermore, in many cases, a chosen recovery procedure, e.g. full database restore and recovery, is not needed when a more targeted recovery procedure would resolve the issues more quickly. A lengthy recovery time impacts the ability for the primary database to be reinstated as a new standby database for resumption of Data Guard protection. For non-Data Guard environments, a lengthy recovery time can severely impact business operations solely dependent on the production database. In both cases, an administrator's time is extremely precious and cannot be wasted on hunting for the root cause and even worse, devising a non-optimal or improper recovery plan.

The Data Recovery Advisor is a new tool aimed at reducing a user's time spent analyzing and formulating a suitable recovery plan for a given failure. A 'failure' in the context of the DRA can be a missing, inaccessible, or wrong version of a file (e.g. control file, data file), physical corruptions resulting from I/O errors, or logical block inconsistency. After identifying all current failures, the DRA then

recommends the optimal, feasible recovery plan, and if the user desires, automatically executes a selected recovery plan. All DRA functions can be accessed via EM or RMAN's command-line interface. A typical workflow using the DRA in EM progresses as follows:

1. When an error occurs, the database automatically invokes Data Integrity Checks to assess the scope of the failure. These checks validate block, table, redo, or database consistency, depending on the nature of the failure. The user is also notified of the failure through error messages, alerts, and trace files. These checks can be proactively run in Enterprise Manager or through user-managed RMAN or PL/SQL scripts – these allow failures to be potentially detected and fixed, before database users or applications even come across them.

In this example, the alert log from the EM home page flags a missing data file:

Alerts

Category Recovery Critical x 4 Warning ! 2

Severity	Category	Name	Impact	Message	Alert Triggered
x	Recovery	Datfiles with Error		Number of missing media files is 1.	Mar 19, 2007 11:40:40 AM

Figure 1. Missing Data File Alert Log Error

The user then navigates to the DRA wizard, found in the 'Perform Recovery' page, under the 'Availability' tab:

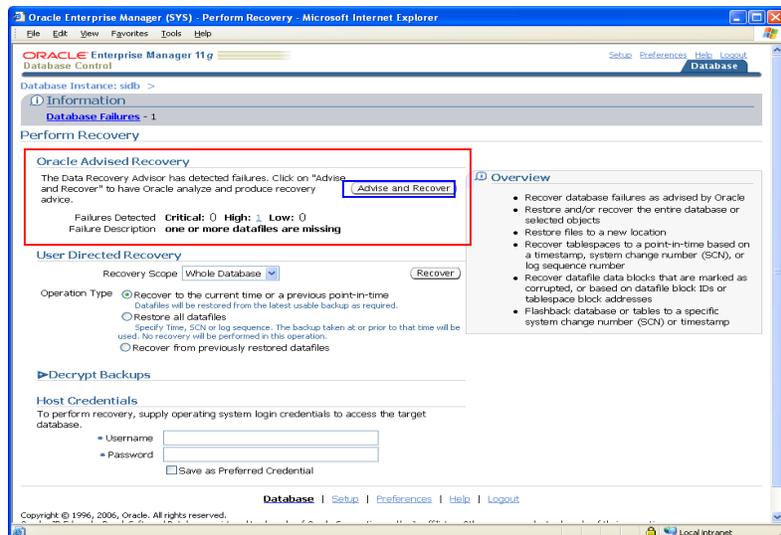


Figure 2. Data Recovery Advisor Home

A summary of the detected failures is presented, categorized by 'critical', 'high', and 'low' priority. A critical failure is one which makes the entire database unavailable, for example, a missing control file; these require immediate attention. A high priority failure makes a database partially unavailable or

unrecoverable, but should still be promptly recovered; these can include missing data files or archived logs, or block corruptions. If a particular high priority failure has little operational impact, e.g. missing data file from a scratch tablespace, it can be re-assigned as low priority and repaired at a later time. Click on ‘Advise and Recover’.

2. All open, critical and high priority failures are reviewed to see what other database components are possibly affected.

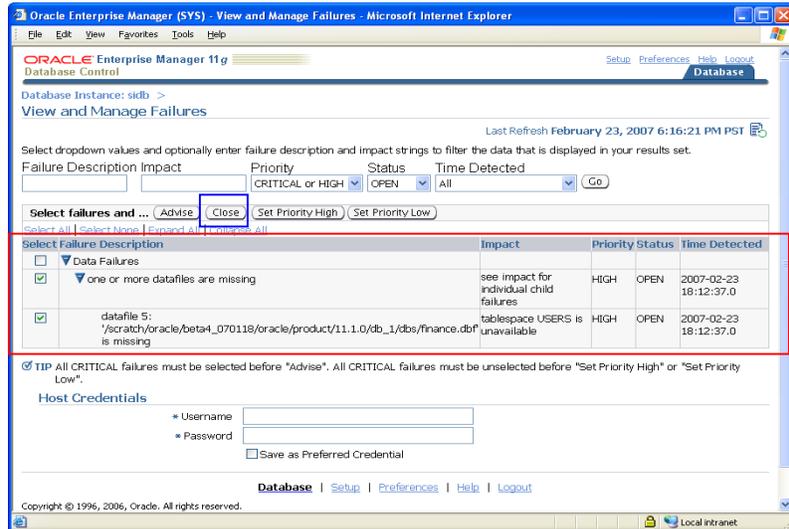


Figure 3. View and Manage Failures

In this case, the only failure detected is a missing data file. This is a critical application tablespace which should be promptly recovered. The user proceeds to retrieve failure diagnosis and repair options from the DRA by clicking ‘Advise’.

3. The first recovery option presented is to rename or move the data file back to the original location. If there were recent data file rename operations that were not followed through with the corresponding OS file renaming or if storage was taken offline for maintenance, this would be the fastest repair option.

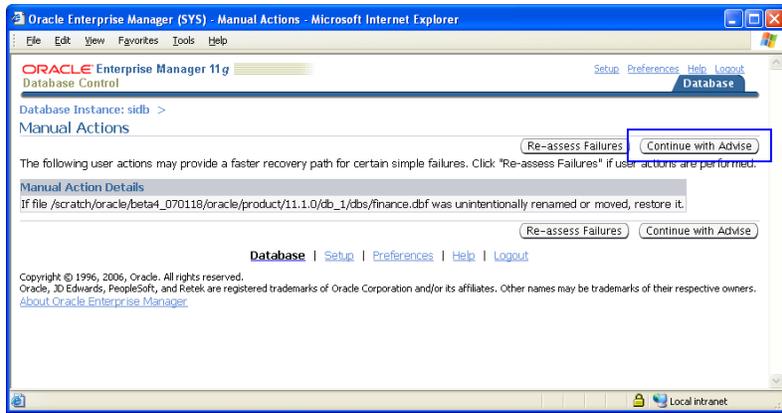


Figure 4. Manual Recovery Actions

The user checks with the storage administrator and no files were renamed, nor storage taken offline. The file has truly gone missing, so it needs to be restored and recovered. The user then retrieves additional recovery options by clicking on ‘Continue with Advise’.

4. The DRA creates an RMAN recovery procedure to restore and recover the missing datafile.

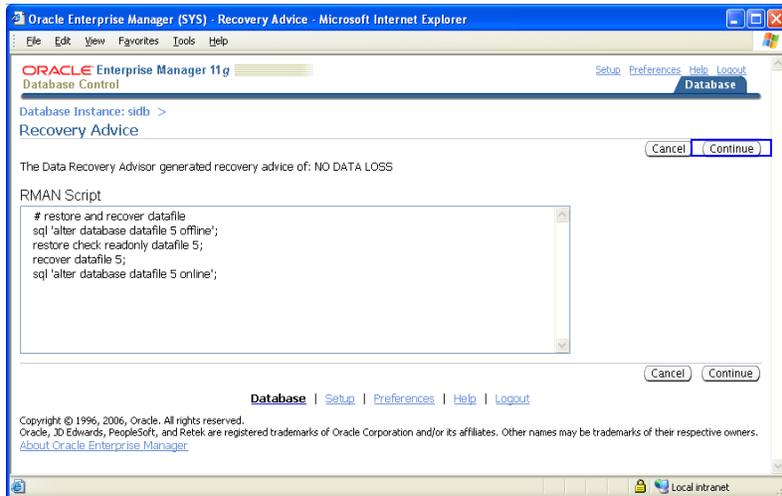


Figure 5. Recovery Advice

The user wants DRA to automatically run this procedure, so clicks ‘Continue’.

5. The user reviews a summary of the original failure and recovery procedure, which is an RMAN script, and submits the recovery job.

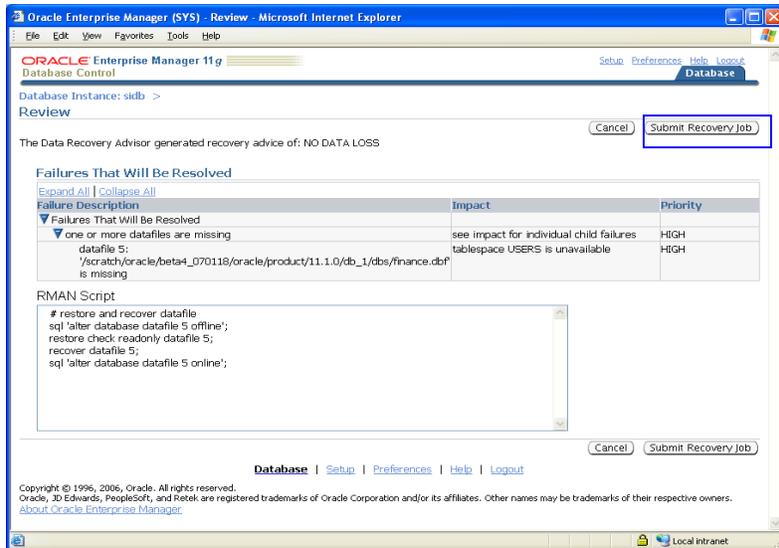


Figure 6. Recovery Job Summary

6. Finally, the recovery job is verified by reviewing the job output. This missing data file is now online and usable.

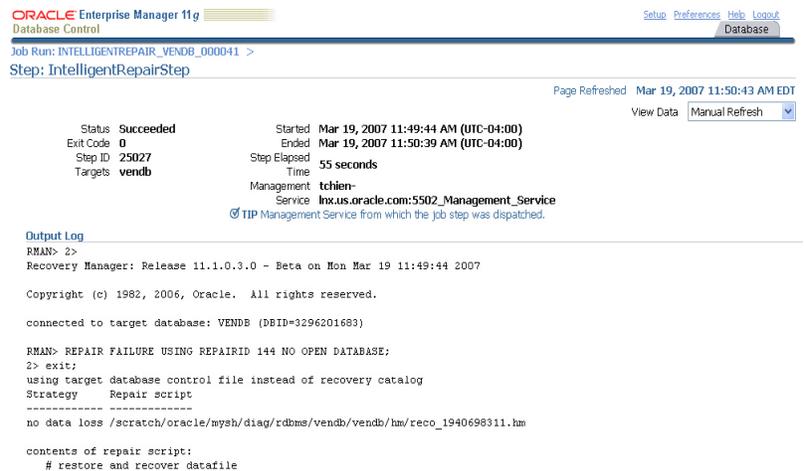


Figure 7. DRA Recovery Job Output

In summary, the Data Recovery Advisor provides the following advantages over traditional repair techniques:

- The Data Recovery Advisor can potentially detect, analyze, and repair data failures *before* a database process discovers the corruption and signals an error. Early warnings help limit damage caused by corruption.
- The Data Recovery Advisor automatically diagnoses failures, assesses their impact, and reports these findings to the user. Manually assessing symptoms of data failures and correlating them into a problem statement can be complex, error-prone, and time-consuming.

- The Data Recovery Advisor automatically determines the best recovery options. If multiple failures are present, users must determine the right sequence of recovery execution, try to consolidate recovery plans, and minimize downtime. For example, when faced with a corrupt datafile, missing control file, and lost current redo log group, the user might devote considerable time to implement recovery procedures for each of these problems, while the DRA would just recommend a single, consolidated recovery plan to restore the database and perform point-in-time recovery.
- The DRA runs checks to ensure that the suggested recovery options are feasible in the database environment. For example, if a standby database has been configured, and the primary database suffers widespread corruption, then the first DRA-suggested recovery procedure via EM Grid Control could be to failover to the standby database, to quickly preserve database availability. Following that, the user can run the suggested data recovery procedures on the old primary database. If Flashback Database is configured on the primary database, and the required flashback logs are present, then this option may be presented as the best recovery option versus a data file restore and recovery from a tape backup, as recovery time will be much shorter.
- Execution of a data recovery can be complex and error-prone. If you choose an automated recovery option, then Data Recovery Advisor executes the recovery and verifies its success.

RECOVERY MANAGER (RMAN)

Oracle Recovery Manager (RMAN), a command-line and Enterprise Manager-based tool, is the Oracle method for efficiently backing up and recovering your Oracle database. RMAN is tightly integrated with the server, providing block-level corruption detection during backup and restore. RMAN optimizes performance and space consumption during backup with file multiplexing and compression.

RMAN offers:

- **Native integration with the server:** RMAN is aware of the various data structures that the database uses, so that the appropriate backup and recovery operations can be performed correctly, and validates all blocks for corruptions during the operation. If a corruption is found, RMAN can quickly and easily recover the corrupted blocks. RMAN backups can be performed while the database is online, and does not generate additional redo during the backup, as is the case for OS backups while the database is in 'hot backup mode'.
- **Automated management of backups on disk:** RMAN can make use of the Flash Recovery Area, a directory on filesystem or ASM disk group, where all backups and recovery-related files are kept. If additional space in the Flash Recovery Area needs to be reclaimed for new backups, Oracle will automatically delete files that are obsolete or have already been backed up to tape.

“RMAN allows us to easily manage backup and recovery for all Oracle databases. In particular, time is of the essence when performing recovery, and RMAN significantly reduces the skill and effort required by our DBAs. In addition, since RMAN comes with the Oracle database, it relieves us from having to certify yet another third party tool.”-

- Prasad Badiganti, Senior DBA
Fannie Mae

“We saved about \$500,000 in licensing and maintenance fees by implementing RMAN instead of continuing with a 3rd party software, not to mention backup failures were reduced by over 90%. It is a big win!”

- Charles Pack, IT Architect
CSX Corporation

- **Incremental backups:** RMAN optimizes incremental backup performance by only backing up blocks which have changed since the last full backup. This results in faster backup performance and smaller backup sizes.
- **Incrementally updated backups:** Incremental backups can be rolled into data file image copies in-place, thus eliminating the need to apply incrementals on recovery. The resultant image copies can be utilized as a newer full backup, or directly used to take the place of production data files, in a recovery situation. This reduces overall recovery time, in addition to reducing the need to take full backups.
- **User-defined scripts:** Common RMAN tasks can be scripted in order to automate these tasks. In addition, RMAN stores and manages the scripts in a central repository, so that they can be applied to more than one database. In a large environment with multiple databases, this provides for ease of use, uniformity, consistency, and accuracy of backup and recovery operations.
- **Comprehensive reporting capabilities:** The RMAN repository contains detailed records about all aspects of backup and recovery including names, dates, sizes, locations etc of backups. RMAN also keeps track of which backups are obsolete and which are required. It can provide detailed reports of all backup and restore activity. In the event of data loss, being able to quickly and correctly determine which backups are needed for recovery is critical.
- **Centralized management with Enterprise Manager:** RMAN is integrated with Oracle Enterprise Manager, which allows the database administrator to manage all backup and recovery activities from a central Web-based console.
- **Scalable, tested, and proven deployments:** RMAN scales with the available hardware and performs operations in parallel to provide the best possible performance. RMAN has been proven to deliver multi-terabyte/day backups for companies such as FannieMae, Chevron Texaco, and CSX. Customer case studies can be found on [OTN](#).

Oracle Database 11g RMAN provides additional features to improve performance, security, and manageability.

Improved Performance

- Multisection backups
 - RMAN can back up or restore a single file in parallel by dividing the work among multiple channels. Each channel backs up one file section, which is a contiguous range of blocks. This speeds up overall backup and restore performance, and particularly for bigfile tablespaces, in which a data file can be sized upwards of several hundred GB to TB.
- Faster backup compression

“Our RMAN backup strategy helped us survive a major media failure, and database recovery completed 80% faster than our previous methods. Switching to RMAN from operating system backup methods was definitely the right decision for us!”

**- Siva Muthuraman, Senior DBA
Purdue Pharma L.P.**

- o In addition to the 10g backup compression algorithm (BZIP2), RMAN now supports the ZLIB algorithm, which offers 40% better performance, with a trade-off of < 20% lower compression ratio, versus BZIP2.
- Undo optimization
 - o During full backup, undo that is not needed for recovery of the backup (i.e. transactions that have already been committed), is not backed up. This reduces the overall time and space consumption for the backup.
- Improved block media recovery performance
 - o During block media recovery, if flashback logging is enabled and contains older, uncorrupted blocks of the corrupt blocks in question, then these blocks will be used, instead of being restored from a backup. By restoring blocks from flashback logs instead of a backup, the recovery operation completes faster.
- Improved media recovery performance for databases on symmetric multiprocessing (SMP) systems
 - o The media recovery process on SMP systems can now handle more parallelism and utilizes a more efficient apply algorithm, resulting in improved performance.

Enhanced Security

- Virtual Private Catalog - allows the catalog administrator to grant visibility of a subset of registered databases in the catalog to specific RMAN users.

Lower Space Consumption

- Network-enabled database duplication without backups
 - o A clone database on a remote site can now be easily created directly over the network with the enhanced DUPLICATE command, without the need for existing backups.

Better Manageability

- Improved integration with Data Guard
 - o Persistent RMAN configurations for a primary or standby database can be made by just connecting to the catalog, without a connection to the target database.
 - o Archived logs can be configured to be deleted when they have been shipped or applied to any standby database or mandatory standby database.

- A backup control file taken on primary or standby can be restored directly to any database. This eliminates the need to backup the controlfile at each database.
- Backups can be taken on any combination of primary or physical standby databases, and defined to be accessible for restore on specific databases, depending on the network topology of the database environment.

Additional New Features

“RMAN online backups increased the speed of our backups by 30% and reduced application downtime by 85%, versus third party tools.”

**- Rama Balaji, Senior Oracle DBA
Infoteknow International, Inc.**

- Improved handling of long-term backups
 - Long-term backups created with the BACKUP ... KEEP option only back up the archive logs needed to make the backup consistent. No further archive log backups are retained.
- Backup failover for archived redo logs in the flash recovery area
 - When backing up the flash recovery area, RMAN can fail over to archiving destinations outside the recovery area. RMAN can use an intact copy of an archived log in an alternative location to continue writing backups when an archived redo log in the recovery area is missing or corrupted.
- Improved block corruption detection
 - Several database components and utilities, including RMAN, can now detect a corrupt block and record it in V\$DATABASE_BLOCK_CORRUPTION. Also, when instance recovery detects a corrupt block, it will be recorded in this view automatically. The database automatically updates this view when block corruptions are detected or fixed.
- Block change tracking support for standby databases, enabling fast incremental backups.
- Merge Catalog - the new IMPORT CATALOG command allows one catalog schema to be merged into another, for either the whole schema or just the metadata for specific DBIDs.
- Integration with Volume Shadow Copy Service (VSS)-enabled applications on Windows platforms
 - The Oracle database can participate in the VSS infrastructure on Windows platforms, with compatible backup management applications and storage systems. This new feature allows VSS-enabled backup management applications to snapshot the Oracle database and restore at the datafile, tablespace, or database level.

FLASHBACK TECHNOLOGIES

Resolving human and logical error can be one of the most challenging tasks for the database administrator – it might take minutes to damage a database, but then hours to repair it due to lengthy analysis and extraction methods. Oracle Flashback Technologies were developed to counter these types of errors. Flashback provides point-in-time viewing and quick recovery at the row, transaction, table, and database level. With Flashback, the time to fix a logical error is no greater than the time it took to make the error, and it is extremely easy to use, e.g. a single SQL command can recover the database instead of performing complex media recovery. Flashback provides fine-grained surgical analysis and repair for localized damage, e.g. when the wrong customer order is deleted. It also allows for correction of more widespread damage yet does it quickly to avoid long downtime, e.g. when all of this month's customer orders have been deleted. The following Flashback operations debuted in Oracle Database 10g:

“By using Flashback Query, we've extended our reporting and troubleshooting capability, providing to the minute data research options which is a big time saver and management tool.”

**- Greg Penk, VP of Data Administration
Banknorth Group**

- **Flashback Query** allows the user to query data at some point-in-time in the past to reconstruct lost data that may have been deleted or changed by accident
- **Flashback Versions Query** provides a mechanism to view changes made to the database over time at the row level.
- **Flashback Transaction Query** provides a mechanism to view changes made to the database at the transaction level.
- **Flashback Table** provides the ability to recover a table, or a set of tables, to a specified point in time in the past very quickly and easily.

All the aforementioned Flashback operations can be performed online, while concurrent queries are running. Concurrent updates can also be running during the operation, with the exception of Flashback Table.

The Flashback suite also includes:

“Flashback Database is an extension to our RMAN data protection strategy for our production environment. In our QA environment, Flashback Database is a huge time-saver by giving us the ability of quickly rolling back changes to a test point, in preparation for re-tests.”

**- Joshua Ort, Database Administrator
ReserveAmerica**

- **Flashback Database** -- a revolutionary strategy for performing point-in-time recovery. It quickly rewinds an Oracle database to a previous time to correct any problems caused by logical data corruption or user error. The valid time period for a Flashback Database operation relies on setting adequate retention of flashback logs, which are created and maintained in the Flash Recovery Area.
- **Flashback Drop** -- a safety net for dropped objects. You can very quickly and easily 'undrop' a table and its dependent objects. This is enabled by default and takes no additional space.

With Oracle Database 11g, two new Flashback capabilities have been added: Flashback Transaction and Flashback Data Archive.

Flashback Transaction

Large-scale database applications rely on complex sequences of transactions, to ensure atomicity and consistency of a group of inserts, updates, or deletes. In the event of a 'bad' transaction, the administrator must trail back-in-time to see what changes were effected by the transaction and ascertain any dependencies (e.g. transactions that modified the same data after the 'bad' transaction), to ensure that undoing the transaction preserves the original, good state of the data and any related data. Performing this type of transaction analysis can be laborious, especially for very complex applications.

Now with Flashback Transaction, a single transaction, and optionally, all of its dependent transactions, can be flashed back with a single PL/SQL operation or by using an intuitive EM wizard to identify and flashback the problem transactions. Flashback Transaction relies on the availability of archived redo logs for the given transaction and its dependents, to backout the changes.

A Flashback Transaction flow in EM is shown below:

1. Review transaction history with Flashback Versions Query, assuming affected tables are known, or browse transaction history for a specified time period with Logminer (shown below).

ORACLE Enterprise Manager 11g Database Control

Database Instance: vendb > Logged in As SYS

LogMiner Results

Summary

Matching Transactions **241** Query Filter **where seg_owner <> 'SYS'**
 Matching Redo Records **11375** Total Time **7 seconds**

The results show transactions containing redo records that matched the query filter. Transactions may contain other redo records. Click on a Transaction ID to view the all of the redo records in a transaction. The results can be filtered further by searching the sql redo.

Transaction Results

Search SQL Redo: Go View By: Transaction Summary

Previous 50 201-241 of 241 Next

Transaction ID	DB User	OS User	Start Time	Start SCN	Commit SCN	Commit Time	Machine Name	SQL Redo
0D001900E1090000	SCOTT	oracle	Mar 30, 2007 2:03:20 PM	4229104	4229112	Mar 30, 2007 2:03:20 PM	tchien-lnx	4 SCOTT.DEPT (4 updates)
0B00080068070000			Mar 30, 2007 2:03:31 PM					1 SYSMAN.MGMT_FAILOVER_TABLE (1 update)
1000080005090000			Mar 30, 2007 2:03:36 PM					1 SYSMAN.MGMT_SYSTEM_PERFORMANCE_LOG (1 insert)
12001300E8090000			Mar 30, 2007 2:03:36 PM					1 SYSMAN.MGMT_SYSTEM_PERFORMANCE_LOG (1 insert)
0C0011000C090000			Mar 30, 2007 2:03:36 PM					1 SYSMAN.MGMT_SYSTEM_PERFORMANCE_LOG (1 insert)
0E0010067070000			Mar 30, 2007 2:03:36 PM					1 SYSMAN.MGMT_SYSTEM_PERFORMANCE_LOG (1 insert)
13001C00E2090000			Mar 30, 2007 2:03:36 PM					1 SYSMAN.MGMT_SYSTEM_PERFORMANCE_LOG (1 insert)
0D001D00E0090000			Mar 30, 2007 2:03:36 PM					1 SYSMAN.MGMT_SYSTEM_PERFORMANCE_LOG (1 insert)
0F000A00E0090000	SCOTT	oracle	Mar 30, 2007 2:03:39 PM					4 SCOTT.DEPT (4 updates)
12000800E9090000			Mar 30, 2007 2:03:42 PM					10 SYSMAN.MGMT_JOB_HISTORY, SYSMAN.MGMT_JOB_EXECUTION, ... (9 updates, 1 insert)
13001A00E0090000			Mar 30, 2007 2:03:42 PM					4 SYSMAN.MGMT_JOB_HISTORY, SYSMAN.MGMT_JOB_EXECUTION (4 updates)
0D001300E1090000			Mar 30, 2007 2:03:42 PM					46 SYSMAN.MGMT_JOB_HISTORY, SYSMAN.MGMT_JOB_EXECUTION, ... (20 updates, 12 inserts, 13 delete...)

TIP The transaction summary shows the first two tables modified by the transaction, along with the number of inserts, deletes and updates that matched the query filter.

Database | Setup | Preferences | Help | Logout

Figure 8. Review Transaction History with Logminer

Click on Transaction ID (highlighted in red box) to review details of the row changes effected by the 'bad' transaction.

ORACLE Enterprise Manager 11g Database Control

Database Instance: vendb > Logged in As SYS

Transaction Details

Transaction ID **0D001900E1090000** Start SCN **4229104** Start Time **Mar 30, 2007 2:03:14 PM**
 DB User **SCOTT** Commit SCN **4229112** Commit Time **Mar 30, 2007 2:03:20 PM**
 OS User **oracle** Machine Name **tchien-lnx**

Flashback Transaction Previous Transaction Next Transaction OK

SCN	Operation	Schema	Table	SQL Redo
4229112	START			set transaction read write;
4229112	UPDATE	SCOTT	DEPT	update 'SCOTT', 'DEPT' set 'LOC' = 'BOSTON' where 'DEPTNO' = 10 and 'LOC' = 'NEW YORK' and ROWID = 'AAAQR3AAEAAAAAAAAA';
4229112	UPDATE	SCOTT	DEPT	update 'SCOTT', 'DEPT' set 'LOC' = 'BOSTON' where 'DEPTNO' = 20 and 'LOC' = 'DALLAS' and ROWID = 'AAAQR3AAEAAAAAAAAA';
4229112	UPDATE	SCOTT	DEPT	update 'SCOTT', 'DEPT' set 'LOC' = 'BOSTON' where 'DEPTNO' = 30 and 'LOC' = 'CHICAGO' and ROWID = 'AAAQR3AAEAAAAAAAAA';
4229112	UPDATE	SCOTT	DEPT	update 'SCOTT', 'DEPT' set 'LOC' = 'BOSTON' where 'DEPTNO' = 40 and 'LOC' = 'BOSTON' and ROWID = 'AAAQR3AAEAAAAAAAAA';
4229112	COMMIT			commit;

Flashback Transaction Previous Transaction Next Transaction OK

Database | Setup | Preferences | Help | Logout

Figure 9. Examine 'Bad' Transaction Details

Click Flashback Transaction (highlighted in blue box above) to enter the wizard and undo these changes.

- Review any dependent transactions. Details of the changes effected by the dependent transaction (shown below as a node under the parent transaction) can also be investigated by clicking on its Transaction ID, if desired.



Figure 10. Review Dependent Transactions

All dependent transactions are also selected for flashback, by clicking on 'Change Recovery Option' and selecting 'Cascade'.

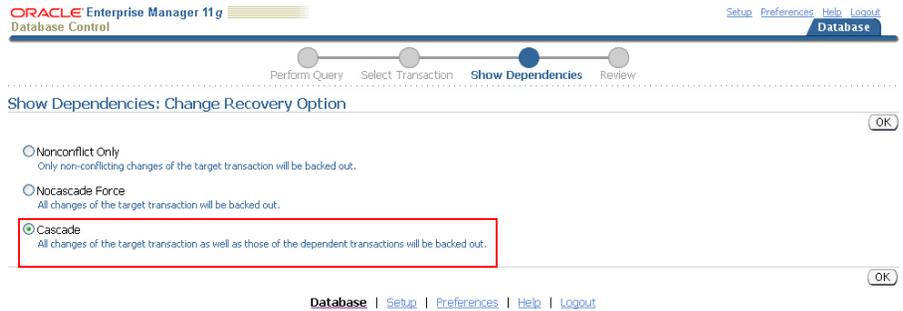


Figure 11. 'Cascade' Recovery Option

- Review Undo SQL that was executed from the previous step, as a compensating transaction, to flashback the 'bad' transaction and its dependent transactions. Click Finish to commit the compensating transaction.

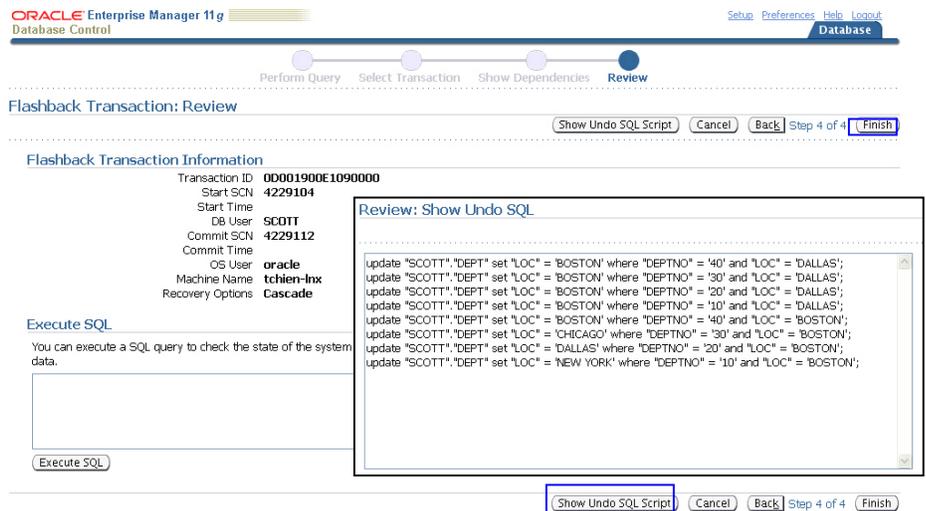


Figure 12. Review Undo SQL & Commit Compensating Transaction

Note that a SQL query can be executed to validate the state of the flashed back data, before clicking Finish to commit. This allows the administrator to ensure that the flashed back data is correct before committing the compensating transaction, or if not correct, the wizard can simply be cancelled and all changes will be undone.

Flashed back transactions can be tracked using the following new tables:

- The system table `DBA_FLASHBACK_TRANSACTION_STATE` shows whether a transaction is alive or backed out. If a transaction appears in this table, it is backed out. Each user can view their own flashed back transactions with `USER_FLASHBACK_TRANSACTION_STATE`. This table is maintained atomically with respect to compensating transactions. If a compensating transaction is backed out, all changes that it made are also backed out, and the table will reflect this. For example, if compensating transaction `ct` backs out transactions `t1` and `t2`, then `t1` and `t2` appear in `DBA_FLASHBACK_TRANSACTION_STATE`. If `ct` itself is later backed out, the effects of `t1` and `t2` are reinstated, and `t1` and `t2` are removed from `DBA_FLASHBACK_TRANSACTION_STATE`.
- The system table `DBA_FLASHBACK_TRANSACTION_REPORT` provides a detailed report for each backed-out transaction. Each user can view their own report with `USER_FLASHBACK_TRANSACTION_REPORT`. Details such as compensating transaction ID and name, undo SQL, and user ID who performed the back out can be retrieved.

Flashback Data Archive

Flashback Data Archive allows long-term retention, e.g. years, of changed data to a table or set of tables for a user-defined period of time. The administrator simply creates a Flashback Data Archive (which can logically span one or more tablespaces), specifies a space quota and retention period for the archive, and then

creates the required tables in the archive. Users and applications can use Flashback Query, as normal, for these special tables within the Flashback Data Archive retention period. ILM, auditing, and compliance applications can now use Flashback Data Archive, rather than building the change tracking mechanisms themselves. More information on Flashback Data Archive can be found in the Oracle Advanced Application Developer's Guide.

CONCLUSION

The Oracle Database Repair Technologies empowers the database administrator to address and resolve a wide range of physical and logical issues within the database. Compared to third party backup and recovery tools, the built-in Oracle technologies offer a number of advantages:

- Intelligent recovery

The new Data Recovery Advisor (DRA) assists the administrator to quickly identify, assess, and recover from physical corruptions and media loss. The DRA presents recovery options in an intelligent manner, by grouping related failures into a single recovery plan and checking the viability of the plan given the existing database configuration, e.g. Data Guard, Flashback Database, RMAN backups. The administrator's time spent hunting down the root cause of a database failure and developing an action plan, goes down dramatically. In addition, Enterprise Manager provides regularly scheduled Data Integrity Checks, which can proactively monitor the integrity of the database – any failures are immediately reported on the EM console and can also be notified to the administrator via email or page.

- Comprehensive, Oracle-optimized backup and recovery

Recovery Manager (RMAN) is the only Oracle-aware backup and recovery tool, integrated with the database server, and leveraging that in-depth knowledge for robust block corruption detection, fast incremental backups, incrementally updated backups, comprehensive backup management, along with numerous other unique features. RMAN provides a wealth of new functionality including (i) backup performance improvement with intrafile parallelism and faster backup compression algorithm, (ii) enhanced security for recovery catalog users, (iii) reduced space consumption for RMAN duplicate database cloning, and (iv) better manageability for Data Guard environments.

Oracle Secure Backup (OSB) is the RMAN-integrated tape backup solution, leveraging backup performance-enhancing capabilities such as unused block compression and undo block optimization, in addition to strong backup encryption based on the industry-leading Oracle data encryption infrastructure. OSB also provides full support for NAS and filesystem backup, so that database, configuration, and application files can be cohesively backed up using a single tool and interface.

- Fine-grained, logical recovery

Flashback Technologies focus on identifying and resolving one of the most nefarious causes of data quality problems – human and logical error. Flashback can analyze and recover on the row and table level, for fine granular repair, or rewind the entire database to undo extensive logical errors affecting a wide range of schemas, stored procedures, and dependent objects.

New Flashback features include Flashback Transaction, a single-command operation to undo a transaction and its dependents, and Flashback Data Archive, a method to track changes to a table over the lifetime of the table, whether that be months or years. Flashback Data Archive supports Flashback Query for the tracked tables, over the specified archive retention time period.

As business operations continually evolve, to keep up with internal, marketplace, and regulatory demand for critical information, so do the IT operations that are behind that data management. Database administrators must be ready to evolve with rapidly growing data volume and at the same time, more rigid backup and recovery requirements. With the Oracle Data Repair Technologies, they can successfully meet that challenge head-on utilizing a rich breadth of tools and solutions. From intelligent database failure diagnosis and repair, to comprehensive backup and recovery, to repairing transaction, table, database issues with a single command, Oracle provides the most advanced and industry-leading recovery solutions, at *no* additional cost, *today*.



Oracle Database 11g Data Repair Technologies

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