Simplifying / Demystifying
EMC’s TimeFinder Integration
with Oracle Flashback

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**Introduction**

Integrating EMC’s TimeFinder™ Business Continuity application with Oracle can be difficult. The objective of this article is to describe Oracle’s Flashback and EMC’s TimeFinder technologies and to illustrate how the two applications work together to help end users recover lost data within an Oracle 11g Relational Database Management (RDBMS) environment.

Diagrams and screen shots will show how these technologies can help Database Administrators (DBAs) and Storage Administrators recover from a wide range of data loss situations. Then, we will move to the integration phase to see how you can use the two applications to develop a “Get Well” or “Recovery Plan.”

We will discuss “Point in Time” recovery, “Flashback Rewind,” and “Recovery Time Objectives.” Once the basics for the two technologies have been presented, the article will present the following advanced topics:

a. Enabling and Disabling Oracle Flashback  
b. Dropping and/or Deleting data (to simulate a data corruption situation)  
c. Recovering or Flashing back to a previous point in time  
d. The concept of developing a “Get Well” or “Recovery Plan”

**Application Environment**

Let’s first review our application environment. DBAs and Storage Administrators should have an in-depth understanding of their environments. I have set up an Oracle 11g application running on a Linux operating platform for this article. The Oracle application has a number of tables and views, each with a varying number of records.
We will be referencing these tables and views (Reference figure 1). I will drop one of these tables, simulating a data loss situation, to show how Oracle “Flashback” can help recover.

```
SQL> select owner, table_name, tablespace_name
from dba_tables
where owner = 'STUDENT';

<table>
<thead>
<tr>
<th>OWNER</th>
<th>TABLE_NAME</th>
<th>TABLESPACE_NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>STUDENT</td>
<td>ADDRESS</td>
<td>ORA_APP1</td>
</tr>
<tr>
<td>STUDENT</td>
<td>PHONE</td>
<td>ORA_APP1</td>
</tr>
<tr>
<td>STUDENT</td>
<td>EDUCATION</td>
<td>ORA_APP1</td>
</tr>
<tr>
<td>STUDENT</td>
<td>JOB</td>
<td>ORA_APP1</td>
</tr>
<tr>
<td>STUDENT</td>
<td>EDUCATION_CODE</td>
<td>ORA_APP1</td>
</tr>
</tbody>
</table>

SQL> select owner, view_name
from dba_views
where owner = 'STUDENT';

<table>
<thead>
<tr>
<th>OWNER</th>
<th>VIEW_NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>STUDENT</td>
<td>DEP_INFO</td>
</tr>
<tr>
<td>STUDENT</td>
<td>E_L_INFO</td>
</tr>
<tr>
<td>STUDENT</td>
<td>JGR_INFO</td>
</tr>
<tr>
<td>STUDENT</td>
<td>SALL_INFO</td>
</tr>
</tbody>
</table>
```

Flashback Overview
Flashback was introduced with Oracle 9i and has been improved with the release of Oracle 10g and now 11g. It is generally used to protect “End Users” or “Operators” from generating day to day operation errors that might include inadvertently removing data. The DBA or System Analyst needs to understand what data objects must to be put back and where all the data elements go. This is not easy when supporting an RDBMS environment.

We are all familiar with the ‘undo’ command in Word or Excel. We type something incorrectly; by selecting the undo icon the state of your Word document or Excel model steps back one transaction at a time. In its simplest form, Oracle Flashback can be referred to as “Undo” and simply plays back every transaction until it reaches the desired point in time, also known as the selected “recovery point.”
Flashback Variations

There are a number of Flashback variations. The Database Administrator can Flashback **Transactions**. Choosing this type of Flashback ensures “Atomicity” or “Consistency” of all database transactions in the reverse order.

**Restore Point** is another form of Flashback. The DBA uses this Flashback functionality to roll back the database to a specific point in time or to a specific System Change Number (SCN) point.

**Flashback Database** ensures that the entire database is restored to a previous point in time. The DBA uses this Flashback function after discovering that data corruption has filtered throughout the database.

Other Flashback functionality includes Flashback **Drop**, **Table**, and **Query**. As you can see, the DBA has a wide range of Flashback options that provide “undo” capability. With Flashback, the DBA can select a previous point in time and then undo all the database transactions until reaching the desired point in time. This is a very clean recovery method that both the DBA and/or the System Analyst can use to address a wide range of data recovery situations.

Any user that has full Database Administrative privileges or DBA privileges can use this functionality. There would be chaos if every user had access to this functionality simultaneously. Think of two or three users working on a single Microsoft Word document and using the undo functionality at the same time. No one would know what the state the document was in. Apply that concept to a database and you can see that Flashback or rollback functionality needs to be used with great care. This is why most, if not all, Oracle Database environments have a single user or account with DBA privileges. For this article, I have set up an Oracle user account called “Student” with full DBA privileges.

You should perform administrative tasks on a database from the account users’ perspective. Implementing any Flashback functionality begins with analysis and
planning. Understanding the previous sentence is key to understanding when and how Flashback and TimeFinder should be used to help recover from a database corruption situation. Invoking Flashback and TimeFinder commands is simple; understanding what’s being done and the subsequent impact is not so simple. That is why careful planning is required before any Flashback or TimeFinder implementation.

Setting up an Oracle Flashback Environment
Let’s consider a data recovery situation using Oracle 11g Flashback functionality.

Setup is required to get Flashback to work. I have attached a SQL script that I used to get my Flashback environment set up and running (Reference figure 2). I used a DBA privileged account to set the database in hot backup mode and then set my Flashback retention time to thirty-two hours. Next, I set my Flashback destination size to 512 meg and my Flashback mount point to /ora2. These Flashback settings will vary depending on your database environment.

"Analysis" and "Planning" may result in a retention time, destination size and/or a mount point that is much larger than what I am displaying in Figure 2. The
Planning is required because the database must be shut down and restarted to configure for Flashback. Shutting down and restarting an Oracle production database in many environments is considered a poor business practice since uptime is tracked in many organizations. In some situations, 97% production database availability in any month or quarter may be unsatisfactory. Apply care and caution with respect to shutting down and starting any Oracle production database.

Enabling Flashback

Now that we know what Flashback is and some of the basic requirements to get it to work, let's try it. In Figure 1, you saw a table named ‘Address.’ It currently has seventy records. (Reference Figure 3).

```sql
SQL> select count(*) from address;
    COUNT(*)  --- Fig 3 ---
       --- 70
```

Please note that our application has a number of views. Ed_Info is a view that combines records from our Address, Phone, Education, and Education_Code tables. Losing any of these tables would result in data loss into our Ed_Info view. In other words, the procedure that produces the view “Ed_Info” would stop working. (Reference Figure 4)
This procedure collects records from a number of tables and presents them in a view. Losing any of the tables will result in a view or procedure that will stop working. We are going to drop the “Address” table and use Flashback to bring it back into the database. Flashback will undo every transaction within the database and reestablish the “Address” table with all its records.

The DBA has to manually recommit all the transactions to bring this table back prior to Flashback functionality. Restoring or bringing back a table is simple. However, when something goes wrong in a database and the DBA does not know what went wrong, implementing a correction can be overwhelming.
I am simply going to drop the “Address” table to simulate data loss or corruption in our simulated database environment. After dropping the table, I will try to perform a record count on the table. The result will be “Table or View does not exist.” This is the same error message you would receive if an end user entered an incorrect table name.

```sql
SQL> drop table address;
Table dropped.
SQL> select count(*) from address;
select count(*) from address
ERROR at line 1:
ORA-00942: table or view does not exist
SQL> flashback table "ADDRESS" to before drop;
Flashback complete.
SQL> select count(*) from address;
    -- Fig 5 --
     COUNT(*)  
----------
        70
```  

At this point, I have a corrupted database environment. We now need to take a closer look at Flashback. The dropped table is placed in a recycle bin contained within the Oracle instance. Remember when we were setting up our Flashback environment? Refer back to figure 2, specifically lines 24 and 25 in our create Flashback script, that references the database recovery destination mount point.

We set the mount point to “/ora2”. This is very important. When the storage administrator makes a replica of the database, they must ensure that this device is included in any replication process such as EMC’s TimeFinder. This is why communication between DBAs and Storage Administrators is so important.
From time to time, the DBA may need to add a new device using Oracle Automated Storage Management (ASM) or enable Flashback and direct its recycle bin destination to a new storage device resulting in a new storage structure for the database. The new storage layout is now mis-aligned with any TimeFinder device group configuration. The TimeFinder process will continue to work but when you need that replicated copy of the database, you will discover that the TimeFinder process is replicating only part of it. **If you only have part of the database, you have nothing.**

If you learn anything from this article, please learn that replicating a database must include all elements of the instance. This relies on communication between the DBA and the Storage Administrator. If the same person fills both roles, ensure that any storage database reconfiguration is adjusted into your replication process.

```sql
SQL> drop table address;
Table dropped.
SQL> desc user_recyclebin;
Name          Null? Type       
-------------- ---------- ------------
OBJECT_NAME   NOT NULL VARCHAR2(30)
ORIGNAL_NAME  VARCHAR2(32)
OPERATION     VARCHAR2(25)
TYPE          VARCHAR2(19)
CREATETIME    VARCHAR2(19)
DROPTIME      VARCHAR2(19)
DROPSCN       NUMBER
PARTITION_NAME VARCHAR2(32)
CAN_UNDROP    VARCHAR2(32)
CAN_PURGE     VARCHAR2(32)
RELATED       NOT NULL NUMBER
BASE_OBJECT   NOT NULL NUMBER
PURGE_OBJECT  NOT NULL NUMBER
SPACE         NUMBER

SQL> select OBJECT_NAME, ORIGINAL_NAME from user_recyclebin;
OBJECT_NAME        ORIGINAL_NAME
-------------------- -------------------
BINSVRarKFK35nGQAB/AQBA5A==$2 BINSYP/klehPfPTqQAB/AQBA9A==$1
BINSVRarKFKK55ngQAB/AQBA5A==$0 ADDRESS

SQL> Flashback table "ADDRESS" to before drop;
Flashback complete.
SQL> select OBJECT_NAME, ORIGINAL_NAME from user_recyclebin;
no rows selected
```
We briefly mentioned the Flashback Recycle Bin in previous paragraphs. A metadata table is used to track all activity that Flashback can recall when it is enabled (Reference figure 2 - line 26, alter database flashback on). Reference figure 6, where I perform a describe on this metadata table “user_recyclebin” and proceed to select its contents. Notice that this table is now tracking the “Address” table for a possible recall.

“Flashback table “ADDRESS” to before Drop;” (Reference figure 5 and 6) is the command to recall or undo the dropped “Address” table. Notice the table name is in upper case (capital) letters. All data placed in an Oracle metadata table is in upper case letters; the command will fail if you try to recall this table using lower case letters.

I have recalled or Flashbacked the Address table and all its contents (seventy records). Please keep in mind that we set the Flashback retention time for thirty-two hours. Using Flashback to recover this data would not be an option if the DBA discovered that the table was missing after the retention time window passed. As a result, the time window is critical and will vary depending on the business rules the database is supporting. Ensure that all your Flashback parameter settings are in compliance with your business rules. Understanding and setting these rules is a collaborative effort among Business Analysts, DBAs, Storage Administrators, and Systems Administrators.

See illustration on the following page.
SRDF®/TimeFinder – Flashback Environment

Figure 7 represents a best practice scenario when replicating an Oracle database environment. The R1 side of the diagram represents the production database that is synchronized via an RDF link to its R2 pairs. The production side is an active database represented with the symbol “DB-UP.” Utilizing SRDF/S (Synchronous Mode) across the RDF Link represents a mirror copy of the R1 environment. On the R2 side, the devices are in and un-mounted representing an inactive database. A set of BCVs has been paired with the R2 devices on the target array. We are able to create a point in time replica of the production database using EMC’s TimeFinder consistent split technology.

We can mount this environment to a second host because the BCVs are split. The BCV side of the diagram represents a second Oracle database that is up and running. This replica is a point in time copy of the production environment and can be used for reporting (also known as “Decision Support”) Application Testing, Application Development or Database Troubleshooting.
Notice the “Full” and “Incremental” notations. Initially, when creating a replica of an Oracle environment, a full copy of the database is required. The first copy must include all the “Data” objects. Incremental copies of all objects excluding the “Data” object can be performed once the full copy has been made. Apply the logs on the target side to bring the target database current. Copying the “Data” objects can be time consuming if the production database size is significant. Replicating the data once will save time and bandwidth across the network.

Also notice the Flashback (FBack) devices. We learned earlier that the functionality of Flashback can be turned on and off, and device assignments can be made outside of those devices assigned to any database production environment. When enabling Flashback, ensure the device assignments are included in an RDF and/or TimeFinder replication process. The key is that I want to enable Flashback functionality on the BCV copy utilizing the Flashback Recycle-Bin that was created on the Production volumes.

Take another look at the RDF (R1 to R2) and BCV (R2 to BCV) groups. The RDF “Full” group includes the Oracle “Data” objects; the RDF “Incremental” group does not. This holds true for the BCV group. Creating Full and Incremental device groups requires careful planning. Both the DBA and the Storage Administrator need to understand the types of replication that will be performed and whether Flashback will be enable or disabled.

**ASM and SRDF/TimeFinder Configurations**

Automated Storage Management (ASM) applies here as well. With ASM, a DBA has control of storage volumes for the database he or she is controlling. Devices can be added to the ASM group if additional storage is required. Oracle will rebalance all the database objects evenly across the ASM group once the new volumes are added. When the database needs to be replicated using RDF or TimeFinder, the device groups needs to include the new ASM volumes that were
just added. In the event that the device groups are not updated to match the ASM volume groups, the problem will not surface until the replicated database is needed; by then it's too late. Remember, if you do not replicate everything, you have nothing.

DBA Roles and Responsibility in a Flashback Environment
Up to this point, we dropped the “Address” table, Flashed it back, and solved the problem. Everything we did was controlled. Unfortunately, this is not the real world. DBAs are confronted with a number of database issues most of which stem from uncontrolled situations. They are under enormous pressure to keep the database up and running at all times since businesses lose money when the database is down. A successful DBA will always know the “last good point in time.” With Flashback, if that time is within the retention target window, maybe he or she can Flashback the database to that point.

Let's say that last known point was two day ago and the database is Flashbacked to that time. What about all the transactions that were entered since? Many business applications would find this solution unacceptable. The other issue is identifying the cause of the problem. The DBA may Flashback only to move forward from that point and discover that the problem has been recreated. Again, this is unacceptable.

EMC’s TimeFinder can help. Getting a copy of the production database will enable the DBA to work on a solution to any give situation. Enabling Oracle Flashback on the BCV copy will give the DBA another option to help fix any data corruption without impacting the production environment.

The DBA can work offline from the production environment once the database is replicated. Often, a table has been corrupted or records have been inserted into a number of tables incorrectly. In other words, the database is not totally down. A “Get Well” plan can be created and tested with a BCV copy of the database.
There are a number of options to bring the production database back on line once the DBA understands and creates a plan. One option is to write a script to address the problem. This script could include a SQL Flashback routine that was tested on the BCV backup database.

A second option is to restore the BCV copy back onto the R2 volumes and then perform an RDF restore back onto the R1 production volumes. You will need to shut down the production database to implement this option and the business would have to agree. Performing a full or incremental restore back onto the R1 volumes would be part of the recovery plan that was tested on the BCV copy.

Your recovery plan may look like Figure 8. Diagram your plan and identify the steps to help the technical staff and end users better understand it. For our scenario, we start analyzing and implementing our recovery using a BCV ‘gold copy.’ If the results of testing require a full restore, the steps would look something like Figure 8.
Step 1. Split the RDF link. It does not matter if we use a consistent split because at the moment what’s on the R1 is also on the R2 volumes, and it’s all bad. Remember, we were in synchronous mode across the RDF link (Reference figure 7).

Step 2. Shut down the production database.

Step 3. Restore the contents of the BCV onto the R2 volumes once the production database is shut down and the volumes are unmounted.

Step 4. Once you have restored the invalid tracks from the BCV volumes onto the R2 devices, split the BCV Volumes from their R2 pairs. Use a consistent split; or shut down the BCV database to ensure a point in time restore from the BCV volumes to the R2 devices.

Step 5. Restore the RDF from the R2 devices to the R1 volumes.

Step 6. Split the RDF link once you have fully synchronized all tracks has been accomplished.

Step 7. Mount the database volumes; perform an Oracle startup. At this point, test that the database is back on line.

Step 8. If everything looks all right, activate the RDF link in an established / synchronized mode moving invalid tracks from the R1 volumes to the R2 devices.

This sounds complicated, but remember that the DBA has an environment and the tools to test a recovery plan before implementation using a TimeFinder copy of the production database and Oracle Flashback.
This plan is only an example of restoring a database in full. Recovery plans vary depending on the situation. Diagramming your plan and listing all the actions will ensure that your technical team and end users understand the process. Also, “Test, Test, and Test” before implementing any recovery process.

**Flashback and TimeFinder in Non-Disastrous Environments**

You can also use Oracle Flashback and TimeFinder in non-disastrous situations. The Storage Administrator could make a copy of the database and then let the End Users Flashback the copied database to a given point in time for “Testing,” “Reporting” or “Development” using EMC’s TimeFinder Business Continuance application. With a TimeFinder copy of a production database, end users can also recreate point in time environments using Oracle Flashback. Let’s say the organization needs to recreate last quarters’ financial reports. The backup database copy can be reset to twelve midnight on the last day of the desired quarter with TimeFinder and Oracle Flashback.

**Summary**

The main goal of this article was to show how Oracle Flashback and EMC’s TimeFinder application can be used in an integrated database environment. We looked at how Flashback helps DBAs solve a wide range of database corruption situations. We also discussed how EMC’s TimeFinder application can be used to create a “Get Well” plan when dealing with a data loss situation. The key is to use a replicated copy of the production database. Using Flashback on the replicated BCV copy enables the database technical support staff to create and test a “Get Well” plan without impacting the production database.
What was learned in this article:

A. First we discussed the various types of Flashback.

B. Next, we set up a Flashback environment (Note - Set up parameters will vary from database to database)

C. We "Enabled" / "Disabled" Flashback functionality  
   a. alter database flashback on;  
   b. alter database flashback off;

D. We discussed what Oracle objects are required for a good replicated copy  
   a. Make sure your RDF or BCV copies include all required Oracle "Objects" / "Volumes."  
   b. If you replicate only part of the database you have nothing.

E. We discussed the creation of a “Get Well” plan which should involve:  
   a. Business Analyst  
   b. Systems Analyst  
   c. Storage Administrators  
   d. System Administrators  
   e. DBAs

F. Test, Test, and Test your “Get Well” plans.

G. Implementing both Flashback and TimeFinder is easy; understanding the impact is critical.

Diagramming your “Get Well” plan and documenting the steps (Reference figures 7 and 8 as examples) gets everyone involved, and helps them to understand what needs to be done. Oracle Flashback and EMC’s TimeFinder functionality are powerful tools to keep any Oracle RDBMS environment online.
Biography

Bob is a Technology Solutions Education Consultant at EMC who is a member of the Business Continuance Curriculum team responsible for development, management and maintenance of all Business Continuance training programs.

He delivers many key Solutions/Application integration programs and workshops for EMC employees, partners, and customers on a world-wide basis, and has contributed to the development of exams for the EMC Proven Professional program.

Bob holds an Expert level EMC Proven Professional certification in the Symmetrix Business Continuity, Implementation Engineering track.