Online Operations in Oracle 12.2

New Features and Enhancements

Christian Gohmann

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About me…

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- **Experiences with Oracle** since 2006 (8i – 12c)
  - Architecture, Installation & Configuration
  - High Availability Solutions (RAC, Data Guard)
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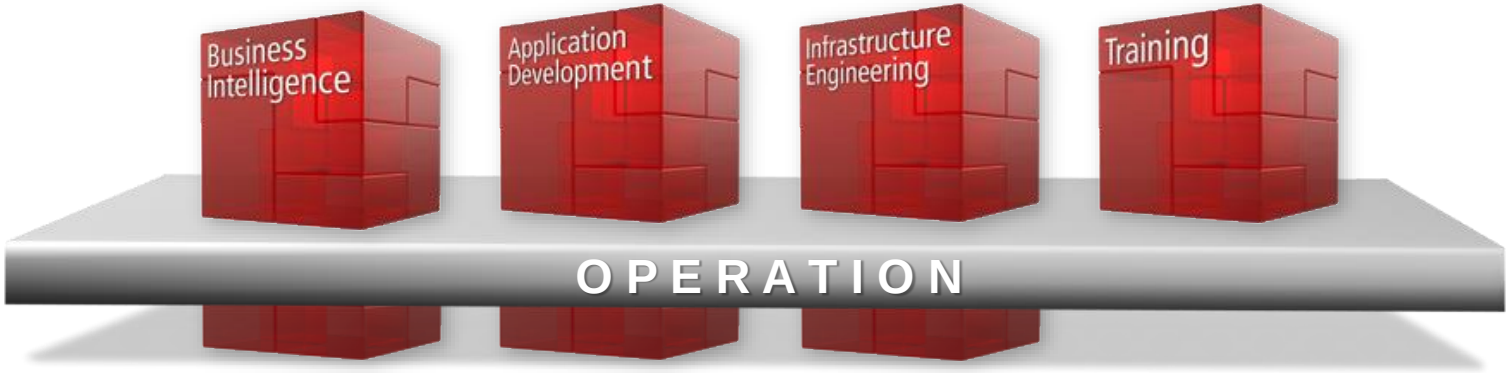

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Agenda

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Introduction

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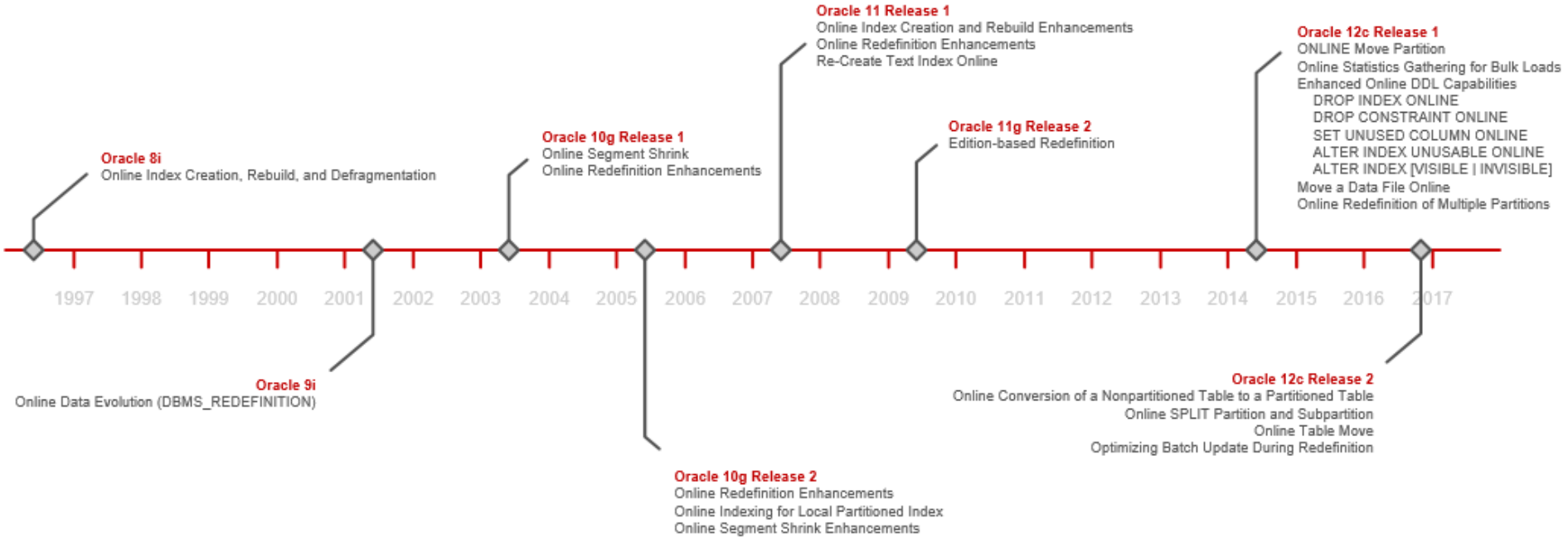
History of Online Operations



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How does it works?

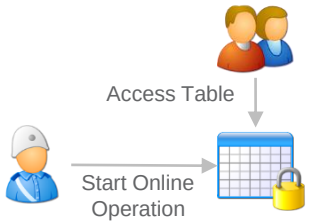

Table or Partition is **locked in ROW EXCLUSIVE mode**

```
SQL> LOCK TABLE "BOOKS" IN ROW EXCLUSIVE MODE NOWAIT;
```


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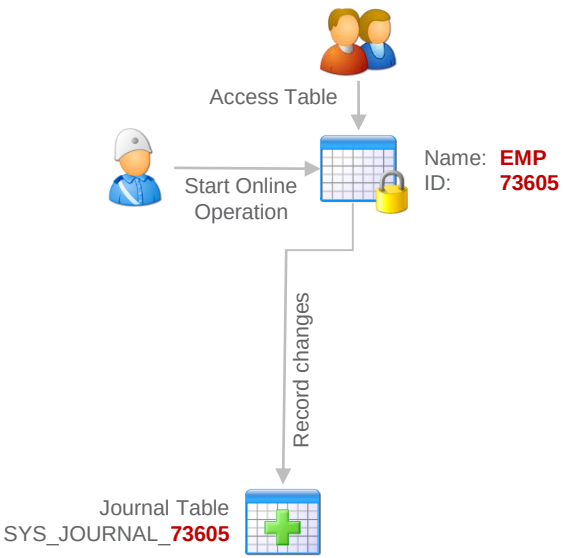
How does it works?



Journal Table SYS_JOURNAL_nnnnn is created to capture every DML against the source table

- Created as Index Organized Table
- Uses the Object ID of the source Table / Partition

```
SQL> create table "DEMO_OSP"."SYS_JOURNAL_73605" (
        rid rowid,
        opcode char(1),
        primary key(rid)
     ) organization index tablespace "DEMO_OSP_DATA";

-- Example Data
RID                 O
------------------ -
AAASDBAAFAAAACQABo D  -- Delete
AAASDBAAFAAAACTAAx U  -- Update
AAASDBAAFAAANIsAAA I  -- Insert
```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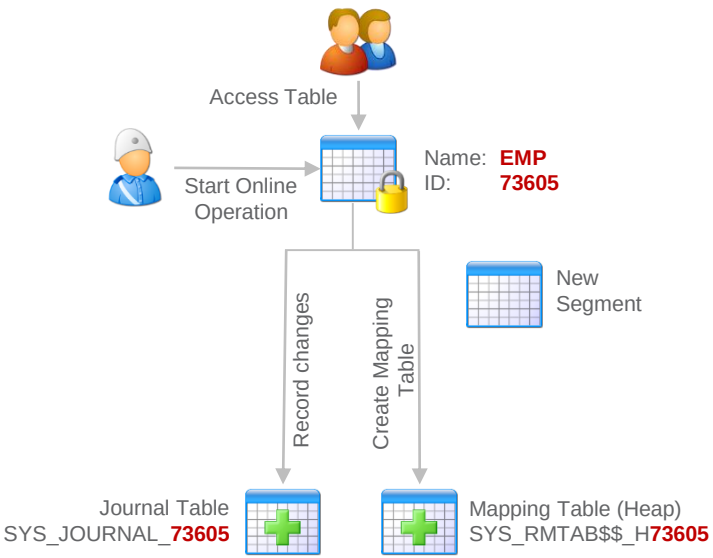
How does it works?



Create Mapping Table, which **maps the ROWID** of the **Source** Table / Partition with the **newly created** Table / Partition

- Created as Heap Organized Table
- Undocumented ROWID_MAPPING_TABLE clause is used (not usable directly in a session)

```
SQL> create table "DEMO_OSP"."SYS_RMTAB$$_H73605" (
        src_rowid rowid not null
        tgt_rowid rowid not null)
     segment creation immediate nologging
     tablespace "DEMO_OSP_DATA" rowid_mapping_table;
```

- One row for each row of the Source Table
  - Requires 20 bytes + row overhead + Table overhead

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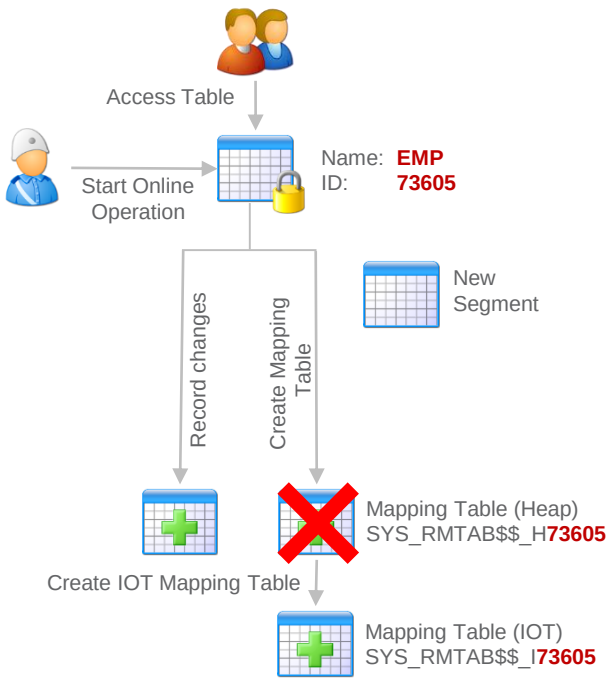
How does it works?



An Index Organized Table version of the Mapping Table is created

- Uses as source the Heap Organized Mapping Table
- ROWID_MAPPING_TABLE clause is used again

```
SQL> create table  "DEMO_OSP"."SYS_RMTAB$$_I73605" (
        src_rowid, tgt_rowid,
        constraint pk_SYS_RMTAB$$_I73605
        primary key (src_rowid))
        segment creation immediate organization index
        tablespace  "DEMO_OSP_DATA"  noparallel
        nologging rowid_mapping_table as (
           select src_rowid, tgt_rowid
             from "DEMO_OSP"."SYS_RMTAB$$_H73605"));
```

- Heap Organized Mapping Table is dropped after the creation

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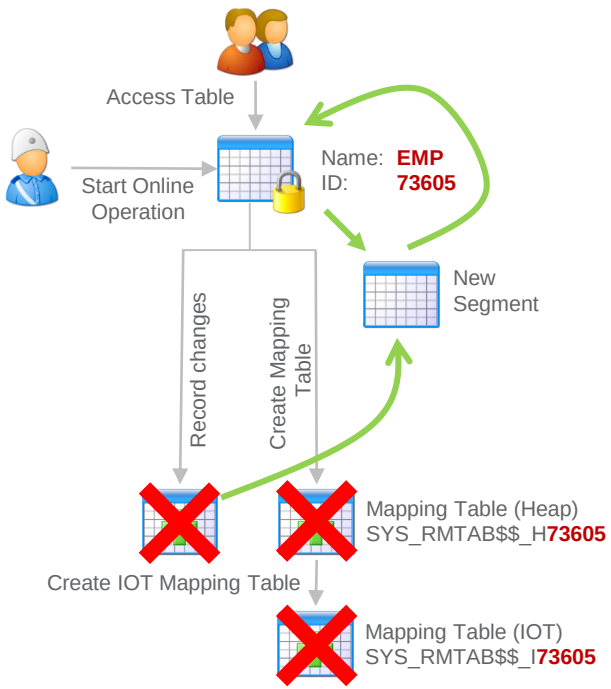
How does it works?



Newly created Table/Partition is filled with the required data

- Captured changes from the Journal Table are merged into the newly created Table / Partition
- Existing Object is updated / extended with new segment(s) after the merge (in the Data Dictionary)

Cleanup all temporarly created objects

```
SQL> drop table "DEMO_OSP"."SYS_JOURNAL_73605" purge
SQL> drop table  "DEMO_OSP"."SYS_RMTAB$$_I73605" purge
```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ALTER TABLE Enhancements

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Online Conversion of a Table to a partitioned Table 1/4

- Enhancement of the ALTER TABLE command to allow **conversion of a non-partitioned tables to a partitioned table** online
  - Concurrent **DML operations are permitted**
  - Trying to run the ALTER TABLE statement against a partitioned table terminates with *ORA-14427: table does not support modification to a partitioned state DDL*
- Tables with **Domain Indexes cannot be online converted** (ORA-14427)
- Totally **two times the space** of the non-partitioned table is additionally required

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Online Conversion of a Table to a partitioned Table 2/4

- **Indexes are maintained** during conversion
- Use optional **UPDATE INDEXES clause to change partition state of indexes** as well
  - Indexed columns or uniqueness of an index cannot be changed
  - TABLESPACE clause can be added to set the target location for the indexes
- Default behaviour for indexes not mentioned in UPDATE INDEXES clause

Index Type	Touched?	New Index Type	Rebuild?
Global Partitioned Index	✗		✗
Non-Prefixed Index	✓	Global Non-partitioned Index	✗
Prefixed Index	✓	Local Partitioned Index	✗
Bitmap Index	✓	Local Partitioned Index	✗

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Online Conversion of a Table to a partitioned Table 3/4

- Example

```
SQL> ALTER TABLE BOOKS MODIFY
  PARTITION BY RANGE (release_date)
  ( PARTITION BOOKS_PRE_2015
       VALUES LESS THAN (TO_DATE('01.01.2015 00:00:00', 'dd.mm.yyyy HH24:MI:SS')),
    PARTITION BOOKS_2015
       VALUES LESS THAN (TO_DATE('01.01.2016 00:00:00', 'dd.mm.yyyy HH24:MI:SS')),
    PARTITION BOOKS_2016
       VALUES LESS THAN (TO_DATE('01.01.2017 00:00:00', 'dd.mm.yyyy HH24:MI:SS')),
    PARTITION BOOKS_2017
       VALUES LESS THAN (TO_DATE('01.01.2018 00:00:00', 'dd.mm.yyyy HH24:MI:SS'))
   ) UPDATE INDEXES ONLINE;
```


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Online Conversion of a Table to a partitioned Table 4/4

DEMO

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Online Split Partition / Subpartition

- Partitions and Subpartitions can be split online while DML operations are ongoing
- Indexes are maintained automatically
  - No need to explicit set UPDATE INDEXES clause
- Syntax

```
SQL> ALTER TABLE BOOKS SPLIT PARTITION BOOKS_ACTION_THRILLER
   VALUES ('Action')
   INTO ( PARTITION BOOKS_ACTION,
          PARTITION BOOKS_THRILLER
) ONLINE;
```

- Totally **two times the space** of Table (Sub)partition is **additionally required**

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Online Table Move

- Moving an table to a new segment can be done online while DML is still permitted
  - Until Oracle 12c Release 1 only Index-organized tables could be moved online
  - Rowids will be changed during the move
- Indexes are maintained during move when UPDATE INDEXES clause is used
  - Otherwise they will be UNSABLE after the move
- Any statistics become invalid and have to gathered again
- Syntax:

```
SQL> ALTER TABLE sh.orders MOVE ONLINE [UPDATE INDEXES];

-- Move table to a new tablespace and activate basic compression
SQL> ALTER TABLE sh.orders MOVE ONLINE COMPRESS UPDATE INDEXES TABLESPACE ts_new;
```


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Online Redefinition Enhancements

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Optimized Batch Updates 1/3

- Optimized performance of **bulk updates using direct mode**
  - Update is not logged in the redo logs
  - Recovery of the database would lead to logical block corruption
- Requires to run EXECUTE_UPDATE procedure of DBMS_REDEFINITION package
  - Internally well known components of Online Redefinition are used
  - Removes also fragmentation of the affected rows
  - Ensures that the update is atomic

```
SQL> EXEC DBMS_REDEFINITION.EXECUTE_UPDATE (update_stmt => 'UPDATE ... SET ...');
```

- In the case of an error, use ABORT_UPDATE to undo changes

```
SQL> EXEC DBMS_REDEFINITION.ABORT_UPDATE;
```


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Optimized Batch Updates 2/3

- Restrictions
  - Only one execution of EXECUTE_UPDATE at the same time
  - DML changes of other sessions are gone after EXECUTE_UPDATE finishes
  - UPDATE Trigger are not permitted
  - Partition-extended names are not permitted
  - User-defined Types and some Oracle-supplied types are not permitted
  - No support for hidden, virtual, unused, identity and pseudo columns
  - The table cannot be an object table
  - Virtual Private Database (VPD) policies are not permitted
  - Check constraints cannot exists
  - No support of row archival feature
- **Enabling Force Logging has no effect on EXECUTE_UPDATE**

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Optimized Batch Updates 3/3

- Examples
  - #1: Table Size: 166 MB, 4 Million Rows, Update amount: 100% (One Column)
  - #2: Table Size: 416 MB, 10 Million Rows, Update amount: 100 % (One Column)
  - #3: Table Size: 416 MB, 10 Million Rows, Update amount: 25% (One Column)

#	Test	Time (s)	Divergence	Redo Size (MB)	Divergence
1	Conventional Update	36		1265	
	Optimized Batch Update	48	+ 33 %	539	- 58 %
2	Conventional Update	541		3238	
	Optimized Batch Update	700	+ 29 %	1000	- 70 %
3	Conventional Update	137		805	
	Optimized Batch Update	567	+ 313 %	997	+ 23 %

- If the table uses NOLOGGING, the generated amount of Redo is further reduced

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Refresh Dependent Materialized Views 1/2

- During Online Redefintion, fast refreshable MViews can be refreshed automatically
  - Avoiding a time consuming complete refresh after the Online Redefinition finished
  - ROWID and Join MViews are not supported
- Set REFRESH_DEP_MVIEWS Parameter for procedures REDEF_TABLE or START_REDEF_TABLE to Y
  - Can be changed later using DBMS_REDEFINITION.SET_PARAM procedure

```
SQL> BEGIN
   DBMS_REDEFINITION.SET_PARAM (
      redefinition_id => 1,
      param_name => 'refresh_dep_mviews',
      param_value => 'Y'
);
```

  - Check column REFRESH_DEP_MVIEWS in DBA_REDEFINITION_STATUS

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Refresh Dependent Materialized Views 2/2

- Refresh occurs during each execution of **SYNC_INTERIM_TABLE** and **FINISH_REDEF_TABLE**
  - Documentation states that refresh occurs while executing START_REDEF_TABLE too - but this is not working
  - MView is in the state NEEDS_COMPILE after FINISH_REDEF_TABLE (Bug?)
- Example

```
SQL> BEGIN
   DBMS_REDEFINITION.START_REDEF_TABLE (
      uname => USER,
      orig_table => 'DEMO_ORG_TABLE',
      int_table => 'DEMO_INT_TABLE',
      refresh_dep_mviews => 'Y'
   );
END;
/
```


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Rolling Back Online Redefinition 1/3

- Roll back the changes done by the Online Redefinition
  - Every DML change will be preserved
  - Materialized View and Materialized View Log are used internally (not visible in Data Dictionary Views)
- To enable rollback functionality, **START_REDEF_TABLE** has to be started with parameter **ENABLE_ROLLBACK** set to TRUE

```
SQL> BEGIN
   DBMS_REDEFINITION.START_REDEF_TABLE (
      uname => USER, orig_table => 'DEMO_ORG_TABLE',
      int_table => 'DEMO_INT_TABLE', enable_rollback => TRUE
   );
END;
```

- Former original table will be maintained after the Online Redefinition finished
  - **SYNC_INTERIM_TABLE** can be used to force a synchronisation of the former original table

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Rolling Back Online Redefinition 2/3

- Use **ROLLBACK** procedure to roll back to the original table definition

```
SQL> BEGIN
   DBMS_REDEFINITION.ROLLBACK (
      uname => USER,
      orig_table => 'DEMO_ORG_TABLE',
      int_table => 'DEMO_INT_TABLE'
   );
END;
/
```

- If the capability to roll back the changes is not required anymore, run **ABORT_ROLLBACK** to remove the internally used database objects
  - Until the objects for the rollback exists, no other Online Redefinition can be started for this table

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Rolling Back Online Redefinition 3/3

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Monitoring Progress 1/2

- New View **V$ONLINE_REDEF** introduced with 12.2.0.1
- **One status row** for each running Online Redefinition
- **Updated during execution of each step** within the redefinition process chain
  - Provides the SQL statements and its SQL ID for executed refresh statements
  - Can be joined with V$SQL and V$SQL_MONITOR to check the progress of the statement
- After the Online Redefinition is completed, the progress is not visible anymore

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Monitoring Progress 2/2

- Process states over the lifetime of a online redefinition

```
SQL> SELECT original_table_name AS "ORG_TABLE",
            interim_table_name AS "INTERIM_TABLE", operation, suboperation,
            detailed_message, progress, refresh_statement_sql_id AS "SQL_ID
       FROM V$ONLINE_REDEF;

ORG_TABLE  INTERIM_TABLE  OPERATION            SUBOPERATION                  DETAILED_MESSAGE               PROGRESS          SQL_ID
---------- -------------- -------------------- ----------------------------- ------------------------------ ----------------- --------------
DEMO_OR_LR DEMO_OR_LR_NEW START_REDEF_TABLE     create/verify materialized... create/verify MV logs          step 2 out of 7
DEMO_OR_LR DEMO_OR_LR_NEW COPY_TABLE_DEPENDENTS copy the indexes                                             step 3 out of 7
DEMO_OR_LR DEMO_OR_LR_NEW COPY_TABLE_DEPENDENTS copy the constraints                                         step 4 out of 7
DEMO_OR_LR DEMO_OR_LR_NEW SYNC_REDEF_TABLE      refresh the materialized view                                step 2 out of 3   3c4n9a8hx9mvm
DEMO_OR_LR DEMO_OR_LR_NEW FINISH_REDEF_TABLE    validate register dependent   validate ... dependent indexes step 2 out of 10
DEMO_OR_LR DEMO_OR_LR_NEW FINISH_REDEF_TABLE    validate register dependent   validate ... constraints       step 2 out of 10
```


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Miscellaneous

Support for Tables with BFILE columns

- No ORA-12088 error is thrown during *_REDEF_TABLE procedures

Locking Enhancements

- **Exclusive Lock** during execution of FINISH_REDEF_TABLE is **not required** anymore

Restart Online Redefinition after a failure

- Check column **RESTARTABLE** in **DBA_REDEFINITION_STATUS**, if the operation can be restarted or not
- E.g. when the tablespace runs out of space

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Oracle 12c Release 2 Database New Features Guide
http://docs.oracle.com/database/122/NEWFT/toc.htm

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