(Single) Table Recovery

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HALLO, GRÜEZI, HI!

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AGENDA

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INTRODUCTION

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7 CHALLENGE

- Real-life customer request to restore two tables dropped the day before

> *Two database tables need restoring which have been **dropped accidentally** on the **XX01XXP** database.*
>
> *Tables names are as follows :*
>
> ***1. APP_OWNER.SALES_DATA***
>
> ***2. APP_OWNER.SALES_DATA_ARC***
>
> *These are required for Monthend processing hence is very urgent.*
>
> *Please restore to the point in time **26.01.2023 09:00**.*

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8 DATABASE

- Affected target database was a **PDB in a single-tenancy CDB**
- Version was 19c (19.16)
- All Tablespaces were created as **Bigfile Tablespaces** and encrypted with **Transparent Data Encryption (TDE)**
  - Indexes and Tables were in separate Tablespaces
- Datafiles were located on **ASM (4-node RAC system)**
- Total size of the PDB was 62 TB
  - Size of the Tablespace with the affected tables was 14 TB
  - Nearly 3 TB were occupied by Undo Tablespaces

Create separate Tablespaces if multiple applications are hosted in the database.

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9 FOREIGN KEY CONSTRAINTS

- The number of tables to restore can increase when foreign key constraint are in place
- Check if ON DELETE clause is used

```
SQL> SELECT c.owner, c.table_name, c.constraint_name, c.r_constraint_name,
            p.owner AS "PARENT_OWNER", p.table_name AS "PARENT_TABLE_NAME",
            c.delete_rule
       FROM dba_constraints c
            JOIN dba_constraints p ON (c.r_constraint_name = p.constraint_name)
      WHERE p.owner = 'HR'
            AND p.table_name = 'EMPLOYEES';

OWNER TABLE_NAME     CONSTRAINT_NAME R_CONSTRAINT_NAME PARENT_OWNER PARENT_TABLE_NAME DELETE_RULE
----- -------------- --------------- ----------------- ------------ ----------------- -----------
HR    DEPARTMENTS    DEPT_MGR_FK     EMP_EMP_ID_PK     HR           EMPLOYEES         CASCADE
HR    EMPLOYEES      EMP_MANAGER_FK  EMP_EMP_ID_PK     HR           EMPLOYEES         NO ACTION
HR    JOB_HISTORY    JHIST_EMP_FK    EMP_EMP_ID_PK     HR           EMPLOYEES         SET NULL
```

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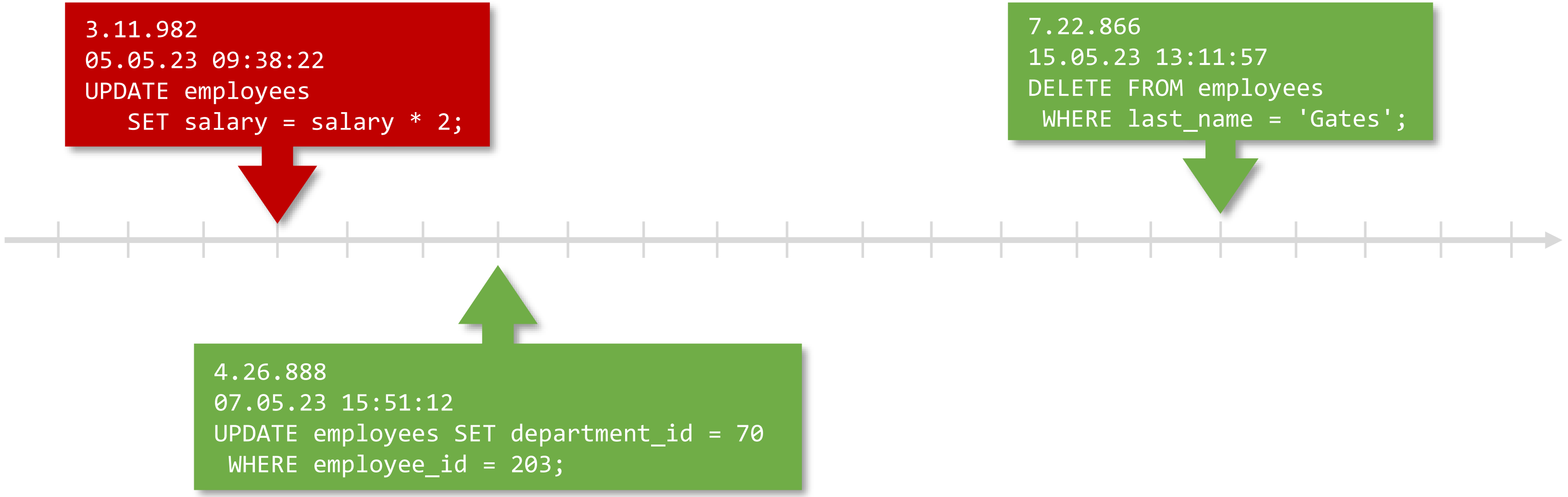
10 TRANSACTIONS

- Keep in mind that **good** transactions might need be to saved after a **bad** transaction happened



```
3.11.982
05.05.23 09:38:22
UPDATE employees
   SET salary = salary * 2;
```

```
4.26.888
07.05.23 15:51:12
UPDATE employees SET department_id = 70
 WHERE employee_id = 203;
```

```
7.22.866
15.05.23 13:11:57
DELETE FROM employees
 WHERE last_name = 'Gates';
```

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FLASHBACK

INTRODUCTION

- Flashback was introduced with 9i and enhanced with later versions
- A **set of different data recovery solutions** to reverse human errors or to query historical date
    - Supports recovery on all levels (row, transaction, table, database)
- Depending on the feature either **Undo data** or **Flashback Logs** are used
    - Fast Recovery Area is required to support the storage of Flashback Logs

Most of the Flashback features requires the Enterprise Edition.

13 USE CASES

- Query a historical state of a table or show all changes in a historical order
- Rollback of committed transactions
- Restore of a dropped table
- Track changes of a table over a long period (versioning)
- Reset of the database to a previous state with a physical restore
    - For example, to reverse a failed application update

14 UNDO RETENTION

- All Flashback features are using the **before images of a row** in the UNDO Tablespace to construct a previous state of a table
  - Except Flashback Drop and Flashback Database
- Database parameter **undo_retention** controls how long UNDO of committed transactions will be kept (default 900 seconds)

```
SQL> ALTER SYSTEM SET undo_retention = 86400 SCOPE = BOTH;
```

- Per default, the **Undo retention is not guaranteed**
  - Unexpired Undo Extents will be overridden, if not enough space is available

```
SQL> ALTER TABLESPACE UNDOTBS RETENTION GUARANTEE;
```

Automatic Undo Management is required to use Flashback.

ORA-01555 SNAPSHOT TOO OLD

- If the required UNDO is not available, an ORA-01555 error is raised

```
SQL> SELECT first_name, last_name, salary
       FROM employees AS OF TIMESTAMP TO_TIMESTAMP('15.05.2023', 'dd.mm.yyyy');

ERROR at line 2:
ORA-01555: snapshot too old: rollback segment number 343 with name
"_SYSSMU343_1952840052$" too small
```

- Query column SSOLDERRCNT of **(G)V$UNDOSTAT** to retrieve the number of occurrences
- PL/SQL package **DBMS_UNDO_ADV** provides useful functions/procedures to optimize the Undo Retention/Tablespace

The same error is raised, when you try to create a historical or for a long-running Data Pump export.

16 AS OF TIMESTAMP / SCN

- To provide the desired point-in-time a timestamp (`AS OF TIMESTAMP`) or a SCN (`AS OF SCN`) can be provided in a SELECT statement

```
SQL> SELECT first_name, last_name, salary
       FROM employees AS OF TIMESTAMP TO_TIMESTAMP('15.05.2023', 'dd.mm.yyyy');
```

- If all statements of a session need the same point-in-time, **DBMS_FLASHBACK** can be used to set it

```
SQL> EXEC DBMS_FLASHBACK.ENABLE_AT_TIME(TO_TIMESTAMP('15.05.2023', 'dd.mm.yyyy'));
SQL> EXEC DBMS_FLASHBACK.ENABLE_AT_SYSTEM_CHANGE_NUMBER(123456);
SQL> EXEC DBMS_FLASHBACK.DISABLE;
```

EXECUTE privileges are required to use DBMS_FLASHBACK.

FLASHBACK QUERY

- Shows the state of a table for a specific point-in-time in the past
- Example: Show the new and old salary of an employee

```
SQL> UPDATE employees SET salary = salary*2 WHERE last_name = 'Gates';
SQL> SELECT last_name, salary FROM employees WHERE last_name = 'Gates‘;

FIRST_NAME           LAST_NAME                     SALARY
-------------------- ------------------------- ----------
Timothy              Gates                           5800

SQL> SELECT last_name, salary
       FROM employees AS OF TIMESTAMP TO_TIMESTAMP('15.05.2023', 'dd.mm.yyyy')
      WHERE last_name = 'Gates';

FIRST_NAME           LAST_NAME                     SALARY
-------------------- ------------------------- ----------
Timothy              Gates                           2900
```

FLASHBACK VERSION QUERY

- Shows the different versions of rows for a **specific time period**

```
SQL> SELECT versions_starttime, versions_endtime, versions_xid,
            versions_operation, last_name, salary
       FROM employees
            VERSIONS BETWEEN TIMESTAMP
               TO_TIMESTAMP('15.05.2023 10:35', 'dd.mm.yyyy HH24:MI') AND
               TO_TIMESTAMP('15.05.2023 10:47', 'dd.mm.yyyy HH24:MI')
      WHERE last_name = 'Gates';

VERSIONS_STARTTIME   VERSIONS_ENDTIME     VERSIONS_XID     V LAST_NAME  SALARY
-------------------- -------------------- ---------------- - ---------- ------
15.05.2023 10:45:54                       080019005F040000 D Gates        2900
15.05.2023 10:44:39  15.05.2023 10:45:54  080013005E040000 U Gates        2900
                     15.05.2023 10:44:39                     Gates        5800
```

FLASHBACK TRANSACTION QUERY

- To use it **Supplemental Logging for Primary Keys and Foreign Keys** is required
- The dynamic view **FLASHBACK_TRANSACTION_QUERY** will be used to generate the Undo statement(s) for a transaction

```
SQL> SELECT operation, row_id, undo_sql
       FROM flashback_transaction_query WHERE xid = '04000100B0030000';

OPERATION  ROW_ID              UNDO_SQL
---------- ------------------- ----------------------------------------
DELETE     AAAUEMAAPAAAALdAAy  insert into "HR"."EMPLOYEES"("EMPLOYEE_ID",
                               "FIRST_NAME","LAST_NAME","EMAIL","PHONE_NUMBER",
                               "HIRE_DATE","JOB_ID","SALARY","COMMISSION_PCT",
                               "MANAGER_ID","DEPARTMENT_ID") values ('150',
                               'Peter','Tucker','PTUCKER','011.44.1344.129268',
                               TO_DATE('30-JAN-05', 'DD-MON-RR'),'SA_REP',
                               '10000','.3','145','80');
```

NLS_DATE_FORMAT is used

Use Flashback Version Query to get the transaction ID.

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FLASHBACK TABLE

- Allows the **rollback of all transactions of a table** in one command
- ROWIDs will change during the Flashback
  - Row movement for a table must be enabled (otherwise ORA-08189)

```
SQL> ALTER TABLE employees ENABLE ROW MOVEMENT;
SQL> FLASHBACK TABLE hr.employees
     TO TIMESTAMP TO_TIMESTAMP('15.05.2023 16:58', 'dd.mm.yyyy HH24:MI');
SQL> ALTER TABLE employees DISABLE ROW MOVEMENT;
```

- As an alternative to SCN and Timestamp, a restore point can be used
  - Requires SELECT ANY DICTTIONARY or FLASHBACK ANY TABLE or SELECT_CATALOG_ROLE grant

```
SQL> FLASHBACK TABLE hr.employees TO RESTORE POINT before_update;
```

Enabled Triggers are disabled during the Flashback and afterwards reenabled.

FLASHBACK DROP 1/3

- Restore of a dropped table using the recycle bin of the database
- To activate the feature, database parameter **`recyclebin`** must be set to on (default)

```
SQL> ALTER SYSTEM SET recyclebin = 'ON' SCOPE = BOTH;
```

- If activated, the table is renamed instead of dropped
  - Dependent objects (indexes, constraints) are also renamed
- How long a dropped table can be restored cannot be set
  - It depends on the data growth in the Tablespace
  - If the Tablespace would need a physical extension, the blocks of an object in the recycle bin will be reused

Use DROP … PURGE to drop a table directly.

FLASHBACK DROP 2/3

- Query DBA|USER_RECYCLEBIN (or the synonym RECYCLEBIN) to check the recycle bin

```
SQL> DROP TABLE job_history;
SQL> SELECT object_name, original_name, type, droptime, can_undrop
       FROM user_recyclebin;

OBJECT_NAME                    ORIGINAL_NAME           TYPE  DROPTIME            CAN
------------------------------ ----------------------- ----- ------------------- ---
BIN$/Dw5W/AeUb/gUwEAAH/pSg==$0 JHIST_DEPARTMENT_IX     INDEX 2023-05-21:21:56:19 NO
BIN$/Dw5W/AfUb/gUwEAAH/pSg==$0 JHIST_EMPLOYEE_IX       INDEX 2023-05-21:21:56:19 NO
BIN$/Dw5W/AgUb/gUwEAAH/pSg==$0 JHIST_JOB_IX            INDEX 2023-05-21:21:56:19 NO
BIN$/Dw5W/AhUb/gUwEAAH/pSg==$0 JHIST_EMP_ID_ST_DATE_PK INDEX 2023-05-21:21:56:19 NO
BIN$/Dw5W/AiUb/gUwEAAH/pSg==$0 JOB_HISTORY             TABLE 2023-05-21:21:56:19 YES
```

Although an index has the value NO for CAN_UNDROP, it will be restored when the table is restored.

FLASHBACK DROP 3/3

- Restores the table from the recycle bin
  - The original name or the name of the object in the recycle bin are supported

```
SQL> FLASHBACK TABLE job_history TO BEFORE DROP;
SQL> FLASHBACK TABLE "BIN$/Dw5W/AiUb/gUwEAAH/pSg==$0" TO BEFORE DROP;
```

- Indexes will not be renamed to their original name

```
SQL> SELECT index_name FROM user_indexes WHERE table_name = 'JOB_HISTORY‘;

INDEX_NAME
------------------------------
BIN$/Dw5W/AeUb/gUwEAAH/pSg==$0
...
```

Generate the ALTER INDEX … RENAME statements based on the recycle bin before restoring the table.

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FLASHBACK (PLUGGABLE) DATABASE 1/3

- "Rewinds" the database to a point-in-time in the past using Flashback Logs
    - A fast forward is also possible when no OPEN RESETLOGS was executed
- The **Recovery Writer Process (RVWR)** writes Flashback data to the Flashback Logs
- Query column FLASHBACK_ON of V$DATABASE to check if it is enabled

```
SQL> SELECT flashback_on FROM v$database;

FLASHBACK_ON
------------------
YES
```

- Database parameter **`db_flashback_retention_target`** controls the upper limit
    - Flashback Logs are deleted, when the FRA is running out of space (except for Guaranteed Restore Points)

Creating a Guaranteed Restore Point activates Flashback Log Mode implicitly.

FLASHBACK (PLUGGABLE) DATABASE 2/3

Requirements:

- Archive Log Mode
- Fast Recovery Area

```
SQL> ALTER SYSTEM SET db_recovery_file_dest_size = 1T SCOPE = BOTH;
SQL> ALTER SYSTEM SET db_recovery_file_dest = '+FRA' SCOPE = BOTH;
```

- Flashback Log Mode

```
SQL> ALTER DATABSE FLASHBACK ON;
```

- Local Undo Mode to support Flashback for a single PDB in a CDB

Starting with 23c a dedicated area for the Flashback Logs can be defined (`db_flashback_file_dest_size` and `db_flashback_file_dest`).

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26 FLASHBACK (PLUGGABLE) DATABASE 3/4

1. Close the PDB or bring the database to the MOUNTED state

```
SQL> ALTER PLUGGABLE DATABASE PDB1 CLOSE IMMEDIATE INSTANCES = ALL;
```

2. Flashback the PDB/database

```
SQL> FLASHBACK PLUGGABLE DATABASE PDB1
     TO TIMESTAMP TO_TIMESTAMP('15.05.2023 11:00:00', 'dd.mm.yyy HH24:MI:SS');
```

3. Open the PDB/database in read-only mode

```
SQL> ALTER PLUGGABLE DATABASE PDB1 OPEN READ ONLY;
```

💡 To open the PDB/database after a Flashback directly in read-write mode, you need to use the OPEN RESETLOGS option.

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27 FLASHBACK (PLUGGABLE) DATABASE 4/4

4. Extract the required data (e.g., SQL Loader or Data Pump export over DB-Link)
5. Recover the PDB/database using RMAN

```
RMAN> ALTER PLUGGABLE DATABASE PDB1 CLOSE IMMEDIATE INSTANCES = ALL;
RMAN> RECOVER PLUGGABLE DATABASE PDB1;
```

6. Open the PDB/database read-write

```
SQL> ALTER PLUGGABLE DATABASE PDB OPEN INSTANCES = ALL;
```

💡 You can create a DB-Link from the CDB to the PDB to run the Data Pump export.

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LOGMINER

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GENERAL

- LogMiner was introduced with Oracle 8i
- Allows the **analysis of the contents of (archive) redo logs** for various use cases
    - Detection of logical corruption
    - Recovery of single database objects
    - Auditing of executed DML and DDL statements
    - Enhanced trend analysis and capacity planning
- Internally used by Oracle Data Guard (Logical Standby) and other third-party logical replication tools
- Implemented in PL/SQL
    - DBMS_LOGMNR, DBMS_LOGMNR_D

LogMiner can be used out-of-the-box, but it has limitations.

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OBJECT IDS

- LogMiner can be used to analyze (archive) redo logs of any database (8.0 and higher)
- Oracle **stores only object IDs** (including column IDs) in the redo stream
- To generate working SQL statements, the **IDs need to be translated** to names
- 3 ways are supported
  - Flat file (backward compatibility)
  - Storing the Data Dictionary in the redo logs
    `DBMS_LOGMNR.DICT_FROM_REDO_LOGS`
  - Usage of the Data Dictionary (preferred method)
    `DBMS_LOGMNR.DICT_FROM_ONLINE_CATALOG`

Creating a flat file dump of a PDB is desupported in 21c (ORA-65040).

SUPPLEMENTAL LOGGING 1/2

- Oracle **stores as little as possible REDO information** in the Redo Logs
- These REDO information can be used to recover the database, but LogMiner needs more information to generate working SQLs (e.g. for chained rows)
- Storing extra REDO information (additional column values) is called **Supplemental Logging**
- It can be activated on CDB or PDB level or for specific tables

```
SQL> ALTER DATABASE ADD SUPPLEMENTAL LOG DATA;
SQL> ALTER DATABASE ADD SUPPLEMENTAL LOG DATA (PRIMARY KEY) COLUMNS;
SQL> ALTER DATABASE ADD SUPPLEMENTAL LOG DATA (UNIQUE) COLUMNS;
SQL> ALTER DATABASE ADD SUPPLEMENTAL LOG DATA (FOREIGN KEY) COLUMNS;
SQL> ALTER DATABASE ADD SUPPLEMENTAL LOG DATA (ALL) COLUMNS;
SQL> ALTER DATABASE ADD SUPPLEMENTAL LOG DATA FOR PROCEDURAL REPLICATION;
SQL> ALTER DATABASE ADD SUPPLEMENTAL LOG DATA SUBSET DATABASE REPLICATION;
```

For Golden Gate, available since 19c

To check Supplemental Logging on PDB level use DBA_SUPPLEMENTAL_LOGGING.

SUPPLEMENTAL LOGGING 2/2

- Impact of Supplemental Logging to the generated SQLs by the LogMiner

```
SQL> ALTER DATABASE ADD SUPPLEMENTAL LOG DATA (PRIMARY KEY) COLUMNS;
SQL> ALTER DATABASE ADD SUPPLEMENTAL LOG DATA (ALL) COLUMNS;

OPERATION SQL_REDO                                SQL_UNDO
--------- --------------------------------------- -----------------------------------------
UPDATE    update "HR"."EMPLOYEES"                 update "HR"."EMPLOYEES"
           set                                     set
              "SALARY" = 14400                        "SALARY" = 7200
           where                                   where
              "EMPLOYEE_ID" = 164 and                 "EMPLOYEE_ID" = 164 and
              "FIRST_NAME" = 'Mattea' and             "FIRST_NAME" = 'Mattea' and
              "LAST_NAME" = 'Marvins' and             "LAST_NAME" = 'Marvins' and
              "EMAIL" = 'MMARVINS' and                "EMAIL" = 'MMARVINS' and
              ...                                     ...
              "MANAGER_ID" = 147 and                  "MANAGER_ID" = 147 and
              "DEPARTMENT_ID" = 80 and                "DEPARTMENT_ID" = 80 and
              ROWID = 'AAAUEMAAPAAAALeACi';           ROWID = 'AAAUEMAAPAAAALeACi';
```

33 IDENTIFY (ARCHIVE) REDO LOGS

- Identify the required (Archive) Redo Logs

```
SQL> SELECT thread#, sequence#, name, deleted
       FROM gv$archived_log
      WHERE first_time BETWEEN
              TO_TIMESTAMP('22.05.2023 07:25', 'dd.mm.yyyy HH24:MI') AND
              TO_TIMESTAMP('22.05.2023 08:40', 'dd.mm.yyyy HH24:MI');

THREAD# SEQUENCE# NAME                                                        DEL
------- --------- ---------------------------------------------------------- ---
      1       143 /opt/oracle/FREE/archivelog/2023_05_22/o1_mf_1_143_l6pbc7hd_.arc  YES
      1       144 /opt/oracle/FREE/archivelog/2023_05_22/o1_mf_1_144_l6pbocy4_.arc  NO
```

Restore of the Archive redo Log is required

- Restore already deleted Archive Redo Logs using RMAN

```
RMAN> RESTORE ARCHIVELOG SEQUENCE 143 THREAD 1;
```

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34 START LOGMINER

- Add the required files and start LogMiner (from CDB$ROOT)

```
SQL> BEGIN
   DBMS_LOGMNR.ADD_LOGFILE(
      logfilename => '/opt/oracle/FREE/archivelog/2023_05_22/o1_mf_1_143_l6pbc7hd_.arc',
      options => DBMS_LOGMNR.NEW
   );
   DBMS_LOGMNR.ADD_LOGFILE(
      logfilename => '/opt/oracle/FREE/archivelog/2023_05_22/o1_mf_1_144_l6pbocy4_.arc',
      options => DBMS_LOGMNR.ADDFILE
   );

   DBMS_LOGMNR.START_LOGMNR(
      options => DBMS_LOGMNR.COMMITTED_DATA_ONLY + DBMS_LOGMNR.PRINT_PRETTY_SQL +
                 DBMS_LOGMNR.NO_ROWID_IN_STMT + DBMS_LOGMNR.DICT_FROM_ONLINE_CATALOG
   );
END;
/
```

Resets the list of mined (Archive) Redo Logs

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EXTRACT REDO/UNDO SQLS

- Use the dynamic view **V$LOGMNR_CONTENTS** to retrieve the required SQLs

```
SQL> SELECT xid, start_timestamp, operation, sql_redo, sql_undo
       FROM v$logmnr_contents WHERE table_name = 'EMPLOYEES' AND operation = 'DELETE';

XID              START_TIM OPERATION SQL_REDO                                 SQL_UNDO
---------------- --------- --------- ---------------------------------------- ---------------------------------------
04000100B0030000 21-MAY-23 DELETE    delete from "HR"."EMPLOYEES"             insert into "HR"."EMPLOYEES"
                                      where                                    values
                                         "EMPLOYEE_ID" = 150 and                  "EMPLOYEE_ID" = 150,
                                         "FIRST_NAME" = 'Peter' and               "FIRST_NAME" = 'Peter',
                                         "LAST_NAME" = 'Tucker' and               "LAST_NAME" = 'Tucker',
                                         "EMAIL" = 'PTUCKER' and                  "EMAIL" = 'PTUCKER',
                                         "PHONE_NUMBER" = '011....129268' and     "PHONE_NUMBER" = '011....129268',
                                         "HIRE_DATE" = '30-JAN-05' and            "HIRE_DATE" = '30-JAN-05',
                                         "JOB_ID" = 'SA_REP' and                  "JOB_ID" = 'SA_REP',
                                         "SALARY" = 10000 and                     "SALARY" = 10000,
                                         "COMMISSION_PCT" = .3 and                "COMMISSION_PCT" = .3,
                                         "MANAGER_ID" = 145 and                   "MANAGER_ID" = 145,
                                         "DEPARTMENT_ID" = 80;                    "DEPARTMENT_ID" = 80;
```

Create a table from the dynamic view V$LOGMNR_CONTENTS to run multiple queries without mining the (Archive) Redo Logs again.

RECOVERY MANAGER (RMAN)

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DUPLICATE DATABASE

- **Creates a (historical) copy of a database** on the same server/cluster or on a different server/cluster
- Tablespaces and PDBs can be excluded
  - SYSTEM, SYSAUX and the UNDO Tablespaces are mandatory
- A copy from the active database or from an existing backup can be performed
- Starting with 18c, RMAN supports cloning of a single PDB into an existing CDB using RMAN
  - Has a lot of limitations, not recommended
- Two important terms
  - **TARGET:** Database that will be cloned (`CONNECT TARGET`)
  - **AUXILIARY:** Target instance of the clone operation (`CONNECT AUXILIARY`)

Push and pull clones are supported – a pull clone requires less preparation work.

AUXILIARY INSTANCE

- To create a clone, RMAN needs a so-called **Auxiliary Instance**
- Create the Auxiliary Instance on the target server/cluster in the target Oracle Home
- Only mandatory parameter for the Auxiliary Instance is `db_name`
    - But it is better to create a PFILE of the target database and adjust the values

```
SQL> CREATE PFILE = '/tmp/initAUXDB.ora' FROM SPFILE;
```

- Start the Auxiliary Instance

```
SQL> CREATE SPFILE FROM PFILE = '/tmp/initAUXDB.ora‘;
SQL> STARTUP NOMOUNT
```

For push clones a static Listener entry is required for the Auxiliary Instance.

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EXAMPLE

- Connect to RMAN Catalog (optional), Target and Auxiliary and create the clone

```
RMAN> CONNECT CATALOG rman/rman@RMANDB
RMAN> CONNECT TARGET sys/manager@XX01XXP
RMAN> CONNECT AUXILIARY /

RUN {
   ALLOCATE CHANNEL disk1 DEVICE TYPE DISK;
   ALLOCATE CHANNEL sbt1 DEVICE TYPE SBT_TAPE ...;
   ALLOCATE AUXILIARY CHANNEL auxd1 DEVICE TYPE DISK;
   ALLOCATE AUXILIARY CHANNEL aux1 DEVICE TYPE SBT_TAPE ...;
   SET UNTIL TIME "TO_TIMESTAMP('22.05.2023 07:25', 'dd.mm.yyyy HH24:MI')";
   DUPLICATE TARGET DATABASE TO AUXDB
      SKIP PLUGGABLE DATABASE HRPDB
      SKIP TABLESPACE CRMPDB:ARCH_DATA;
}
```

It is recommended to allocate disk channels even when all backups are stored on tape.

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40 RECOVER TABLE

- Introduced with Oracle 12c
- Can be used to **recover single/multiple table (partitions)**
- Creates a minimal historical clone of the database including SYSTEM, SYSAUX, UNDO and the Tablespaces containing the tables (+ Tablespaces of dependent objects)
- An **Automatic Instance** is used for the recovery
- Three options are available for the handling of the tables after the recovery
  - Replace the table(s) in the target database (default)
  - Create a Data Pump dump of the table(s) (`NOTABLEIMPORT`)
  - Create the table with a new name in the target database (`REMAP TABLE`)
- ASM and filesystem are supported locations

If REMAP TABLE is used, named Constraints and Indexes are not imported.

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AUTOMATIC INSTANCE 1/2

- An automatic instance is started for the table recovery
- It uses a system generated database unique and instance name
- After the operation completed (with success or failure), the instance is automatically removed

```
Removing automatic instance
shutting down automatic instance
Oracle instance shut down
Automatic instance removed
auxiliary instance file /u01/oradata/C21SFE1_SITE1/controlfile/o1_mf_l6rycb5d_.ctl deleted
```

- To avoid the deletion of the Auxiliary Instance, use the clause `KEEP AUXILIARY`
  - Available since 19c or via one-off patch 22820798 in 12c Release 2
  - https://christian-gohmann.de/2020/05/08/keep-rman-auxiliary-instance-after-failure/

AUTOMATIC INSTANCE 2/2

- Parameters of an Automatic Instance (21c)

```
Creating automatic instance, with SID='olgD'

initialization parameters used for automatic instance:
db_name=C21SFE1
db_unique_name=olgD_pitr_C21SFE1PDB1_C21SFE1
compatible=21.0.0
db_block_size=8192
db_files=200
diagnostic_dest=/u00/app/oracle
_pdb_name_case_sensitive=false
_system_trig_enabled=FALSE
db_domain=goh.trivadis.local
sga_target=2048M
processes=200
db_create_file_dest=/opt/oracle
log_archive_dest_1='location=/opt/oracle'
enable_pluggable_database=true
_clone_one_pdb_recovery=true
#No auxiliary parameter file used
```

Same size as the source database

EXAMPLE

- Connect to RMAN Catalog (optional), Target and start the table recovery

```
RMAN> CONNECT CATALOG rman/rman@RMANDB
RMAN> CONNECT TARGET sys/manager@XX01XXP

RMAN> RUN {
   SET AUXILIARY PARAMETER FILE TO '/tmp/init.ora';
   RECOVER TABLE HR.EMPLOYEES OF PLUGGABLE DATABASE XX01XXP
     UNTIL TIME "TO_DATE('15.05.2023 14:45', 'dd.mm.yyyy HH24:MI’)”
     AUXILIARY DESTINATION '+DATA'
     DATAPUMP DESTINATION '/dumps/XX01XXP’
     REMAP TABLE HR.EMPLOYEES:HR.EMPLOYEES_RESTORED
     KEEP AUXILIARY
   ;
}
```

Optional

💡 To use a different memory configuration, use an Auxiliary Parameter File (Doc ID 2430319.1).

SUMMARY

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OPTIMIZATION POTENTIAL

- Optimize the database design
  - Add new Tablespaces for Indexes or archived data
  - Create business-critical tables in a dedicated Tablespace
- Optimize the Undo Tablespace and retention time
- Increase the Flashback retention time
- Activate Flashback Time Travel (also known as Flashback Data Archive)
  - Undo data is saved for a longer period

```
SQL> CREATE FLASHBACK ARCHIVE longterm_arc TABLESPACE arc_data RETENTION 1 YEAR;
SQL> ALTER TABLE sales_data FLASHBACKL ARCHIVE longterm_arc;
```

- Create a Physical Standby database with a delayed application of Redo

FURTHER INFORMATION

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LINKS

- **Using LogMiner to Analyze Redo Log Files**
  https://docs.oracle.com/en/database/oracle/oracle-database/21/sutil/oracle-logminer-utility.html
- **Using Oracle Flashback Technology**
  https://docs.oracle.com/en/database/oracle/oracle-database/21/adfns/flashback.html
- **Oracle Database 21c Backup and Recovery User's Guide**
  https://docs.oracle.com/en/database/oracle/oracle-database/21/bradv/
- **My Oracle Support**
  https://support.oracle.com

QUESTIONS AND ANSWERS

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