

# ORACLE RECOVERY MANAGER (RMAN) 10g: RELOADED

*Tammy Bednar, Oracle*

## EVOLUTION AND REVOLUTION

A backup of the database may be the only means you have to protect the Oracle database from a media failure. The importance of recovering critical data is self evident with the numerous tools and methods provided to DBAs. The cost and complexity of protecting the Oracle data ranges from the simple weekly backups to tape to the more involved file snapshots or standby databases. Oracle Data Guard<sup>1</sup> is architected to help enterprises survive disasters, human errors and corruptions that can adversely impact the Oracle database. Each tool and option provides their own benefits of continual availability and a fast backup and/or recovery of the Oracle database.

The method or tool that you employ to protect and recover your data, should provide:

- reliability. All files that are required for recovery are backed up and can be easily restored for recovery operations.
- flexibility. The Oracle database can be backed up or restored at the database, tablespace, datafile, and block level.
- manageability. The backup files are organized and managed so they are available for restore operations.
- availability. A backup operation should not interfere with database transaction processing and the recovery operation should be fast and efficient.

Oracle's Recovery Manager continues to mature with each new release and the revolutionary technological advances included in Oracle Database 10g will provide the simple, reliable, and automatic recovery tool that you have been waiting for. This paper presents the new Oracle Database 10g features to provide for the management of backup and recovery files, enhanced incremental backups, and the sharing of the same tablespace data on heterogeneous-platforms. Let the revolution begin!

## **RECOVERY MANAGER**

Recovery Manager (RMAN) is Oracle's utility to manage the backup, and more importantly the recovery, of the database. It eliminates operational complexity while providing superior performance and availability of the database. Recovery Manager debuted with Oracle8 to provide DBAs an integrated backup and recovery solution.

Recovery Manager determines the most efficient method of executing the requested backup, restore, or recovery operation and then executes these operations in concert with the Oracle database server. Recovery Manager and the server automatically identify modifications to the structure of the database and dynamically adjust the required operation to adapt to the changes.

Oracle Database 10g Recovery Manager feature set revolutionize the recovery of critical Oracle data out of the box. At no extra cost or additional install, RMAN manages the backup and recovery of the Oracle database files. Since RMAN is tightly integrated with the Oracle kernel, it provides the insight and wisdom to efficiently recover your Oracle databases.

---

<sup>1</sup> For more information on Data Guard, please go to [http://otn.oracle.com/deploy/availability/htdocs/odg\\_overview.html](http://otn.oracle.com/deploy/availability/htdocs/odg_overview.html).

## FLASH RECOVERY AREA

Your money today purchases more disk space than 5 years ago or even 1 year ago. While you may only need a few Gig of disk space to meet your current storage needs, the sheer size of disks may provide you with the luxury of unused storage. Are you staying up late a night trying to figure out what to do with all of that free disk space? How about keeping your database backups on disk? Making a backup to disk is faster since you are eliminating the tape-write bottleneck. But more importantly, if database media recovery is required, then your datafile backups are readily available. Restore and recovery operation time is reduced since you don't need to find a tape and a free tape device to restore the needed datafiles and archive logs.

But wait a minute. Backing up to disk is not a new concept. DBAs have implemented this type of backup and recovery strategy for many years. RMAN has always been able to backup and recover your database from a disk location. What is the Flash Recovery Area and what makes it invaluable to a DBA?

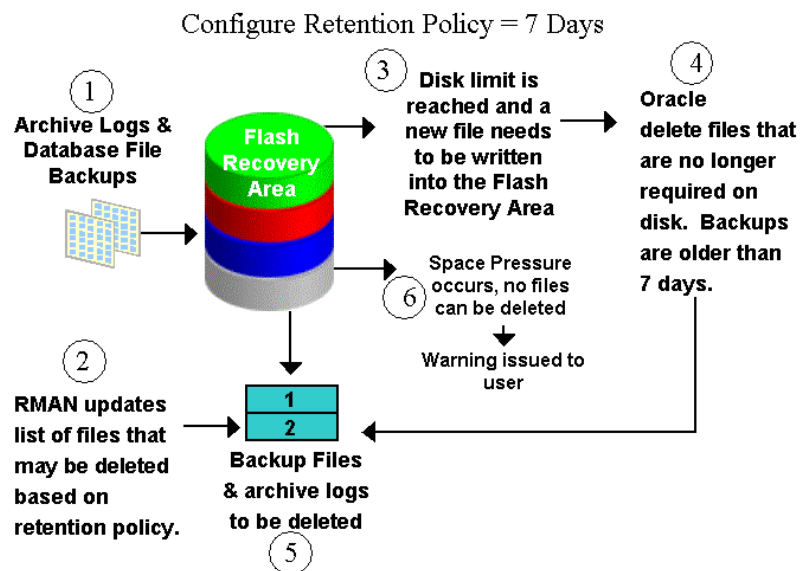
The Flash Recovery Area is a unified storage location for all recovery related files and activities in an Oracle database. By defining one init.ora parameter, all RMAN backups, archive logs, control file autobackups, and datafile copies are automatically written to a specified files system or ASM Disk Group.

DB\_RECOVERY\_FILE\_DEST = /oracle/flash\_recovery\_area

Allocating sufficient space to the Flash Recovery Area will ensure faster, simpler, and automatic recovery of the Oracle database. Your recovery time objective is now dependent on the amount of free space to which you can allocate to recovery related files. Some studies have shown that 95% of most recovery operations only require 3 days worth of backups. So, if you have the disk space to maintain 3 days of database backups and archive logs, the required backup will be locally available. A system administrator will not be required to retrieve a tape or free up a tape device to restore required backup files.

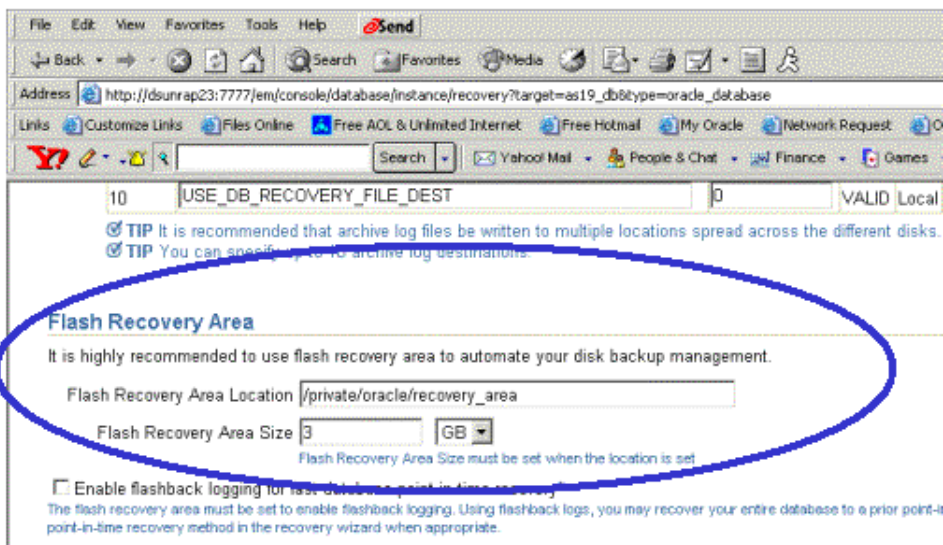
Ok, so now Oracle Database 10g provides a parameter to organize recovery related files into one location on disk. And now you may be saying, 'So what? How does that help me out when I can already perform backups to disk on my own and configure all the archive log destinations that I need.' I am glad you asked that.

The Flash Recovery Area manages the files on disk. By configuring the RMAN RETENTION POLICY, the Flash Recovery Area will automatically delete obsolete backups and archive logs that are no longer required based on that configuration. If you set the RETENTION POLICY to a recovery window of 7 days, then RMAN will retain all backups required to recover the database 7 days in the past. If enough disk space is set aside for all of the recovery files, then you only need to backup to tape to meet your off-site disaster recovery and long-term archival requirements.



All files that are needed to completely recover a database from a media failure are part of the Flash Recovery Area. Those recovery related files include:

- *Control file:* A copy is created in the Flash Recovery Area location at database creation.
- *Archived log files:* When the Flash Recovery Area is configured, the archiver background process then creates archived files in the Flash Recovery Area and in other configured LOG\_ARCHIVE\_DEST\_n locations.
- *Flashback logs:* the Flash Recovery Area automatically manages Flashback Database logs.
- *Control file autobackups:* The default location for control file .
- *Data file copies:* The default location for data file copies created by RMAN is stored in the Flash Recovery Area.
- *RMAN backups:* The default location for RMAN to create files during backup & copy operations. It is also the default location to restore archive logs from tape if they are required during a recover task.



Enterprise Manager provides an interface to define the Flash Recovery Area.

The Flash Recovery Area provides:

- Unified storage location of related recovery files
- Management of the disk space allocated for recovery files
- Simplified database administration tasks
- Much faster backup
- Much faster restore
- Much more reliable due to inherent reliability of disk

## **AUTOMATIC STORAGE MANAGEMENT**

You just can't discuss backup and recovery without mentioning file storage in the same breath. They go hand-in-hand. Oracle10g provides DBAs a simplified management interface for storage resources. Automatic Storage Management (ASM) eliminates the need for manual performance tuning. It groups physical storage into a set of virtual disks that provide redundancy options to enable a high level of protection. ASM facilitates non-intrusive

storage allocations and provides automatic rebalancing. It spreads database files across all available storage to optimize performance and resource utilization. It saves DBAs time by automating manual tasks and increase the ability to manage larger databases and more of them with increased efficiency.

The Flash Recovery Area can be configured using ASM. Backups are protected automatically because ASM is designed to tolerate failures and automatically remirror when a disk or array fails. In addition, ASM prevents non-Oracle process from overwriting or corrupting your files used for recovery. For more information on ASM, take a look at the OracleWorld technical white paper 40140 - Oracle Database 10g: Simplify Your Job with Automatic Storage Management.

## **CHANGE TRACKING FILE**

Incremental backups have been part of RMAN since it was first released in Oracle8.0. Incremental backups provide the capability to backup only the changed blocks since the previous backup. Oracle Database 10g delivers the ability for faster incrementals with the implementation of the change tracking file feature.

When you enable block change tracking, Oracle tracks the physical location of all database changes. RMAN automatically use the change tracking file to determine which blocks need to be read during an incremental backup and directly accesses that block to back it up. When block change tracking is not enabled, then the entire datafile is read during each incremental backup to find and backup only the changed blocks, even if just a very small part of that file has changed since the previous backup. Use the following command to enable block change tracking.

```
ALTER DATABASE ENABLE BLOCK CHANGE TRACKING;
```

By making incremental backups and the change tracking file part of your backup strategy you can

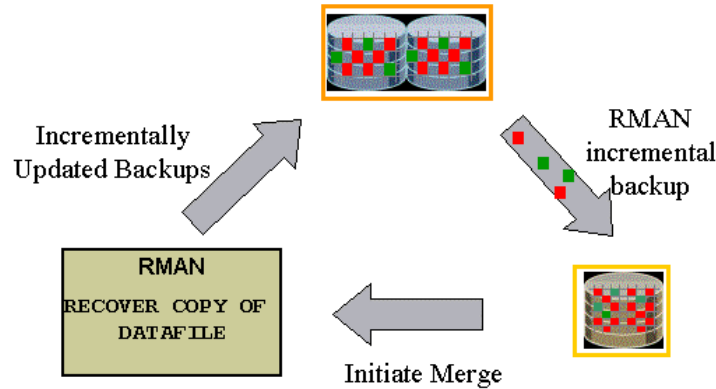
- reduce the amount of time needed for daily backups.
- save network bandwidth when backing up over a network.
- recover UNLOGGED changes to database. For example, when the NOLOGGING option is used with direct load, inserts do not create redo log entries and their changes cannot be applied with media recovery. Incremental backups capture the changed block images and can be used for recovery.
- reduce the backup file storage. Depending on the number of updated blocks and the frequency of backups, an incremental backup will be smaller than a full database backup and consumes less storage.
- enable fast backups of changed blocks.

## **INCREMENTALLY UPDATED BACKUPS**

Oracle's Database 10g Incrementally Updated Backups feature merges the image copy of a datafile with a RMAN incremental backup. The resulting image copy is now updated with the block changes captured by the incremental backup. The merging of the image copy and incremental backup is initiated with the RMAN RECOVER command. It occurs in the background and does not require a database instance.

Shrinking backup windows are no longer an issue. Oracle has eliminated the requirement to make a whole database backup with the ability to continually update the datafile image copies with the latest incremental backup. A backup strategy based on incrementally updated backups can help you keep the time required for media recovery of your database to a minimum. RMAN restores the incrementally updated image copy of your database, and only needs to apply the archive logs generated since the last backup. Time required for media recovery is now a function of how

often you create the incremental backup and apply it to the image copy.

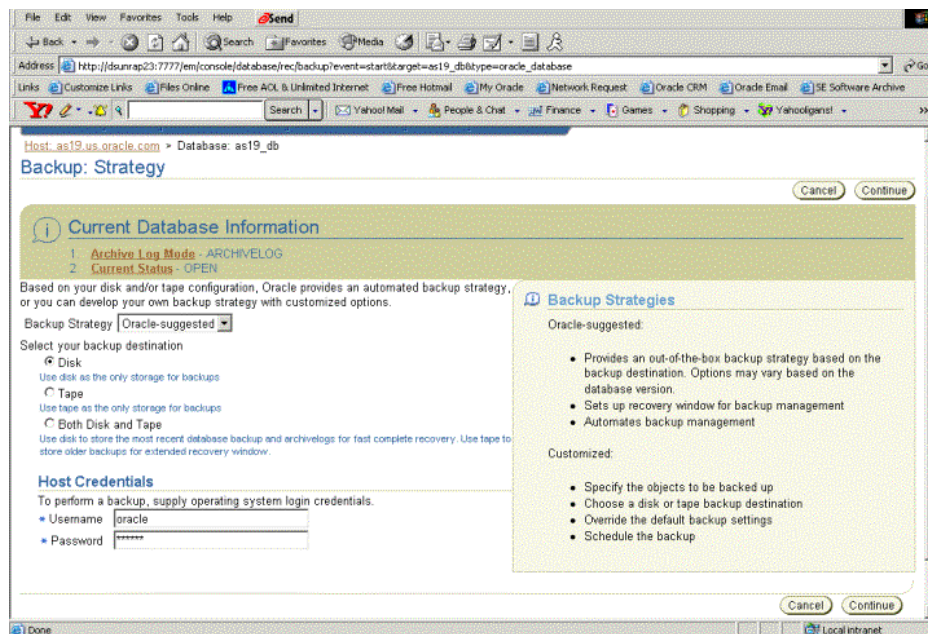


Applying incremental backups to data file image copies

- eliminates the need to perform a whole database backup.
- reduces the time required for media recovery since the image copy is updated with the latest block changes.

### ORACLE SUGGESTED STRATEGY

A backup solution utilizing the Flash Recovery Area, Incremental Backups, and Incrementally Updated Backups provides fast and easy recovery for the Oracle database. The Enterprise Manager Backup Wizard delivers the mechanism to configure and schedule database backups.

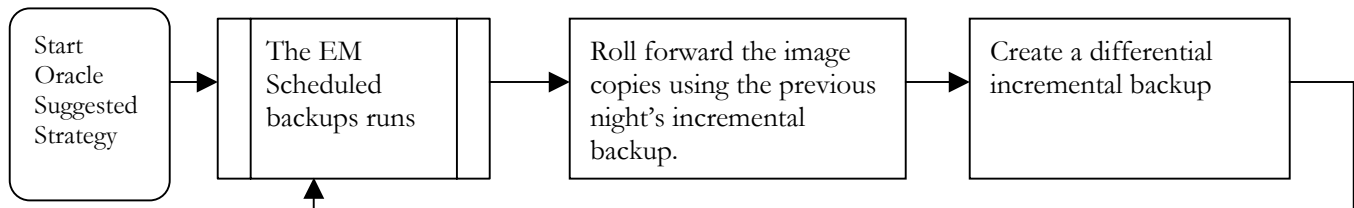


The backup wizard prompts you to

1. configure the Flash Recovery Area so that all RMAN backups and archive logs will be written to the specified directory.
2. determine the optimal time that a backup should be run on your host. Usually the backup is scheduled when the lowest user activity is running.
3. review and confirm the backup time. Enterprise Manager will submit the backup job to run each night at the same time.

For each datafile, the Oracle Suggested Strategy calls for backups to be made as follows:

- At the beginning of day 1 of the strategy (the time the first scheduled job actually runs), an incremental level 0 datafile copy backup. It contains the datafile's contents at the beginning of day 1. In a restore-and-recovery scenario, the redo logs from day 1 can be used to recover to any point during day 1.
- At the beginning of day 2, an incremental level 1 backup is created, containing the blocks changed during day 1. In a restore-and-recovery scenario, this incremental level 1 can be applied to quickly recover the rolled-forward level 0 backup to the beginning of day 2, and redo logs can be used to recover to any point during day 2.
- At the beginning of each day n for days 3 and onwards, the level 1 backup from the beginning of day n-1 is applied to the level 0 backup. This brings the datafile copy to its state at the beginning of day n-1. Then, a new level 1 is created, containing the blocks changed during day n-1. In a restore-and-recovery scenario, this incremental level 1 can be applied to quickly recover a restored backup to the beginning of day n, and redo logs can be used to recover the database to any point during day n.



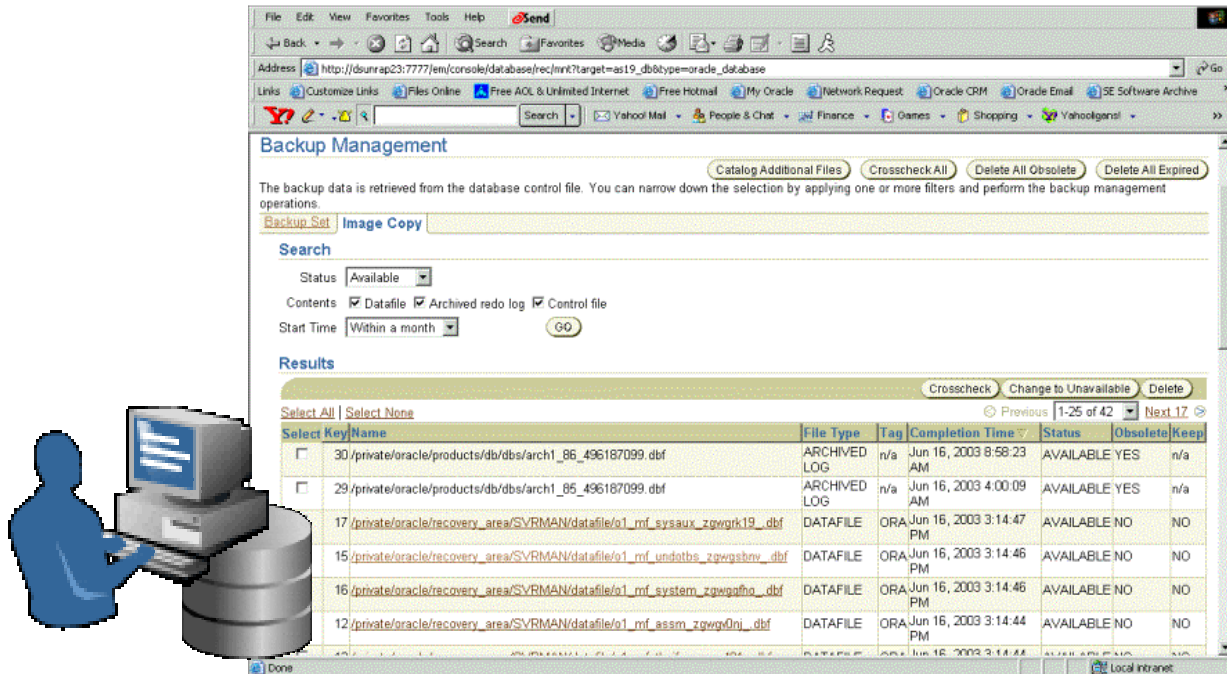
This strategy may sound complicated, but it is completely automated by Enterprise Manager. You can also implement the suggested strategy on your own by simply running the following two RMAN commands during each backup window:

```

RECOVER COPY OF DATABASE WITH TAG oracle_strategy;
BACKUP INCREMENTAL LEVEL 0 DATABASE FOR RECOVER OF COPY WITH TAG
oracle_strategy;
  
```

## BACKUP MANAGEMENT

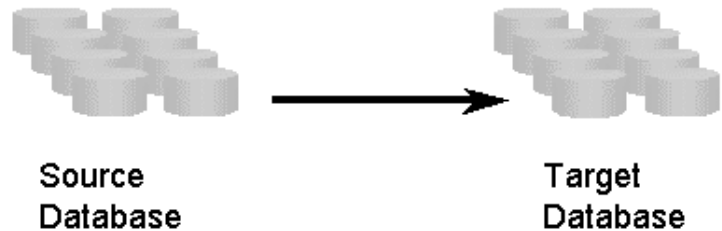
Enterprise Manager 10g provides the ability to list and modify RMAN backups. You can view the RMAN backups, archive logs, control file backups, and image copies. If you select the link on the RMAN backup, it will display all files that are located in that backup.



**CROSS PLATFORM TRANSPORTABLE**

The Oracle Transportable Tablespace feature allows users to quickly move a tablespace across Oracle databases. It is the most efficient way to move bulk data between databases.

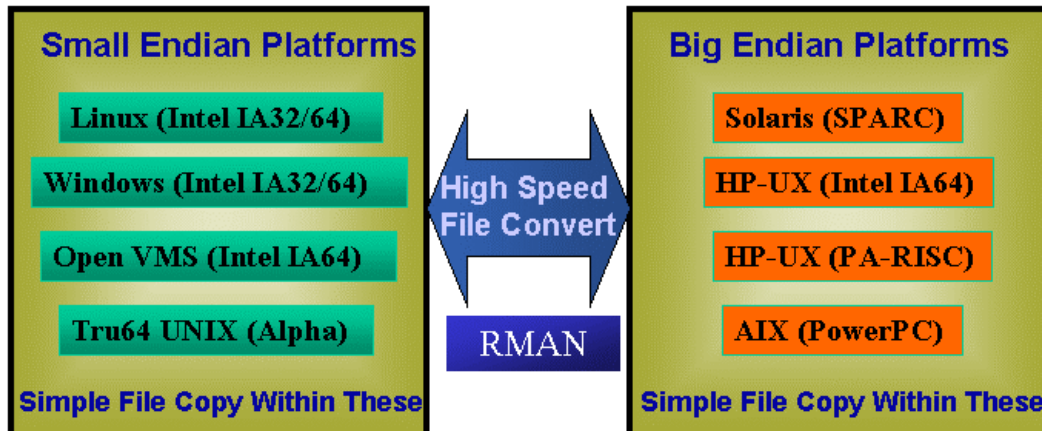
Moving data using transportable tablespaces can be much faster than performing either an export/import or unload/load of the same data. This is because transporting a tablespace only requires the copying of datafiles and integrating the tablespace structural information. You can also use transportable tablespaces to move index data, thereby avoiding the index rebuilds you would have to perform when importing or loading table data.



Oracle Database 10g provides the ability to transport tablespaces across platforms. This functionality can be used to:

- Provide an easier and more efficient means for content providers to publish structured data and distribute it to customers running Oracle on a different platform
- Simplify the distribution of data from a data warehouse environment to data marts which are often running on smaller platforms
- Enable the sharing of read only tablespaces across a heterogeneous cluster
- Allow a database to be migrated from one platform to another

Many, but not all, platforms are supported for cross-platform tablespace transport. You can query the V\$TRANSPORTABLE\_PLATFORM view to see the platforms that are supported, and to determine their platform IDs and their endian format (byte ordering).



If the source platform and the target platform are of different endianness, then an additional conversion step must be done on either the source or target platform to convert the tablespace being transported to the target format. If they are of the same endianness, then no conversion is necessary and tablespaces can be transported as if they were on the same platform.

Before a tablespace can be transported to a different platform, it must have been read/write a least once in an Oracle10g database with compatibility set to 10.0.0 or higher. This is because that action makes the datafiles within the tablespace platform aware, meaning that each file identifies the platform to which it belongs.

### AND THE REVOLUTION DOESN'T END YET

While I have highlighted a few of the Oracle Database 10g recovery features in the last few pages, there is yet more functionality to be released.

- *Compression of archive logs and backups.* If disk space is a premium, then you can still reduce the time to recover the database by keeping compressed RMAN backups and archive logs on disk. Uncompressing the backed up files is not necessary since the recovery operations can use the compressed backup files.
- *Restore tolerates missing or corrupt backup.* RMAN's goal is to restore the database with all known backups. Ideally the last backup taken is used to completely recover the database. If the last backup is unavailable, then RMAN will automatically determine the next valid backup that can be used for recovery.
- *Automated recovery through a previous point in time recovery.* It is sometimes necessary to recover your database to a previous point in time, then open it with the RESETLOGS option. Prior to Oracle 10g, if the database was damaged after the resetlogs, but before taking another full backup, so that you need to recover using the last backup taken before the resetlogs, the recovery process would be complicated and error-prone. In 10g, Oracle recovery transparently handles the case where some datafiles have been restored from backups that were taken prior to a RESETLOGS open.
- *Fully automated tablespace point-in-time recovery.* RMAN provides a single command to recover a tablespace to a point in time in the past. This operation is completely automatic and at the end of the recovery, the tablespace is available for use.
- *Automatic channel failover on backup or restore.* How many times have you almost finished a backup or restore operation and the last file is has not completed its operation because the channel stopped due to an error? RMAN will finish the work on any other allocated channels and then automatically continue to complete the operation.

- *Tablespace Rename.* In some cases, tablespaces share the same tablespace name, especially if they have been cloned. With cross-platform transportable tablespace capability, it becomes much easier to move data around at the tablespace level. The rename tablespace capability provides the ability to make tablespaces more portable.
- *Drop Database.* If you regularly create databases for testing and qualification purposes, you know that after you are done using the temporary database, you need to delete the files that belong to that database. Otherwise, your disk becomes full of orphaned datafiles. A new RMAN DROP DATABASE command provides the process to delete all database files from the OS.

## **RMAN VS. USER MANAGED RECOVERY**

Recovery Manager provides efficient recovery of the Oracle database. But many DBAs continue to use their homegrown scripts to perform the backup and recovery operations. The table below compares RMAN with User Managed common recovery operations.

Operation	Recovery Manager Steps	User Managed Steps
Lost datafile	<ol style="list-style-type: none"> <li>1. Offline the datafile and/or tablespace.</li> <li>2. RMAN Restores the datafile backup.</li> <li>3. RMAN recovers the datafile while automatically restore any required archive logs.</li> <li>4. Online the datafile and/or tablespace</li> </ol>	<ol style="list-style-type: none"> <li>1. Find a backup, preferably the latest backup.</li> <li>2. If it is on tape, request the file to be restored.</li> <li>3. Offline the datafile and/or tablespace</li> <li>4. Issue the recover datafile command.</li> <li>5. If any archive logs are required, restore them.</li> <li>6. Apply the archive logs that are required by the recover command</li> <li>7. Online the datafile and/or tablespace</li> </ol>
Repair corrupted block	<ol style="list-style-type: none"> <li>1. blockrecover <i>block_number</i></li> </ol>	<ol style="list-style-type: none"> <li>1. export data</li> <li>2. The data in the corrupted block is lost unless you can extract it from a standby database or previous backup. It is also very difficult to extract any table data beyond the corrupted block, even if just one block is corrupt</li> <li>3. import the table data</li> </ol>
Tablespace point-in-time recovery	<ol style="list-style-type: none"> <li>1. RECOVER TABLESPACE users, tools UNTIL TIME 'July 7, 2003';</li> </ol>	<ol style="list-style-type: none"> <li>1. Create an init.ora file for the temporary database</li> <li>2. Restore the backups for System, Undo, Users, Tools.</li> <li>3. Recover required archive logs needed for recovery</li> <li>4. Mount the temporary database and recover until July 7, 2003.</li> <li>5. Using the Data Pump facilities, extract data dictionary data so that Users and Tools tablespaces can be plugged into the database.</li> <li>6. Plug the Users and Tools tablespaces into the production database.</li> <li>7. Delete the temporary database files that were restored for the TSPITR operation.</li> </ol>

Loss of all online controlfiles	1. RESTORE CONTROLFILE;	1. Create a create control file script that includes all database files and online logs. 2. Run the script to create the control file. Note: all RMAN backups and archived log information is lost.
Validate Backups	1. Restore database validate;	Can't perform it because there is no tool available.

## **GRID CLUSTERS**

It's a revolution that we will see as an evolution. Grid computing promises to revolutionize the way you do computing. And the way forward for you will be an easy evolution. It will be possible to easily move to Grid a step at a time. Each step brings greater benefits

Enterprises can buy resources for all of an enterprise's needs and provision them to individual applications on demand or based on policy. This leads to efficient utilization of enterprises resources and also provides tremendous reduction in development, deployment, and management costs. It allows you to decide how to deploy the computing resources of the organization, and quickly change that deployment as the needs of the organization change

No matter where the data resides, RMAN knows what data requires a backup and provides the ability to plug in data from any platform using the Cross Platform Transportable Tablespace feature. For more information on GRID, take a look at the Oracle World paper 40123 - Oracle and the Grid.

## **CONCLUSION**

Database backups are the insurance to recover critical data. Oracle Database 10g provides the mechanism to organize and manage recovery related files in the Flash Recovery Area. It eliminates the need to manually track locations of backups and deletes them when they are no longer required for recovery. If your backup window is shrinking, RMAN provides the ability to directly read the changed blocks since the previous backup utilizing the new Change Tracking File functionality. Using the Oracle Database 10g technological advancements and Enterprise Manager, implementing a recovery strategy to meet your recovery time objectives is now achievable.

The method or tool that you employ to protect and recover your data, should provide:

- reliability. RMAN.
- flexibility. RMAN.
- manageability. RMAN.
- availability. RMAN.

If you haven't tested RMAN before, give it a try. We haven't lost a good backup yet! It all starts with Oracle Database 10g!