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Oracle Database 12*c*: New Features for Administrators

Activity Guide – Volume II
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Practices for Lesson 15: Emergency Monitoring and Compare Period ADDM

Chapter 15

Practices for Lesson 15: Overview

Practices Overview

In these practices, you will use Emergency Monitoring to troubleshoot a hanging situation discovered in `orcl` database instance.
Then you can optionally run the Compare Period ADDM demonstration to know how to use this new feature.

Practice 15-1: Using Emergency Monitoring

Assumption

You are managing the target `orcl` database and are already connected to Enterprise Manager Cloud Control in the target `orcl` database. Make sure you restart Enterprise Manager Cloud Control (you stopped it in a previous practice to enable Unified Auditing).

a. Restart the Enterprise Manager Repository Database `em12rep` unless it was already restarted in the previous practice.

```
$ . oraenv
ORACLE_SID = [orcl] ? em12rep
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$ sqlplus / as sysdba

Connected to an idle instance.
SQL> startup
ORACLE instance started.

Total System Global Area   503316480 bytes
Fixed Size                   2916056 bytes
Variable Size              272630056 bytes
Database Buffers           222298112 bytes
Redo Buffers                 5472256 bytes
Database mounted.
Database opened.
SQL> EXIT
$
```

b. Restart the OMS unless it was already restarted in the previous practice.

```
$ export OMS_HOME=/u01/app/oracle/product/middleware/oms
$ $OMS_HOME/bin/emctl start oms
Oracle Enterprise Manager Cloud Control 12c Release 4
Copyright (c) 1996, 2014 Oracle Corporation.  All rights
reserved.
Starting Oracle Management Server...
Starting WebTier...
WebTier Successfully Started
Oracle Management Server Successfully Started
Oracle Management Server is Up
Starting BI Publisher Server ...
BI Publisher Server Already Started
BI Publisher Server is Up
$
```

c. Use https://localhost:7802/em to get the Enterprise Manager Cloud Control Console appear, enter **sysman** in the User Name field and **Oracle123** in the Password field. Then click Login.
The status of the orcl database agent might be in unreachable state because the oms was stopped in a previous practice. However this has no incidence on other practices.

Overview

In this practice you will troubleshoot a hanging situation after users told you they could not connect to the orcl instance anymore.
You can use Emergency Monitoring only from Enterprise Manager Cloud Control.

Tasks

1. Make sure you are already connected to Enterprise Manager Cloud Control in the target orcl database with SYSDBA credentials.
   a. Connect to Enterprise Manager Cloud Control as sysman with Oracle123 password.
   b. After being connected, click “Targets” and then “Databases”.
   c. From the right pane, click the orcl database instance. You are still not connected to orcl.
   d. Therefore, go to any of the menus and try to execute any DBA operation. For example click the Security menu and then “Users” to create a new user or click the Administration menu, then Storage, then Tablespaces to create a tablespace.
   e. Because you created a named credential in Practice 2-3, the named credential is proposed to make a connection as SYSDBA to the instance. You can use it or create a new credential to log in. Log in.
2. In a terminal window, make sure you are at the ~/labs/Emergency directory and your environment points to the orcl instance.

```
$ cd ~/labs/Emergency
$ . oraenv
ORACLE_SID = [orcl] ? orcl
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$
```

3. Execute the Emergency_setup.sh shell script.

```
$ ./Emergency_setup.sh
DROP TRIGGER trig_after_logon
*
ERROR at line 1:
ORA-04080: trigger 'TRIG_AFTER_LOGON' does not exist
```

Leave the Emergency_setup.sh shell script pending.

4. Meanwhile you create a new user. From another terminal window, connect to the `orcl` database as `SYSTEM` with `oracle_4U` password.

```
$ sqlplus system

SQL*Plus: Release 12.1.0.2.0 Production on Wed May 21 05:26:26
2014

Copyright (c) 1982, 2014, Oracle.  All rights reserved.

Enter password: ******
```

But the session is pending.

5. From another terminal window, connect to the `orcl` database `AS SYSDBA` with `oracle_4U` password.

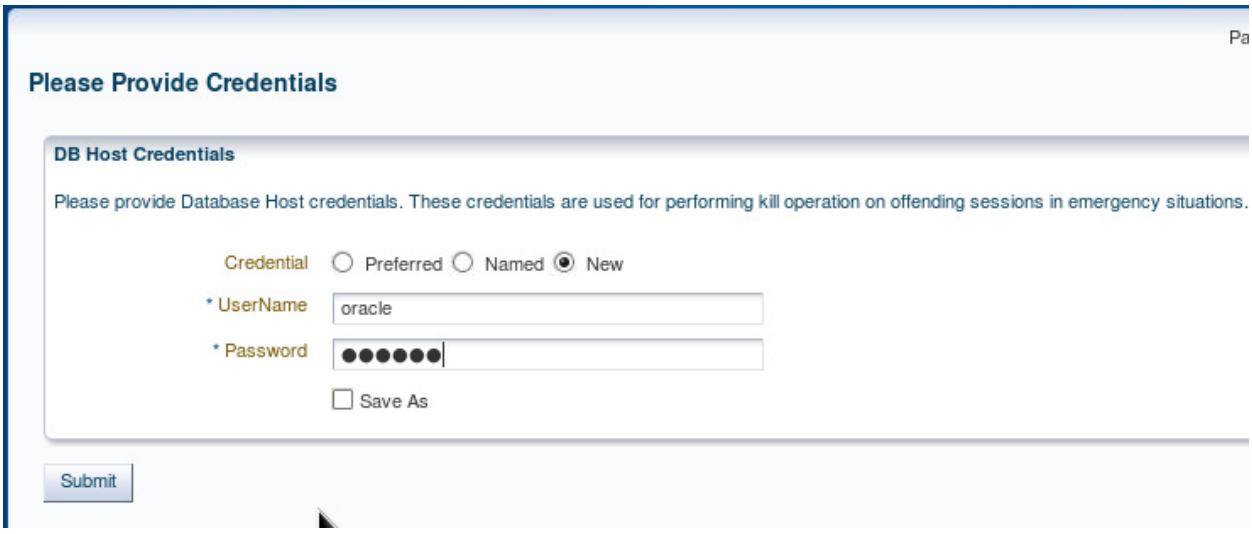
```
$ sqlplus / AS SYSDBA

SQL*Plus: Release 12.1.0.2.0 Production on Wed May 21 05:27:05
2014

Copyright (c) 1982, 2014, Oracle.  All rights reserved.
```

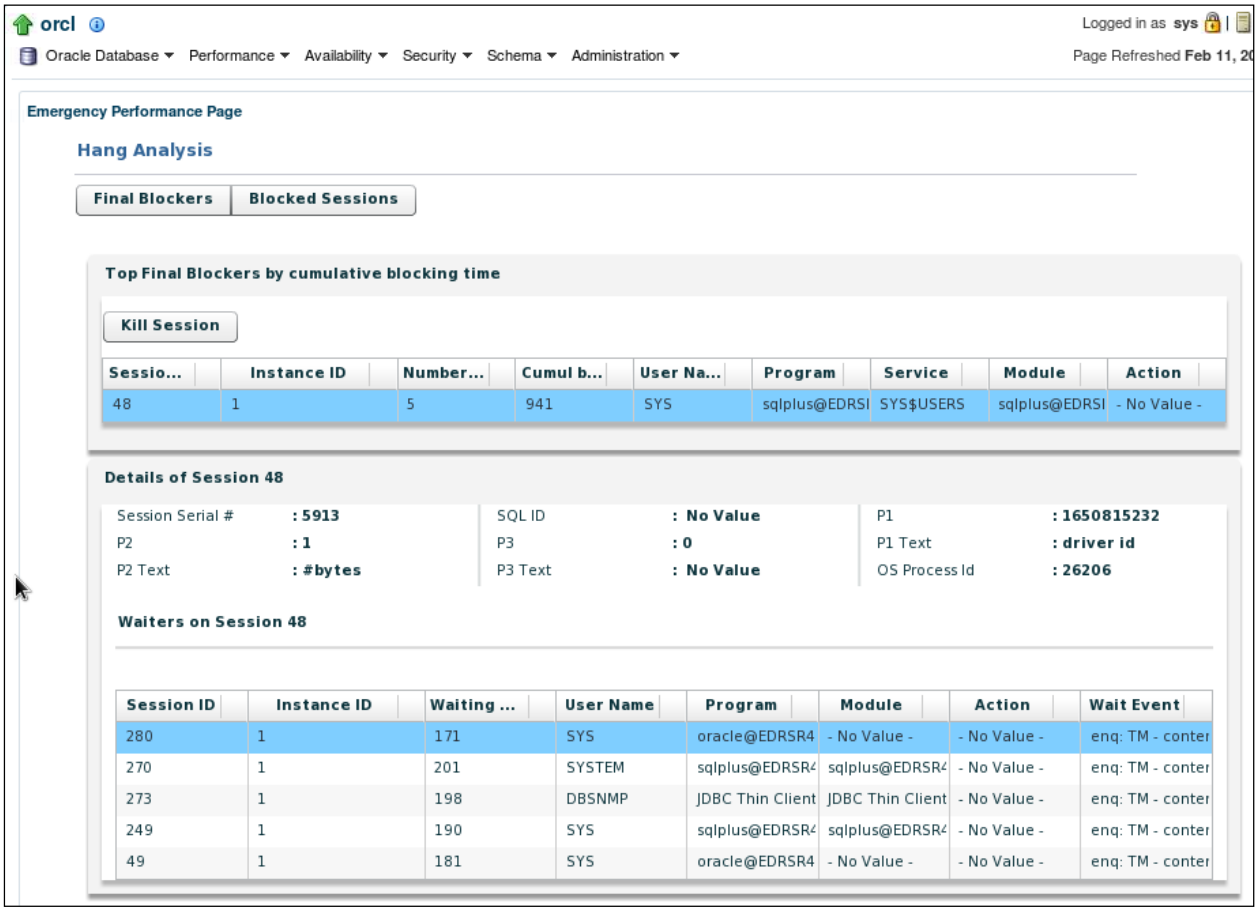
But the session is pending.

6. You will use Emergency Monitoring to quickly solve the hanging situation. Click Performance from the menu, then Emergency Monitoring from the list of options.



In DB Host Credentials, choose New and enter `oracle` for both the UserName and the Password. Then click Submit.

7. The Hanging Analysis page is displayed. It shows the blockers and blocked sessions. To release the blocked sessions, kill the blocking session. Click the Kill Session button. And click YES to approve the operation. A message appears to inform that the session has been killed. Click OK.



8. Check that the sessions that were hanging are now released.

```
$ sqlplus system

Enter password: ******

SQL*Plus: Release 12.1.0.2.0 Production on Wed May 21 05:26:26
2014

Copyright (c) 1982, 2014, Oracle.  All rights reserved.

SQL> EXIT
$
```

Practice 15-2: Cleaning Up

Overview

In this practice you clean up the environment of the `orcl` database.

Tasks

1. From the session where you launched the `Emergency_setup.sh` shell script, clean up the `orcl` database. If the `Emergency_setup.sh` shell script does not end up (because of the 1800 seconds sleep), interrupt it with `CTRL C`.

```
$ ./Emergency_setup.sh
DROP TRIGGER trig_after_logon
*
ERROR at line 1:
ORA-04080: trigger 'TRIG_AFTER_LOGON' does not exist

CTRL C
$
```

2. From one of the released SQL*Plus session, drop the trigger.

```
SQL> ALTER SYSTEM SET "_system_trig_enabled"=FALSE;

System altered.

SQL> DROP TRIGGER trig_after_logon;

Trigger dropped.

SQL> EXIT
$
```

Practice 15-3: Using Compare Period ADDM *(Optional)*

Overview

In this demonstration, you will see how to use the Compare Period ADDM with Enterprise Manager Cloud Control. You discover that during the current period of time, the performance is decreasing. You need to understand why the performance changed, and the root causes of this change, so as to perform appropriate actions to solve the issue.

In this practice, you use a browser to execute the Compare Period ADDM demonstration.

Tasks

Launch a browser and enter in the file:
////home/oracle/demos/Compare_Period_ADDM/Compare_Period_ADDM.html

Practices for Lesson 16: ADR and Network Enhancements

Chapter 16

Practices for Lesson 16: Overview

Practices Overview

In this practice, you will familiarize yourself with viewing an ADR DDL log file and content.

Practice 16-1: Viewing ADR DDL Log File

Overview

In this practice, you will find and view the ADR DDL log file.

Tasks

1. Set the ENABLE_DDL_LOGGING instance parameter to TRUE to activate the DDL logging.

```
$ . oraenv
ORACLE_SID = [orcl] ? orcl
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$ sqlplus / as sysdba


Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
64bit Production
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testing and Unified Auditing options


SQL> ALTER SYSTEM SET enable_ddl_logging=TRUE SCOPE=both;


System altered.


SQL> EXIT
$
```

2. The administrator is performing various administration tasks requiring DDL statements. Execute the $HOME/labs/ADR/ddl.sql script.

```
$ sqlplus system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Enter password: ******


Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
64bit
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testing and Unified Auditing options


SQL> @$HOME/labs/ADR/ddl.sql


Table created.
```

```
Table created.

User created.

User dropped.

Table dropped.

Table dropped.

$
```

3. Check the existence of the DDL log file in the ADR directory.

```
$ cd /u01/app/oracle/diag/rdbms/orcl/orcl/log/ddl
$ ls -ltr
total 4
-rw-rw---- 1 oracle oinstall 1516 May 21 05:33 log.xml
$
```

4. Use ADRCI utility to view the content of the DLL log file.
   a. Launch the `adrci` utility and execute the `SHOW LOG` command.

```
$ adrci
ADRCI: Release 12.1.0.2.0 - Production on Wed May 21 05:33:56
2014

Copyright (c) 1982, 2014, Oracle and/or its affiliates.  All
rights reserved.

ADR base = "/u01/app/oracle"
adrci> SHOW LOG
```

b. A vi editor page is displayed.

```
2014-05-21 05:33:06.239000 +00:00
CREATE TABLE scott.test1 (c NUMBER)
2014-05-21 05:33:11.925000 +00:00
CREATE TABLE scott.test2 (c VARCHAR2(10))
2014-05-21 05:33:20.152000 +00:00
DROP USER new_u1 CASCADE
2014-05-21 05:33:23.755000 +00:00
DROP TABLE scott.test2
2014-05-21 05:33:27.236000 +00:00
DROP TABLE scott.test1
~
~
~
~
~
~
~
~
~
~
~
"/tmp/utsout_10361_13987_1.ado" 12L, 387C
```

c. To quit the editor, use the `:q` vi command.

```
:q
ADR Home = /u01/app/oracle/diag/rdbms/orcl/orcl:
*************************************************************
*********
Output the results to file: /tmp/utsout_10361_13987_1.ado
adrci> EXIT
$
```

5. View the content of the DDL log file with a UNIX command.

```
$ more /u01/app/oracle/diag/rdbms/orcl/orcl/log/ddl/log.xml
<msg time='2014-05-21T05:33:06.239+00:00' org_id='oracle'
comp_id='rdbms'
 msg_id='opiexe:4222:2946163730' type='UNKNOWN' group='diag_adl'
 level='16' host_id='EDRSR41P1' host_addr='139.185.35.141'
 version='1'>
 <txt>CREATE TABLE scott.test1 (c NUMBER)
 </txt>
</msg>
<msg time='2014-05-21T05:33:11.925+00:00' org_id='oracle'
comp_id='rdbms'
 msg_id='opiexe:4222:2946163730' type='UNKNOWN' group='diag_adl'
 level='16' host_id='EDRSR41P1' host_addr='139.185.35.141'>
 <txt>CREATE TABLE scott.test2 (c VARCHAR2(10))
 </txt>
</msg>
<msg time='2014-05-21T05:33:20.152+00:00' org_id='oracle'
comp_id='rdbms'
 msg_id='opiexe:4222:2946163730' type='UNKNOWN' group='diag_adl'
 level='16' host_id='EDRSR41P1' host_addr='139.185.35.141'>
 <txt>DROP USER new_u1 CASCADE
 </txt>
</msg>
<msg time='2014-05-21T05:33:23.755+00:00' org_id='oracle'
comp_id='rdbms'
 msg_id='opiexe:4222:2946163730' type='UNKNOWN' group='diag_adl'
 level='16' host_id='EDRSR41P1' host_addr='139.185.35.141'>
 <txt>DROP TABLE scott.test2
 </txt>
</msg>
<msg time='2014-05-21T05:33:27.236+00:00' org_id='oracle'
comp_id='rdbms'
 msg_id='opiexe:4222:2946163730' type='UNKNOWN' group='diag_adl'
 level='16' host_id='EDRSR41P1' host_addr='139.185.35.141'>
 <txt>DROP TABLE scott.test1
 </txt>
</msg>
$
```

Practices for Lesson 17: In-Memory Column Store

Chapter 17

Practices for Lesson 17: Overview

Practices Overview

In the practice for this lesson, you will configure the database instance to use the IM column store and set in-memory attributes on tables so that querying on the in-memory tables show a performance difference.

The performance of queries using the IM column store and those using the buffer cache might not be as spectacular as expected due to the limitations in memory and disk space of the servers.

A demonstration is available to show you how performance of queries on in-memory segments is improved compared to queries using the buffer cache.

Practice 17-1: Configuring IM Column Store

Overview

In this practice, you set up the appropriate initialization parameter to configure IM column store in the `orcl` database instance.

Tasks

1. Make sure you are in the `~/labs/Memory` directory and your environment points to the `orcl` instance.

```
$ cd ~/labs/Memory
$ . oraenv
ORACLE_SID = [orcl] ? orcl
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$
```

2. Run the `Tables_setup.sh` script to create the `SSB` user identified by the `oracle_4U` password, the `LINEORDER`, `SUPPLIER`, and `DATE_DIM` tables and to load the tables. The `LINEORDER` table contains 700000 rows. While the loading is taking place, continue with the next steps in another session.

```
$ ./Tables_setup.sh
…
Commit point reached - logical record count 699974
Commit point reached - logical record count 700000

Table LINEORDER:
  700000 Rows successfully loaded.
…
Commit point reached - logical record count 1984
Commit point reached - logical record count 2000

Table SUPPLIER:
  2000 Rows successfully loaded.
…
Commit point reached - logical record count 2378
Commit point reached - logical record count 2436
Commit point reached - logical record count 2494
Commit point reached - logical record count 2552
Commit point reached - logical record count 2556

Table DATE_DIM:
  2556 Rows successfully loaded.
```

```
Check the log file:
  control_date.log
for more information about the load.
$
```

3. Set the SGA size to 2 Gb and the IM column store to 1500 Mb.

```
$ sqlplus / as sysdba

Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
64bit Production
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testing and Unified Auditing options

SQL> ALTER SYSTEM SET sga_target=2000M SCOPE=spfile;

System altered.

SQL> ALTER SYSTEM SET inmemory_size=1500M SCOPE=spfile;

System altered.

SQL>
```

4. When the `Tables_setup.sh` script has completed, restart the instance.

```
SQL> SHUTDOWN IMMEDIATE
Database closed.
Database dismounted.
ORACLE instance shut down.
SQL> STARTUP
ORACLE instance started.

Total System Global Area   2097152000 bytes
Fixed Size                    2917384 bytes
Variable Size               402656248 bytes
Database Buffers            100663296 bytes
Redo Buffers                 13856768 bytes
In-Memory Area             1577058304 bytes
Database mounted.
Database opened.
SQL>
```

5. Verify the total size of the SGA and the size of the IM column store.

```
SQL> SHOW PARAMETER sga_target

NAME                                 TYPE        VALUE
------------------------------------ ----------- -------------
sga_target                           big integer 2000M
SQL> SHOW PARAMETER inmemory_size
NAME                                 TYPE        VALUE
------------------------------------ ----------- -------------
inmemory_size                        big integer 1504M
SQL> EXIT
$
```

Practice 17-2: Configuring In-Memory Tables

Overview

In this practice, you will assign in-memory attributes on the LINEORDER and SUPPLIER tables.

Tasks

1. Start a new SQL*Plus session under SSB user and check whether the LINEORDER and SUPPLIER tables are in-memory tables.

```
$ sqlplus ssb

Enter password: ******
Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
64bit Production
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testing and Unified Auditing options

SQL> SELECT table_name, inmemory_compression,
            inmemory_priority "PRIORITY", inmemory_distribute
     FROM   user_tables;
  2   3

TABLE_NAME INMEMORY_COMPRESSION PRIORITY INMEMORY_DISTRIBUTE
---------- -------------------- -------- ------------------
DATE_DIM
SUPPLIER
LINEORDER

SQL>
```

2. You decide that the default in-memory compression level of all tables that you will define as in-memory tables is FOR QUERY LOW. By default, the INMEMORY_CLAUSE_DEFAULT initialization parameter is set to an empty value which means INMEMORY MEMCOMPRESS FOR QUERY LOW.

```
SQL> SHOW PARAMETER inmemory_clause_default

NAME                         TYPE   VALUE
---------------------------- ------ ------------------------------
inmemory_clause_default      string
SQL>
SQL> ALTER SYSTEM SET inmemory_clause_default="INMEMORY
MEMCOMPRESS FOR QUERY LOW";

System altered.
```

```
SQL> SHOW PARAMETER inmemory_clause_default

NAME                          TYPE   VALUE
----------------------------- ------ ------------------------------
inmemory_clause_default  string INMEMORY MEMCOMPRESS FOR QUERY
LOW
SQL>
```

3. Set the LINEORDER and SUPPLIER tables as in-memory tables by assigning them the same in-memory compression level of FOR QUERY LOW. Set an in-memory priority of CRITICAL to the LINEORDER table and an in-memory priority of NONE to the SUPPLIER table.
   If you omit to specify the in-memory compression level, the in-memory compression level will be set to the default. If you omit to specify the in-memory priority level, the in-memory priority level will be set to NONE. This means that no automatic population takes place until you query the table.

```
SQL> ALTER TABLE ssb.lineorder INMEMORY;

Table altered.

SQL> SELECT table_name, inmemory_compression,
            inmemory_priority "PRIORITY", inmemory_distribute
     FROM   user_tables;
  2    3

TABLE_NAME INMEMORY_COMPRESSION PRIORITY INMEMORY_DISTRIBUTE
---------- -------------------- -------- -------------------
DATE_DIM
LINEORDER  FOR QUERY LOW         NONE     AUTO
SUPPLIER

SQL> ALTER TABLE ssb.lineorder INMEMORY PRIORITY CRITICAL;

Table altered.

SQL> ALTER TABLE ssb.supplier INMEMORY;

Table altered.

SQL> SELECT table_name, inmemory_compression,
            inmemory_priority "PRIORITY", inmemory_distribute
     FROM   user_tables;
  2    3
```

```
TABLE_NAME INMEMORY_COMPRESSION PRIORITY INMEMORY_DISTRIBUTE
---------- -------------------- -------- -------------------
DATE_DIM
LINEORDER  FOR QUERY LOW        CRITICAL AUTO
SUPPLIER   FOR QUERY LOW        NONE     AUTO

SQL>
```

4. Check now that the data of tables with a priority other than NONE is automatically populated into the IM column store.

```
SQL> SELECT segment_name, bytes, inmemory_size,
            bytes_not_populated
     FROM   v$im_segments;
  2    3
no rows selected

SQL>
```

The result means that the IMCO background process and the workers are not ready to execute the population tasks. The IMCO process wakes up every 2 minutes to tell the SMCO background process to ask the workers to perform the population tasks.

a. Re-execute the query until the BYTES_NOT_POPULATED shows 0. As long as you re-execute the query, you might see the number of bytes populated into the IM column store increasing.

```
SQL> SELECT segment_name, bytes, inmemory_size,
            bytes_not_populated
     FROM   v$im_segments;

SEGMENT_NAME     BYTES INMEMORY_SIZE BYTES_NOT_POPULATED
------------ --------- ------------- -------------------
LINEORDER     83886080      34799616                   0

SQL>
```

b. You can eventually see the workers performing the population.

```
SQL> !pgrep -lf orcl
23218 ora_pmon_orcl
23220 ora_psp0_orcl
…
23278 ora_smco_orcl
23280 ora_w000_orcl
23282 ora_w001_orcl
23284 ora_imco_orcl
…
```

```
26410 ora_w002_orcl
26416 ora_w003_orcl
…
```

```
SQL>
```

5. The SUPPLIER table is not candidate for population yet because the NONE priority requires a manual intervention. Query the table to get it populated into the IM column store.

```
SQL> SELECT COUNT(*) FROM ssb.supplier;

  COUNT(*)
----------
      2000

SQL> SELECT segment_name, bytes, inmemory_size,
            bytes_not_populated
     FROM   v$im_segments;

SEGMENT_NAME     BYTES INMEMORY_SIZE BYTES_NOT_POPULATED
------------ --------- ------------- ------------------
LINEORDER     83886080      34799616                  0
SUPPLIER        327680       1179648                  0

SQL>
```

Now, the SUPPLIER table is populated into the IM column store.

6. Change the in-memory compression level of the LINEORDER table to FOR CAPACITY HIGH and compute the in-memory compression ratio difference.

   What is the current in-memory compression ratio?

```
SQL> SELECT segment_name, bytes Disk, inmemory_size,
            inmemory_compression COMPRESSION,
            bytes / inmemory_size COMP_RATIO
     FROM   v$im_segments;
2    3    4
SEGMENT_NAME     DISK INMEMORY_SIZE COMPRESSION   COMP_RATIO
------------ --------- ------------- ------------- ----------
SUPPLIER       327680       1179648 FOR QUERY LOW  .277777778
LINEORDER     83886080     34799616 FOR QUERY LOW  2.41054614

SQL>
```

The compression ratio says that 2.5 bytes of disk are converted under 1 byte of in-memory column store.

a. Change the in-memory compression level of the LINEORDER table.

```
SQL> ALTER TABLE ssb.lineorder
                 INMEMORY MEMCOMPRESS FOR CAPACITY HIGH
                          PRIORITY CRITICAL;
   2
Table altered.

SQL>
```

b. Check the new in-memory compression level.

```
SQL> SELECT segment_name, bytes Disk, inmemory_size,
            inmemory_compression COMPRESSION,
            bytes / inmemory_size COMP_RATIO
     FROM   v$im_segments;
  2    3    4
SEGMENT_NAME      DISK INMEMORY_SIZE COMPRESSION   COMP_RATIO
------------ --------- ------------- ------------- ----------
SUPPLIER        327680       1179648 FOR QUERY LOW .277777778

SQL>
```

Note that the LINEORDER table is no more in the IM column store. When the in-memory compression level is updated, the information is updated in the data dictionary with the new segment in-memory compression level. The IMCUs data repopulation with the new in-memory compression level takes place only if the segment is re-queried or manually re-populated. When none of these actions is used, the new in-memory compression level is only reflected in NEWLY populated data.

c. Query the table to get it **fully** populated into the IM column store.

```
SQL> SELECT COUNT(*) FROM ssb.lineorder;

  COUNT(*)
----------
    700000

SQL> SELECT segment_name, bytes, inmemory_size,
            bytes_not_populated
     FROM   v$im_segments;
  2    3
SEGMENT_NAME     BYTES INMEMORY_SIZE  BYTES_NOT_POPULATED
------------ --------- ------------- -------------------
SUPPLIER        327680       1179648                   0

SQL> SELECT segment_name, bytes, inmemory_size,
            bytes_not_populated
```

```
     FROM   v$im_segments;
  2    3
SEGMENT_NAME     BYTES INMEMORY_SIZE BYTES_NOT_POPULATED
------------ --------- ------------- -------------------
LINEORDER     83886080      18022400                   0
SUPPLIER        327680       1179648                   0

SQL>
```

d. Compute the new in-memory compression ratio.

```
SQL> SELECT segment_name, bytes Disk, inmemory_size,
            inmemory_compression COMPRESSION,
            bytes / inmemory_size COMP_RATIO
     FROM   v$im_segments;
  2    3    4
SEGMENT_NAME     DISK INMEMORY_SIZE COMPRESSION      COMP_RATIO
------------ -------- ------------- ---------------- ----------
SUPPLIER       327680       1179648 FOR QUERY LOW    .277777778
LINEORDER    83886080      18022400 FOR CAPACITY HIGH 4.65454545

SQL>
```

Note that the compression ratio is better because it now stores 5 bytes of disk for 1 byte of in-memory column store.

Practice 17-3: Querying In-Memory Tables

Overview

In this practice, you will perform queries and see the execution plan difference when you query tables populated into the IM column store or tables cached in the buffer cache only. You will also see the new IM statistics.

Tasks

1. Start another terminal window session that will be in-memory disabled. A user can enable or disable in-memory queries at the session level by using the `INMEMORY_QUERY` parameter to test the performance difference. The default is "`ENABLE`".
   In the practice environment, the performance of queries using the IM column store and those using the buffer cache might not be as spectacular as expected due to the limitations in memory and disk space of the servers. You will focus on the execution plans. Use demonstrations in Practice 17-5 to see performance tests on servers with sufficient disk and memory resources.

```
$ . oraenv
ORACLE_SID = [orcl] ? orcl
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$ sqlplus ssb
Enter password: ******
Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
64bit Production
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testing options and Unified Auditing options
SQL>
```

2. In the second session, set `INMEMORY_QUERY` to "`DISABLE`" to test the execution of the same query against the buffer cache.

```
SQL> ALTER SESSION SET INMEMORY_QUERY="DISABLE";

Session altered.

SQL>
```

3. Run the following query:

```
SQL> SELECT max(lo_ordtotalprice) most_expensive_order
     FROM ssb.lineorder;
  2
MOST_EXPENSIVE_ORDER
--------------------
             50450906
```

```
SQL> SELECT * FROM table(dbms_xplan.display_cursor());

PLAN_TABLE_OUTPUT
------------------------------------------------------------------
SQL_ID    147v17hqr0mvm, child number 0
-------------------------------------
SELECT max(lo_ordtotalprice) most_expensive_order      FROM
ssb.lineorder

Plan hash value: 2267213921
------------------------------------------------------------------
| Id  | Operation       | Name      | Rows  | Bytes | Cost
(%CPU)| Time     |
------------------------------------------------------------------
|   0 | SELECT STATEMENT   |           |       |       |  2744
(100)|          |
|   1 |  SORT AGGREGATE    |           |     1 |    13 |       |
|
|   2 |   TABLE ACCESS FULL| LINEORDER |   666K|  8466K|  2744
(1)| 00:00:01 |
------------------------------------------------------------------

Note
-----
   - dynamic statistics used: dynamic sampling (level=2)


19 rows selected.

SQL>
```

The execution plan shows a traditional `TABLE ACCESS FULL` operation.

4. Back in the first session, show the default value of the `INMEMORY_QUERY` initialization parameter.

```
SQL> SHOW PARAMETER INMEMORY_QUERY

NAME                           TYPE        VALUE
------------------------------ ----------- -------------
inmemory_query                 string      ENABLE
SQL>
```

5. Run the same query:

```
SQL> SELECT max(lo_ordtotalprice) most_expensive_order
     FROM ssb.lineorder;
  2
MOST_EXPENSIVE_ORDER
--------------------
            50450906

SQL> SELECT * FROM table(dbms_xplan.display_cursor());

PLAN_TABLE_OUTPUT
------------------------------------------------------------------------
SQL_ID    147v17hqr0mvm, child number 1
-------------------------------------
SELECT max(lo_ordtotalprice) most_expensive_order      FROM
ssb.lineorder

Plan hash value: 2267213921

-------------------------------------------------------------------------------
| Id  | Operation            | Name    | Rows | Bytes | Cost (%CPU)| Time
     |
-------------------------------------------------------------------------------
|   0 | SELECT STATEMENT     |         |      |       |     4 (100)|     |
|   1 |  SORT AGGREGATE      |         |    1 |    13 |            |     |
|   2 |   TABLE ACCESS INMEMORY FULL| LINEORDER | 666K| 8466K| 4(100)|
00:00:01|
-------------------------------------------------------------------------------

Note
-----
   - dynamic statistics used: dynamic sampling (level=2)


19 rows selected.

SQL>
```

The execution plan shows the new `TABLE ACCESS INMEMORY FULL` operation.

6. View new statistics for IM column store.

   a. Still in the first session, reconnect to reset the session statistics. Then execute a new query.

```
SQL> CONNECT ssb
Enter password: ******
Connected.
SQL> SELECT lo_orderkey, lo_custkey, lo_revenue
     FROM   lineorder
     WHERE  lo_orderkey = 357;
  2    3
LO_ORDERKEY LO_CUSTKEY LO_REVENUE
----------- ---------- ----------
        357      12079     2825606
        357      12079     6360563
        357      12079     5690272

SQL> SELECT display_name, value
     FROM   v$mystat m, v$statname n
     WHERE  m.statistic# = n.statistic#
     AND    display_name IN (
                  'session logical reads - IM',
                  'IM scan rows', 'IM scan rows valid',
                  'IM scan blocks cache',
                  'IM scan CUs columns accessed' );
  2    3    4    5    6    7    8
DISPLAY_NAME                                             VALUE
-------------------------------------------------- ----------
session logical reads- IM                               10097
IM scan CUs columns accessed                                3
IM scan rows                                           700000
IM scan rows valid                                     700000
IM scan blocks cache                                        0

SQL> save stat1
Created file stat1.sql
SQL>
```

Statistics report how the SQL was executed. `'session logical reads - IM'` statistics is the number of blocks scanned in an IMCU. All other statistics show that columns were accessed from the IM Column store. 700000 valid rows were scanned from the IM column store. `'IM scan blocks cache'` shows the number of blocks fetched from disk because they were on the IMCU fetch list. The value of 0 means that all blocks were already populated from disk into the IM column store when the query executed.

```
SQL> SELECT display_name, value
     FROM   v$mystat m, v$statname n
     WHERE  m.statistic# = n.statistic#
     AND    display_name IN (
                  'IM scan segments minmax eligible',
                  'IM scan CUs pruned',
                  'IM scan CUs optimized read',
                  'IM scan CUs predicates optimized');
   2    3    4    5    6    7    8
DISPLAY_NAME                                        VALUE
---------------------------------------- ----------
IM scan CUs predicates optimized                         0
IM scan CUs optimized read                           0
IM scan CUs pruned                                       0
IM scan segments minmax eligible                        1

SQL> save stat2
Created file stat2.sql
SQL>
```

In this example, there are 1 `'IM scan segments minmax eligible'` which means that there is 1 CU that is eligible for minmax pruning. 0 `'IM scan CUs pruned'` means that 0 IMCUs did not contain any rows matching the value of `LO_ORDERKEY` 357. This means that 0 IMCUs were never scanned. 0 of `'IM scan CUs predicates optimized'` means that there were 0 predicates for which no rows pass minmax comparison. Then the CU contained the value of `LO_ORDERKEY` 357.

b. Back in the second “disabled” session, reconnect to reset the session statistics and execute the query.

```
SQL> CONNECT ssb
Enter password: ******
Connected.
SQL> ALTER SESSION SET INMEMORY_QUERY="DISABLE";

Session altered.

SQL> SELECT lo_orderkey, lo_custkey, lo_revenue
     FROM   lineorder
     WHERE  lo_orderkey = 357;
  2    3
```

```
LO_ORDERKEY LO_CUSTKEY LO_REVENUE
----------- ---------- ----------
        357      12079     2825606
        357      12079     6360563
```

```
        357      12079     5690272

SQL> @stat1

DISPLAY_NAME                                             VALUE
-------------------------------------------------- ----------
session logical reads - IM                                  0
IM scan CUs columns accessed                                0
IM scan rows                                                0
IM scan rows valid                                          0
IM scan blocks cache                                        0

SQL>
```

All IM statistics report values of 0 which means that all blocks were read from disk or the buffer cache when the query executed.

```
SQL> @stat2

DISPLAY_NAME                                             VALUE
-------------------------------------------------- ----------
IM scan CUs predicates optimized                            0
IM scan CUs optimized read                                  0
IM scan CUs pruned                                          0
IM scan segments minmax eligible                            0
```

```
SQL> EXIT
$
```

7. Back into the enabled in-memory session, you will query an in-memory table and a non in-memory table and then display the execution plan.

   a. View the in-memory attributes of the tables.

```
SQL> SELECT table_name, inmemory_compression,
            inmemory_priority
     FROM   user_tables;
  2    3
TABLE_NAME INMEMORY_COMPRESSION INMEMORY_PRIORITY
---------- -------------------- -----------------
DATE_DIM
LINEORDER  FOR CAPACITY HIGH     CRITICAL
SUPPLIER   FOR QUERY LOW         NONE

SQL>
```

   b. Execute the `$HOME/labs/Memory/query1.sql` script to select data from the in-memory `LINEORDER` table and the non in-memory `DATE_DIM` table.

```
SQL> @query1

   REVENUE
----------
5397325863

SQL>
```

   c. Display the execution plan.

```
SQL> SELECT * FROM table(dbms_xplan.display_cursor());

PLAN_TABLE_OUTPUT
------------------------------------------------------------------------
SQL_ID    g8w8ztujuzg2x, child number 0
-------------------------------------
SELECT SUM(lo_extendedprice * lo_discount) revenue    FROM
lineorder l, date_dim d      WHERE  l.lo_orderdate=d.d_datekey
AND   d.d_date='December 24, 1996'

Plan hash value: 2403472142

-----------------------------------------------------------------
| Id  | Operation             | Name    | Rows  | Bytes | Cost (%CPU)| Time
|
-----------------------------------------------------------------
|   0 | SELECT STATEMENT      |         |       |       |    15 (100)|      |
|   1 |  SORT AGGREGATE       |         |     1 |    72 |            |      |
```

```
|*  2 |   HASH JOIN                |          |   757 | 54504 |  15  (14)| 00:00:01
|
|   3 |    JOIN FILTER CREATE      | :BF0000  |1 |    33 |   13   (0)| 00:00:01
|
|*  4 |     TABLE ACCESS FULL      | DATE_DIM |1 |    33 |   13   (0)| 00:00:01
|
|   5 |    JOIN FILTER USE         | :BF0000  | 666K|  24M|           |       |
|*  6 |     TABLE ACCESS INMEMORY FULL| LINEORDER |   666K|    24M|  |    |
```

```
---------------------------------------------------------

Predicate Information (identified by operation id):
---------------------------------------------------

 2 - access("L"."LO_ORDERDATE"="D"."D_DATEKEY")
 4 - filter("D"."D_DATE"='December 24, 1996')
 6 - inmemory(SYS_OP_BLOOM_FILTER(:BF0000,"L"."LO_ORDERDATE"))
       filter(SYS_OP_BLOOM_FILTER(:BF0000,"L"."LO_ORDERDATE"))

Note
-----
   - dynamic statistics used: dynamic sampling (level=2)

32 rows selected.

SQL> EXIT
$
```

The optimizer chooses to work both with the buffer cache AND the IM column store in different portions of the plan.

When the tables are joined via a hash join, the DATE_DIM table is scanned first from the buffer cache. The rows that satisfy the WHERE clause predicate for the D_DATE are used to create a hash table. During the hash table creation, a bloom filter is created based on the D_DATEKEY join column. The bloom filter is then sent as an additional predicate to the LINEORDER table scan. The table is scanned in IM column store. The resulting rows have their join column LO_ORDERDATE hashed and it is compared to D_DATEKEY values in the bloom filter. If a match is found in the bloom filter, that row is sent to the hash join. If no match is found then the row is disregarded.

Practice 17-4: Exporting and Importing In-Memory Tables (*Optional*)

Overview

In this practice, you export and import an in-memory table.

Tasks

1. Use Oracle Data Pump to export the `SUPPLIER` table. Execute the `$HOME/labs/Memory/supp.sql` script to display the in-memory attributes of the `SUPPLIER` table.

```
$ sqlplus ssb

Enter password: ******

Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
64bit Production
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testing and Unified Auditing options

SQL> @$HOME/labs/Memory/supp.sql

TABLE_NAME INMEMORY_COMPRESSION PRIORITY In RAC
---------- -------------------- -------- ---------------
SUPPLIER   FOR QUERY LOW        NONE      AUTO

SQL>
```

2. In another terminal window that we name Session 2, export the in-memory table.

```
$ . oraenv
ORACLE_SID = [orcl] ? orcl
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$ rm /u01/app/oracle/admin/orcl/dpdump/supp_exp.dmp
rm: cannot remove
`/u01/app/oracle/admin/orcl/dpdump/supp_exp.dmp': No such file
or directory
$ expdp ssb dumpfile=supp_exp tables=supplier

Password: ******

Connected to: Oracle Database 12c Enterprise Edition Release
12.1.0.2.0 - 64bit Production
```

```
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testingand Unified Auditing options
Starting "SSB"."SYS_EXPORT_TABLE_01":  ssb/********
dumpfile=supp_exp tables=supplier
Estimate in progress using BLOCKS method...
Processing object type TABLE_EXPORT/TABLE/TABLE_DATA
Total estimation using BLOCKS method: 320 KB
Processing object type TABLE_EXPORT/TABLE/TABLE
Processing object type
TABLE_EXPORT/TABLE/STATISTICS/TABLE_STATISTICS
Processing object type TABLE_EXPORT/TABLE/STATISTICS/MARKER
. . exported "SSB"."SUPPLIER"            214.6 KB    2000 rows
Master table "SSB"."SYS_EXPORT_TABLE_01" successfully
loaded/unloaded
******************************************************************
Dump file set for SSB.SYS_EXPORT_TABLE_01 is:
  /u01/app/oracle/admin/orcl/dpdump/supp_exp.dmp
Job "SSB"."SYS_EXPORT_TABLE_01" successfully completed at Wed
May 21 05:59:44 2014 elapsed 0 00:00:19


$
```

3. From Session 1, drop the table and verify that the table is re-created as an in-memory table with its original attributes.

```
SQL> DROP TABLE supplier PURGE;


Table dropped.


SQL>
```

4. From Session 2, import the table.

```
$ impdp ssb dumpfile=supp_exp.dmp TRANSFORM=INMEMORY:Y


Password: ******


Master table "SSB"."SYS_IMPORT_FULL_01" successfully
loaded/unloaded
Starting "SSB"."SYS_IMPORT_FULL_01":  ssb/********
dumpfile=supp_exp.dmp TRANSFORM=INMEMORY:Y
Processing object type TABLE_EXPORT/TABLE/TABLE
Processing object type TABLE_EXPORT/TABLE/TABLE_DATA
. . imported "SSB"."SUPPLIER"            214.6 KB    2000 rows
Processing object type
TABLE_EXPORT/TABLE/STATISTICS/TABLE_STATISTICS
Processing object type TABLE_EXPORT/TABLE/STATISTICS/MARKER
```

```
Job "SSB"."SYS_IMPORT_FULL_01" successfully completed at Wed May
21 06:00:44 2014 elapsed 0 00:00:22


$
```

5. From Session 1, verify that it is re-created as an in-memory table.

```
SQL> @$HOME/labs/Memory/supp.sql
```

```
TABLE_NAME INMEMORY_COMPRESSION PRIORITY In RAC
---------- -------------------- -------- ---------------
SUPPLIER   FOR QUERY LOW        NONE     AUTO


SQL>
```

The value Y in the `INMEMORY` transform name is the default. Thus, it was not necessary to mention it in the import command.

6. Still from Session 1, drop the table.

```
SQL> DROP TABLE supplier PURGE;

Table dropped.


SQL>
```

7. From Session 2, import the table.

```
$ impdp ssb dumpfile=supp_exp.dmp TRANSFORM=INMEMORY:N

Password: ******

Master table "SSB"."SYS_IMPORT_FULL_01" successfully
loaded/unloaded
Starting "SSB"."SYS_IMPORT_FULL_01":  ssb/********
dumpfile=supp_exp.dmp TRANSFORM=INMEMORY:N
Processing object type TABLE_EXPORT/TABLE/TABLE
Processing object type TABLE_EXPORT/TABLE/TABLE_DATA
. . imported "SSB"."SUPPLIER"            214.6 KB    2000 rows
Processing object type
TABLE_EXPORT/TABLE/STATISTICS/TABLE_STATISTICS
Processing object type TABLE_EXPORT/TABLE/STATISTICS/MARKER
Job "SSB"."SYS_IMPORT_FULL_01" successfully completed at Wed May
21 06:01:38 2014 elapsed 0 00:00:18


$
```

8. From Session 1, verify that it is re-created as a non in-memory table.

```
SQL> @$HOME/labs/Memory/supp.sql

TABLE_NAME INMEMORY_COMPRESSION PRIORITY In RAC
---------- -------------------- -------- ---------------
SUPPLIER   FOR CAPACITY LOW     NONE     AUTO

SQL>
```

Why the table is still an in-memory table but with different in-memory attributes, like the in-memory compression?
The table inherited the in-memory attributes of the tablespace it is stored in. Check the tablespace default in-memory attributes.

```
SQL> COL tablespace_name FORMAT A15
SQL> SELECT tablespace_name, DEF_INMEMORY_PRIORITY,
            DEF_INMEMORY_COMPRESSION, DEF_INMEMORY_DISTRIBUTE
     FROM   DBA_TABLESPACES
     WHERE  tablespace_name = 'EXAMPLE';
  2    3    4
TABLESPACE_NAME DEF_INMEMORY_PRIORITY DEF_INMEMORY_COMPRESSION
--------------- --------------------- ------------------------
DEF_INMEMORY_DISTRIBUTE
-------------------------
EXAMPLE         NONE                  FOR CAPACITY LOW
AUTO

SQL>
```

9. Still from Session 1, drop the table.

```
SQL> DROP TABLE supplier PURGE;

Table dropped.

SQL>
```

10. From Session 2, import the table by using another transform name.

```
$ impdp ssb dumpfile=supp_exp.dmp TRANSFORM=INMEMORY_CLAUSE:\"NO
INMEMORY\"

Password: ******
Master table "SSB"."SYS_IMPORT_FULL_01" successfully
loaded/unloaded
Starting "SSB"."SYS_IMPORT_FULL_01":  ssb/********
dumpfile=supp_exp.dmp TRANSFORM=INMEMORY_CLAUSE:"NO INMEMORY"
Processing object type TABLE_EXPORT/TABLE/TABLE
Processing object type TABLE_EXPORT/TABLE/TABLE_DATA
. . imported "SSB"."SUPPLIER"                                214.6
KB    2000 rows
Processing object type
TABLE_EXPORT/TABLE/STATISTICS/TABLE_STATISTICS
Processing object type TABLE_EXPORT/TABLE/STATISTICS/MARKER
Job "SSB"."SYS_IMPORT_FULL_01" successfully completed at Wed May
21 06:11:56 2014 elapsed 0 00:00:18

$
```

a. From Session 1, verify that it is re-created as a non in-memory table.

```
SQL> @$HOME/labs/Memory/supp.sql

TABLE_NAME INMEMORY_COMPRESSION PRIORITY In RAC
---------- -------------------- -------- ---------------
SUPPLIER

SQL> EXIT
$
```

Lesson 17-5: Using In-Memory Column Store (*Demonstration*)

Overview

In this practice you can use a browser to view two of the seven In-Memory Column Store demonstrations, available under Oracle Learning Library (OLL).

If you want to hear the explanations that accompany the demos, go to OLL.

The IMCS_columns demonstration shows how columns are handled in in-memory objects in the IM column store. Columns can be defined as non in-memory in an in-memory table.

The IMCS_Queries demonstration illustrates how queries on in-memory objects and columns data populated within the IM column store execute. It also shows how fast the queries execute against the IM column store compared to the buffer cache.

Tasks

1. Launch a browser and enter: file:///home/oracle/demos/IMCS_columns/IMCS_columns_player.html.
2. Launch a browser and enter: file:///home/oracle/demos/IMCS_Queries/IMCS_Queries_player.html.

Practices for Lesson 18: In-Memory Caching

Chapter 18

Practices for Lesson 18: Overview

Practices Overview

This practice covers the Full Database In-Memory Caching and Automatic Big Table Caching features in Oracle Database 12*c* PS1 (12.1.0.2).

Practice 18-1: Using Automatic Big Table Caching

Overview

In this practice, you will configure the optional section of the buffer cache, called the automatic big table cache, and monitor the space used in the automatic big table cache by large tables. For ease of reading, Automatic Big Table Caching will be ABTC.

Tasks

1. Before starting the practice, reset the instance memory cache sizes.

```
$ cd ~/labs/Memory
$ . oraenv
ORACLE_SID = [orcl] ? orcl
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$ ./ABTC_setup.sh
Database closed.
Database dismounted.
ORACLE instance shut down.
ORACLE instance started.

Total System Global Area 1048576000 bytes
Fixed Size                  2922312 bytes
Variable Size             499123320 bytes
Database Buffers          541065216 bytes
Redo Buffers                5464064 bytes
Database mounted.
Database opened.
DROP USER abt CASCADE
          *
ERROR at line 1:
ORA-01918: user 'ABT' does not exist


$
```

2. Show the sizes of the caches.

```
$ sqlplus / AS SYSDBA


Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
64bit Production
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testing and Unified Auditing options
```

```
SQL> SHOW PARAMETER sga_

NAME                                 TYPE        VALUE
------------------------------------ ----------- -------------
sga_max_size                         big integer 1000M
sga_target                           big integer 844M
unified_audit_sga_queue_size         integer     1048576
SQL> SHOW PARAMETER db_cache_size

NAME                                 TYPE        VALUE
------------------------------------ ----------- -------------
db_cache_size                        big integer 200M
SQL>
```

3. Ensure that Force Full Database Caching is disabled. Force Full Database Caching is not compatible with ABTC.

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

FOR
---
NO

SQL>
```

4. Configure ABTC.
   a. Set the automatic DOP policy to true.

```
SQL> SHOW PARAMETER PARALLEL_DEGREE_POLICY

NAME                                 TYPE        VALUE
------------------------------------ ----------- -------------
parallel_degree_policy               string      MANUAL
SQL> ALTER SYSTEM SET PARALLEL_DEGREE_POLICY=AUTO SCOPE=BOTH;

System altered.

SQL>
```

   b. Set the ABTC to 40% of the buffer cache

```
SQL> SHOW PARAMETER DB_BIG_TABLE_CACHE_PERCENT_TARGET

NAME                                 TYPE        VALUE
------------------------------------ ----------- -------------
db_big_table_cache_percent_target    string      0
```

```
SQL> ALTER SYSTEM SET DB_BIG_TABLE_CACHE_PERCENT_TARGET=40
SCOPE=BOTH;

System altered.

SQL>
```

5. Run the `Query_tables.sql` script. The script connects under `ABT` user and performs a series of `SELECT` statements on small tables.

```
SQL> @Query_tables
Connected.

  COUNT(*)
----------
        83


  COUNT(*)
----------
        27


  COUNT(*)
----------
        10


  COUNT(*)
----------
        19


  COUNT(*)
----------
        23


  COUNT(*)
----------
         4


  COUNT(*)
```

```
----------
        25

SQL>
```

6. Display the list of objects loaded into the tables loaded into the ABTC.

```
SQL> SELECT bt_cache_alloc, object_count, memory_buf_alloc
     FROM  V$BT_SCAN_CACHE ;
  2
BT_CACHE_ALLOC OBJECT_COUNT MEMORY_BUF_ALLOC
-------------- ------------ ----------------
             .4            0                0

SQL>
```

Observe that no objects are loaded into the ABTC.
`.4` represents the current ratio of the Big Table cache section to the buffer cache when the target ratio is 40.

7. Query a large table in parallel mode.

```
SQL> SELECT /*+ full(LINEORDER) parallel(LINEORDER) */
            count(*)
     FROM SSB.LINEORDER;
  2   3
  COUNT(*)
----------
    700000

SQL>
```

8. Display if the large object is loaded into the ABTC.

```
SQL> SELECT bt_cache_alloc, object_count, memory_buf_alloc
     FROM  V$BT_SCAN_CACHE ;
  2
BT_CACHE_ALLOC OBJECT_COUNT MEMORY_BUF_ALLOC
-------------- ------------ ----------------
             .4            1            10097

SQL>
```

Observe that the object is loaded into the ABTC. `9633` is the number of memory buffers allocated by the ABTC section to objects.

```
SQL> SELECT object_name, size_in_blks, temperature, policy,
            cached_in_mem
     FROM   V$BT_SCAN_OBJ_TEMPS v, dba_objects o
     WHERE  v.dataobj# = o.data_object_id;
```

```
  2   3   4
OBJECT_NAME  SIZE_IN_BLKS TEMPERATURE POLICY    CACHED_IN_MEM
------------ ------------ ----------- ---------- -------------
LINEORDER            9633        3000 MEM_ONLY            9633

SQL> save s1
Created file s1.sql
SQL>
```

Notice the MEM_ONLY policy value. This means that the large table is fully loaded in the ABTC. This is also the reason why the size of the object being scanned on this instance, in blocks is equal to the number of blocks that are cached/allocated in memory for this object.

9. Now, reselect the large table. The performance of query against the ABTC might not be as spectacular as expected due to the limitations in memory and disk space of the servers. Verify that its temperature increases.

```
SQL> SELECT /*+ full(LINEORDER) parallel(LINEORDER) */
            count(*)
     FROM SSB.LINEORDER;
   2   3
  COUNT(*)
----------
    700000

SQL> @s1

OBJECT_NAME  SIZE_IN_BLKS TEMPERATURE POLICY     CACHED_IN_MEM
------------ ------------ ----------- ---------- -------------
LINEORDER            9633        6000 MEM_ONLY            9633

SQL>
```

10. Create another big table. Query the new table and check if the new table is loaded into the ABTC.

```
SQL> DROP TABLE ABT.LINEORDER2;
DROP TABLE ABT.LINEORDER2
               *
ERROR at line 1:
ORA-00942: table or view does not exist

SQL> CREATE TABLE LINEORDER2 as select * from SSB.LINEORDER;

Table created.

SQL> SELECT /*+ full(LINEORDER2) parallel(LINEORDER2) */
```

```
            count(*)
     FROM ABT.LINEORDER2;
  2    3
  COUNT(*)
----------
    700000

SQL> SELECT bt_cache_alloc, object_count, memory_buf_alloc
     FROM  V$BT_SCAN_CACHE ;
  2
BT_CACHE_ALLOC OBJECT_COUNT MEMORY_BUF_ALLOC
-------------- ------------ ----------------
            .4            2            19712

SQL>
```

Note that the table is loaded into the ABTC and that the number of memory buffers allocated by the ABTC section to objects has increased.

```
SQL> SELECT object_name, size_in_blks, temperature, policy,
            cached_in_mem
     FROM   V$BT_SCAN_OBJ_TEMPS v, dba_objects o
     WHERE  v.dataobj# = o.data_object_id
     ORDER BY 1;
  2    3    4
OBJECT_NAME  SIZE_IN_BLKS TEMPERATURE POLICY     CACHED_IN_MEM
------------ ------------ ----------- ---------- -------------
LINEORDER           10097        8000 MEM_ONLY            10097
LINEORDER2           9615        1000 MEM_ONLY             9615

SQL> save s2
Created file s2.sql
SQL>
```

11. Execute `$HOME/labs/Memory/l3.sql` to create another big table and query the data.

```
SQL> @$HOME/labs/Memory/l3.sql

Table created.

700000 rows created.

1400000 rows created.

Commit complete.
```

```
SQL> SELECT /*+ full(LINEORDER3) parallel(LINEORDER3) */
            count(*)
     FROM ABT.LINEORDER3;
  2    3
  COUNT(*)
----------
   2800000

SQL> SELECT bt_cache_alloc, object_count, memory_buf_alloc
     FROM  V$BT_SCAN_CACHE ;
  2
BT_CACHE_ALLOC OBJECT_COUNT MEMORY_BUF_ALLOC
-------------- ------------ ----------------
    .400027579            3            29010

SQL>
SQL> @s2

OBJECT_NAME  SIZE_IN_BLKS TEMPERATURE POLICY     CACHED_IN_MEM
------------ ------------ ----------- ---------- -------------
LINEORDER           10097       10000 MEM_ONLY            10097
LINEORDER2           9615        1000 DISK                 9155
LINEORDER3          38417        3000 MEM_PART            18911

SQL>
```

The LINEORDER3 table is only partially cached in memory and some portion remains on disk. The table cannot be fully cached because the ABTC is full. The sum of the blocks of the three tables is 58129 whereas the number of memory buffers allocated by the ABTC section to objects is 29010. The LINEORDER2 table has been evicted due to a low temperature.

12. Increase the big table cache percent to 60.

```
SQL> ALTER SYSTEM SET DB_BIG_TABLE_CACHE_PERCENT_TARGET=60;

System altered.

SQL>
```

13. Reselect data from the new table.

```
SQL> SELECT /*+ full(LINEORDER3) parallel(LINEORDER3) */
            count(*)
     FROM ABT.LINEORDER3;
  2    3
  COUNT(*)
----------
   2800000

SQL> SELECT bt_cache_alloc, object_count, memory_buf_alloc
     FROM  V$BT_SCAN_CACHE ;
  2
BT_CACHE_ALLOC OBJECT_COUNT MEMORY_BUF_ALLOC
-------------- ------------ ----------------
    .531867071            3            34012

SQL>
```

The number of memory buffers allocated by the ABTC section to objects has increased (34012) but is still insufficient to load the three tables.

```
SQL> @s2

OBJECT_NAME  SIZE_IN_BLKS TEMPERATURE POLICY      CACHED_IN_MEM
------------ ------------ ----------- ---------- -------------
LINEORDER           10097       10000 MEM_ONLY           10097
LINEORDER2           9615        1000 DISK                9155
LINEORDER3          38417        4000 MEM_ONLY           38417

SQL>
```

Now the LINEORDER3 table is now fully cached in memory.

Why the LINEORDER3 table is now fully cached whereas the LINEORDER2 table is no more in the ABTC? When space is required in the big table cache, according to the temperature of the objects, some objects free the space to hotter objects. The LINEORDER2 table is fully replaced by the LINEORDER3 object which has a higher temperature.

14. Increase the buffer cache.

```
SQL> ALTER SYSTEM SET DB_CACHE_SIZE=250M;

System altered.

SQL>
```

15. Reselect data from the LINEORDER2 table.

```
SQL> SELECT /*+ full(LINEORDER2) parallel(LINEORDER2) */
            count(*)
     FROM ABT.LINEORDER2;
  2    3

  COUNT(*)
----------
    700000

SQL> SELECT bt_cache_alloc, object_count, memory_buf_alloc
     FROM  V$BT_SCAN_CACHE ;
  2
BT_CACHE_ALLOC OBJECT_COUNT MEMORY_BUF_ALLOC
-------------- ------------ ----------------
    .53892927            3            34472

SQL>
```

Notice that 34472 memory buffers allocated by the ABTC cache section to objects will not be sufficient because the three tables require 58129 memory buffers.

```
SQL> @s2

OBJECT_NAME  SIZE_IN_BLKS TEMPERATURE POLICY     CACHED_IN_MEM
------------ ------------ ----------- ---------- -------------
LINEORDER           10097       10000 MEM_ONLY           10097
LINEORDER2           9615        2000 MEM_ONLY            9615
LINEORDER3          38417        4000 MEM_ONLY           38417

SQL> EXIT
$
```

Practice 18-2: Setting and Monitoring Force Full Database Caching

Overview

In this practice, you will use configure and monitor the Force Full Database Caching feature.

Tasks

1. Verify that the space used by application data is less than 80% of the instance buffer cache. It would be useless to set the database to Force Full Database Caching if the buffer cache is not large enough to satisfy the requirements of the Force Full Database Caching feature.

   a. If you have performed the previous practice on In-Memory Column Store or the ABTC, execute the script to cleanup SSB and ABT users, reset the IM column store to 0 byte and the ABTC to 0%.

```
$ cd ~/labs/Memory
$ . oraenv
ORACLE_SID = [orcl] ? orcl
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$ ./SSB_cleanup.sh
Database closed.
Database dismounted.
ORACLE instance shut down.
ORACLE instance started.


Total System Global Area  884998144 bytes
Fixed Size                  2920440 bytes
Variable Size             335544328 bytes
Database Buffers          541065216 bytes
Redo Buffers                5468160 bytes
Database mounted.
Database opened.
$
```

   b. Connect to the `orcl` instance.

```
$ sqlplus / as sysdba


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SQL>
```

c. Display the space used by application data, SYSTEM data and UNDO data.

```
SQL> SELECT distinct tablespace_name FROM dba_segments;

TABLESPACE_NAME
------------------------------
UNDOTBS1
SYSAUX
USERS
SYSTEM
EXAMPLE

SQL> SELECT sum(bytes) SPACE_USED FROM dba_segments
     WHERE  tablespace_name <> 'SYSAUX';
  2
SPACE_USED
----------
2194735104

SQL>
```

d. Display the current size of the buffer cache.

```
SQL> SELECT sum(CNUM_SET * BLK_SIZE) CURRENT_CACHE_SIZE
     FROM   x$kcbwds;
  2
CURRENT_CACHE_SIZE
------------------
         483409920

SQL>
```

e. Is SPACE_USED less than 80% of the instance buffer cache?

```
SQL> SELECT (483409920* 80 / 100) AS "80_OF_BUF" FROM dual;

 80_OF_BUF
----------
 386727936

SQL>
```

No, 2194735104 bytes (application and system storage size) is much more than 386727936 bytes (80% of the buffer cache).

2. Increase the SGA_TARGET to enable Force Full Database Caching.

```
SQL> ALTER SYSTEM SET sga_target = 3000M scope=spfile;

System altered.
```

```
SQL> SHUTDOWN IMMEDIATE
Database closed.
Database dismounted.
ORACLE instance shut down.
SQL>
```

3. Configure the database for Force Full Database Caching usage.

   a. Restart the database instance in mount mode.

```
SQL> STARTUP MOUNT
ORACLE instance started.

Total System Global Area 3154116608 bytes
Fixed Size                  2919328 bytes
Variable Size             402654304 bytes
Database Buffers         2734686208 bytes
Redo Buffers               13856768 bytes
Database mounted.
SQL>
```

   b. Set the database in Force Full Database Caching mode.

```
SQL> ALTER DATABASE FORCE FULL DATABASE CACHING;

Database altered.

SQL> ALTER DATABASE OPEN;

Database altered.

SQL>
```

   c. Verify that the database is in Force Full Database Caching mode.

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

FOR
---
YES

SQL>
```

   d. Check the current buffer cache size.

```
SQL> SELECT sum(CNUM_SET*BLK_SIZE) CURRENT_CACHE_SIZE
     FROM   x$kcbwds;
  2
CURRENT_CACHE_SIZE
```

```
------------------
         2610413568


SQL>
```

e. Is the space used less than 80% of the instance buffer cache?

```
SQL> SELECT (2610413568 * 80 / 100) AS "80_OF_BUF" FROM dual;

  80_OF_BUF
-----------
 2088330854

SQL> EXIT
$
```

Now, 2194735104 (application and system storage size) is not far from 80% of the buffer cache (2088330854).

4. Verify that the buffer cache is now large enough to be able to load the data from disk. Monitor the Force Full Database Caching.

   a. Display the `'db block gets from cache'`, `'consistent gets from cache'` and `'physical reads cache'` statistics.
      - The `'db block gets from cache'` tells the number of times a CURRENT block was requested from the buffer cache.
      - The `'consistent gets from cache'` relates the number of times a consistent read was requested for a block from the buffer cache
      - The `'physical reads cache'` displays the total number of data blocks read from disk into buffer cache.

```
SQL> SELECT name, value FROM V$SYSSTAT
     WHERE name IN ('db block gets from cache',
                    'consistent gets from cache',
                    'physical reads cache');
2    3    4

NAME                                             VALUE
---------------------------------------- ----------
db block gets from cache                          3033
consistent gets from cache                     1785583
physical reads cache                             13112

SQL> save s3
Created file s3.sql
SQL>
```

b. Run queries on all application tables.

```
SQL> @list_tab
…
  COUNT(*)
----------
         72


  COUNT(*)
----------
      1826

 …


  COUNT(*)
----------
          8

SQL>
```

c. Then check the `'physical reads cache'` statistics and calculate the buffer cache hit ratio:

```
1 - ('physical reads cache' / ('consistent gets from cache' +
'db block gets from cache'))
```

```
SQL> @s3

NAME                                                  VALUE
---------------------------------------------- ----------
db block gets from cache                            3595
consistent gets from cache                       1868971
physical reads cache                               20209

SQL> SELECT 1 - (20209 / (1868971 + 3595)) Hit FROM dual;

       HIT
----------
.989207857

SQL>
```

5. After re-executing the same queries, observe if the `'physical reads cache'` remains stable. All data is in the buffer cache and the buffer cache hit ratio remains excellent.

```
SQL> @list_tab
…
  COUNT(*)
----------
         72


  COUNT(*)
----------
      1826

 …


  COUNT(*)
----------
         8

SQL>
SQL> @s3

NAME                                          VALUE
---------------------------------------- ----------
db block gets from cache                        3601
consistent gets from cache                   1934530
physical reads cache                           20210

SQL> SELECT 1 - (20210 / (1934530 + 3601)) Hit FROM dual;

       HIT
----------
.989572428

SQL> EXIT
$
```

Regularly verify that the hit ratio remains stable. If the hit ratio decreases, check if the disk data has not increased. In this case, reconsider the buffer cache size.

Practices for Lesson 19: SQL Tuning Enhancements

Chapter 19

Practices for Lesson 19: Overview

Practices Overview

This practice covers the dynamic plans part of the Adaptive Execution Plans feature in Oracle Database 12*c*.

Practice 19-1: Using Dynamic Plans

Overview

In this practice, you will use the dynamic plans part of the Adaptive Execution Plans feature.

Tasks

1. Make sure you are in the `~/labs/Tuning` directory.

```
$ cd ~/labs/Tuning
$
```

2. After having configured the database instance for In-Memory Caching new features, reset the database instance without ABTC or Force Full DB caching.

```
$ . oraenv
ORACLE_SID = [orcl] ? orcl
The Oracle base remains unchanged with value /u01/app/oracle
$ sqlplus / as sysdba

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SQL> SHUTDOWN IMMEDIATE
Database closed.
Database dismounted.
ORACLE instance shut down.
SQL> STARTUP MOUNT
ORACLE instance started.

Total System Global Area 3154116608 bytes
Fixed Size                  2919328 bytes
Variable Size             771753056 bytes
Database Buffers         2365587456 bytes
Redo Buffers               13856768 bytes
Database mounted.
SQL> ALTER DATABASE NO FORCE FULL DATABASE CACHING;

Database altered.

SQL> ALTER SYSTEM SET db_big_table_cache_percent_target=0
SCOPE=BOTH;

System altered.
```

```
SQL> ALTER DATABASE OPEN;

Database altered.

SQL> SELECT force_full_db_caching FROM V$DATABASE;

FOR
---
NO

SQL> SHOW PARAMETER db_big_table_cache_percent_target
NAME                                 TYPE         VALUE
------------------------------------ ----------- -------------
db_big_table_cache_percent_target    string      0
SQL> EXIT
$
```

3. Use the `Tuning_setup.sh` script to create the `OE1` and `SH1` accounts in `ORCL` database, grant them the `SELECT ANY DICTIONARY` privilege and finally create `OE1` and `SH1` tables.

```
$ ./Tuning_setup.sh

SQL*Plus: Release 12.1.0.2.0 Production on Thu May 22 05:44:10
2014

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64bit Production
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Application Testing and Unified Auditing options


SQL> SQL> SQL> SQL> SQL> SQL> SQL> SQL> SQL> SQL> SQL> SQL>
SQL> SQL> SQL> SQL> SQL> SQL> Connected.
SQL>   2  SQL> Connected.
SQL> SQL> SQL> Disconnected from Oracle Database 12c Enterprise
Edition Release 12.1.0.2.0 - 64bit Production
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testing and Unified Auditing options
$
```

4. From the same SQL*Plus session, connect as user `OE1` and use the `$HOME/labs/Tuning/explain1.sql` script to show the execution plan of the following query without executing it:

```
select /*+ monitor*/ product_name
from   order_items o, product_information p
where  o.unit_price = 15
  and  quantity > 1
  and  p.product_id = o.product_id;
```

```
$ sqlplus oe1
Enter password: ******

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Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
64bit Production
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testing and Unified Auditing options
SQL>
SQL> @explain1

Explained.

SQL> set pages 100
SQL> set lines 300
SQL> select * from table(dbms_xplan.display());

PLAN_TABLE_OUTPUT
------------------------------------------------------------------------
Plan hash value: 1255158658
------------------------------------------------------------------------
| Id  | Operation                    | Name              | Rows  | Bytes |
Cost (%CPU)| Time     |
------------------------------------------------------------------------
|   0 | SELECT STATEMENT             |                   |     4 |   128 |     7
     (0)| 00:00:01 |
|   1 |  NESTED LOOPS                |                   |     4 |   128 |
7    (0)| 00:00:01 |
|   2 |   NESTED LOOPS               |                   |     4 |   128 |
7    (0)| 00:00:01 |
|*  3 |    TABLE ACCESS FULL         | ORDER_ITEMS       |     4 |    48 |
3    (0)| 00:00:01 |
|*  4 |    INDEX UNIQUE SCAN         | PRODUCT_INFORMATION_PK |     1 |
|     0     (0)| 00:00:01 |
|   5 |   TABLE ACCESS BY INDEX ROWID| PRODUCT_INFORMATION    |     1 |    20
|     1     (0)| 00:00:01 |
------------------------------------------------------------------------
```

```
Predicate Information (identified by operation id):
---------------------------------------------------

   3 - filter("O"."UNIT_PRICE"=15 AND "QUANTITY">1)
   4 - access("P"."PRODUCT_ID"="O"."PRODUCT_ID")

Note
-----
   - this is an adaptive plan

22 rows selected.

SQL>
```

5. What do you observe?
   The plan is using a simple NESTED LOOP join.

6. Now, execute the `$HOME/labs/Tuning/sel1.sql` to execute the same query:

```
SQL> @sel1

PRODUCT_NAME
--------------------------------------------------
Screws <B.28.S>
Screws <B.28.S>
Screws <B.28.S>
Screws <B.28.S>
…
Screws <B.28.S>
Screws <B.28.S>

52 rows selected.

SQL>
```

7. Show the resulting execution plan:

```
SQL> select * from table(dbms_xplan.display_cursor());
```

```
PLAN_TABLE_OUTPUT
------------------------------------------------------------------
SQL_ID    1h1hsr7dvauan, child number 0
-------------------------------------
select /*+ monitor*/ product_name      from   order_items o,
product_information p        where  o.unit_price = 15 and
quantity
> 1   and  p.product_id = o.product_id
```

```
Plan hash value: 1553478007
-------------------------------------------------------------------------
| Id  | Operation          | Name                | Rows  | Bytes | Cost
(%CPU)| Time       |
-------------------------------------------------------------------------
|   0 | SELECT STATEMENT   |                     |       |       |     7
(100)|       |
|*  1 |  HASH JOIN         |                     |     4 |   128 |     7
(0)| 00:00:01
|*  2 |   TABLE ACCESS FULL| ORDER_ITEMS         |     4 |    48 |     3
(0)| 00:00:01 |
|   3 |   TABLE ACCESS FULL| PRODUCT_INFORMATION |     1 |    20 |     1
(0)| 00:00:01 |
-------------------------------------------------------------------------
Predicate Information (identified by operation id):
---------------------------------------------------


   1 - access("P"."PRODUCT_ID"="O"."PRODUCT_ID")
   2 - filter(("O"."UNIT_PRICE"=15 AND "QUANTITY">1))

Note
-----
   - this is an adaptive plan


27 rows selected.

SQL>
```

8. What do you observe and conclude?
   The actual plan used at execution was a `HASH_JOIN`.
   Why did the plan change?
   The plan changed because the optimizer realized during the execution that the number of rows actually returned from the `order_items` table was much larger than expected. Multiple single-column predicates on the `order_items` table caused the initial cardinality estimate to be incorrect. The misestimation cannot be corrected by extended statistics because one of the predicates is a non-equality predicate.

9. The information learnt via dynamic plans is persisted as an SQL directive. Check the SQL directives created for the previous execution. Use the following column formats.

```
set pages 9999
set lines 300
col state format a8
col subobject_name format a11
col col_name format a12
col object_name format a12
col directive_id format 99999999999999999999
```

```
SQL> connect / as sysdba
Connected.
SQL> select d.directive_id, o.object_type, o.object_name,
       o.subobject_name col_name, d.type, d.state, d.reason
     from   dba_sql_plan_directives d, dba_sql_plan_dir_objects
o
     where  d.DIRECTIVE_ID=o.DIRECTIVE_ID
     and    o.owner ='OE1'
     order by d.directive_id;
  2    3    4    5    6
no rows selected

SQL> /

no rows selected

SQL> save d1
Created file d1.sql
SQL>
```

10. **-- You have to wait for a while before it is persisted. MMON is responsible for the flush.**
    -- In Database 12*c* DML monitoring and column_usage information flush has been transferred to MMON instead of SMON.
    If you do not want to wait, execute the `dbms_spd.flush_sql_plan_directive` procedure.

```
SQL> exec dbms_spd.flush_sql_plan_directive

PL/SQL procedure successfully completed.

SQL> @d1

           DIRECTIVE_ID OBJECT OBJECT_NAME  COL_NAME
TYPE             STATE    REASON
---------------------- ------ ------------ ------------
---------------- -------- -----------------------------------
    2783507998265655681 COLUMN ORDER_ITEMS  UNIT_PRICE
DYNAMIC_SAMPLING USABLE   SINGLE TABLE CARDINALITY MISESTIMATE
    2783507998265655681 TABLE  ORDER_ITEMS
DYNAMIC_SAMPLING USABLE   SINGLE TABLE CARDINALITY MISESTIMATE
    2783507998265655681 COLUMN ORDER_ITEMS  QUANTITY
DYNAMIC_SAMPLING USABLE   SINGLE TABLE CARDINALITY MISESTIMATE

SQL>
```

Practice 19-2: Using Re-Optimization

Overview

In this practice, you discover how the re-optimization (Cardinality Feedback) part of the Adaptive Execution Plans feature in Oracle Database 12*c* works.

Tasks

1. Execute the following query. Note the `gather_plan_statistics` hint is used to display the actual number of rows returned from each operation in the plan. This will allow you to compare the optimizer's estimates with the actual number of rows returned.

```
SELECT /*+ gather_plan_statistics HINT1 */ c.cust_first_name,
                          c.cust_last_name, sum(s.amount_sold)
FROM  sh1.customers c, SH1.sales s
WHERE c.cust_id=s.cust_id
AND   c.cust_city='Los Angeles'
AND   c.cust_state_province='CA'
AND   c.country_id=52790
AND   s.time_id='09-NOV-00'
GROUP BY c.cust_first_name, c.cust_last_name;
```

   Use the `$HOME/labs/Tuning/sel2.sql` script to execute the query.

```
SQL> connect sh1
Enter password: ******
Connected.
SQL> set pages 9999
SQL> set lines 300
SQL> COL sql_text format a30
SQL> @sel2

no rows selected

SQL>
```

2. Display the associated execution plan. What do you observe?
   There is a large difference between the estimated (E-Rows) and the actual number of rows returned (A-Rows). This statement looks like a candidate for re-optimization.

```
SQL> SELECT  * FROM
table(dbms_xplan.display_cursor(FORMAT=>'ALLSTATS LAST'));

SQL_ID    bkc4p9hd7g3cj, child number 0
-------------------------------------
select /*+ gather_plan_statistics HINT1 */
c.cust_first_name,
c.cust_last_name, sum(s.amount_sold)   from     sh1.customers c,
SH1.sales s     where c.cust_id=s.cust_id and
c.cust_city='Los
Angeles'      and   c.cust_state_province='CA'      and
c.country_id=52790   and   s.time_id='09-NOV-00' group by
c.cust_first_name, c.cust_last_name

Plan hash value: 2957067879
--------------------------------------------------------------------
| Id  | Operation                                | Name             | Starts |
E-Rows | A-Rows |   A-Time   | Buffers | Reads  |  OMem |  1Mem | Used-Mem |
--------------------------------------------------------------------
|   0 | SELECT STATEMENT                         |                  |      1 |    |     0
|00:00:00.03 |    1568 |    205 |         |      |       |
|   1 |  HASH GROUP BY                           |                  |      1 |      1 |
     0 |00:00:00.03 |    1568 |    205 |   909K|   909K|       |
|*  2 |   HASH JOIN                              |                  |      1 |      1 |
     0 |00:00:00.03 |    1568 |    205 |  1368K|  1368K| 1304K (0)|
|*  3 |    TABLE ACCESS FULL                     | CUSTOMERS        |      1 |
1 |    932 |00:00:00.04 |    1521 |    0 |       |      |       |
|   4 |    TABLE ACCESS BY INDEX ROWID BATCHED| SALES              |      1 |
1260 |   1076 |00:00:00.01 |      47 |    205 |       |      |       |
|   5 |     BITMAP CONVERSION TO ROWIDS          |                  |      1 |    |
1076 |00:00:00.01 |       2 |   7 |       |      |       |
|*  6 |      BITMAP INDEX SINGLE VALUE   | SALES_TIME_BIX |      1 |     |
     1 |00:00:00.01 |       2 | 7 |       |      |       |
--------------------------------------------------------------------

Predicate Information (identified by operation id):
---------------------------------------------------

   2 - access("C"."CUST_ID"="S"."CUST_ID")
   3 - filter(("C"."CUST_CITY"='Los Angeles' AND
"C"."CUST_STATE_PROVINCE"='CA' AND "C"."COUNTRY_ID"=52790))
   6 - access("S"."TIME_ID"='09-NOV-00')

30 rows selected.

SQL>
```

3. How would you confirm this statement will be re-optimized?
   You can confirm that by checking the value of the `is_reoptimizable` column in `v$sql`. This column indicates that this statement will be re-parsed on the next execution and information learnt on the first execution about the actual number of rows returned will be used to generate a better plan.

```
SQL> COL is_reopt FORMAT A8
SQL> select sql_id, child_number, sql_text,
            is_reoptimizable "is_reopt"
     from   v$sql
     where  sql_text like '%+ gather_plan_statistics
HINT1%SH1%';    2    3   4
SQL_ID          CHILD_NUMBER SQL_TEXT                    is_reopt
------------- ------------ ------------------------------ ------
--
5a297fd6x57cc         0 select sql_id, child_number, s N
                  ql_text,           is_reopti
                  mizable "is_reopt"    from
                   v$sql      where  sql_text li
                  ke '%+ gather_plan_statistics
                  HINT1%SH1%'

bkc4p9hd7g3cj         0 select /*+ gather_plan_statist Y
                  ics HINT1 */   c.cust_
                  first_name, c.cust_last_name,
                  sum(s.amount_sold)    from
                  sh1.customers c, SH1.sales s
                      where c.cust_id=s.cust_id
                    and   c.cust_city='Los An
                  geles'      and   c.cust_state
                  _province='CA'      and   c.co
                  untry_id=52790      and   s.ti
                  me_id='09-NOV-00'    group b
                  y c.cust_first_name, c.cust_la
                  st_name


SQL>
```

4. Confirm your guess is correct:

```
SQL> @sel2

no rows selected

SQL> select * from
table(dbms_xplan.display_cursor(FORMAT=>'ALLSTATS LAST'));
```

```
PLAN_TABLE_OUTPUT
------------------------------------------------------------------------
SQL_ID    bkc4p9hd7g3cj, child number 1
-------------------------------------
select /*+ gather_plan_statistics HINT1 */
c.cust_first_name,
c.cust_last_name, sum(s.amount_sold)   from     sh1.customers c,
SH1.sales s     where c.cust_id=s.cust_id and
c.cust_city='Los
Angeles'      and   c.cust_state_province='CA'      and
c.country_id=52790   and   s.time_id='09-NOV-00' group by
c.cust_first_name, c.cust_last_name

Plan hash value: 520406099

-------------------------------------------------------------------
| Id  | Operation                                | Name            | Starts |
E-Rows | A-Rows |   A-Time   | Buffers |  OMem |  1Mem | Used-Mem |
-------------------------------------------------------------------
|   0 | SELECT STATEMENT                         |                 |      1 |
     0 |00:00:00.01 |    1568 | |      |         |
|   1 |  HASH GROUP BY                           |                 |      1 |   1017 |
     0 |00:00:00.01 |    1568 |   909K|   909K|         |
|*  2 |   HASH JOIN                              |                 |      1 |   1017 |
     0 |00:00:00.01 |    1568 |  1817K|  1817K| 1640K (0)|
|   3 |    TABLE ACCESS BY INDEX ROWID BATCHED| SALES             |      1 |
1260 |   1076 |00:00:00.01 |      47 |         |         |
|   4 |     BITMAP CONVERSION TO ROWIDS          |                 |      1 |
1076 |00:00:00.01 |       2 |    |      |         |
|*  5 |      BITMAP INDEX SINGLE VALUE   | SALES_TIME_BIX |      1 |
     1 |00:00:00.01 |       2 | |      |         |
|*  6 |    TABLE ACCESS FULL                     | CUSTOMERS       |      1 |
932 |    932 |00:00:00.01 |    1521 |   |      |         |
-------------------------------------------------------------------

Predicate Information (identified by operation id):
---------------------------------------------------


   2 - access("C"."CUST_ID"="S"."CUST_ID")
   5 - access("S"."TIME_ID"='09-NOV-00')
   6 - filter(("C"."CUST_CITY"='Los Angeles' AND
"C"."CUST_STATE_PROVINCE"='CA' AND "C"."COUNTRY_ID"=52790))

Note
-----
   - statistics feedback used for this statement
```

```
34 rows selected.

SQL>
```

5. Check if the new child cursor created used feedback statistics. If not proceed with steps 6 and 7.

```
SQL> COL USE_FEEDBACK_STATS FORMAT A18
SQL> select CHILD_NUMBER, USE_FEEDBACK_STATS
"USE_FEEDBACK_STATS"
     from v$sql_shared_cursor
     where SQL_ID = 'bkc4p9hd7g3cj' ;
  2    3
CHILD_NUMBER USE_FEEDBACK_STATS
------------ ------------------
           0 Y
           1 Y


SQL>
```

6. Because the second child cursor created did not use feedback stats (set to "Y"), it is still not the best and need to be hard parsed again with better cardinality estimates.

```
SQL> @sel2

no rows selected

SQL> select * from
table(dbms_xplan.display_cursor(FORMAT=>'ALLSTATS LAST'));

PLAN_TABLE_OUTPUT
--------------------------------------------------------------------
-
SQL_ID    bkc4p9hd7g3cj, child number 2
-------------------------------------
select /*+ gather_plan_statistics HINT1 */
c.cust_first_name,
c.cust_last_name, sum(s.amount_sold)   from     sh1.customers c,
SH1.sales s     where c.cust_id=s.cust_id and
c.cust_city='Los
Angeles'      and   c.cust_state_province='CA'      and
c.country_id=52790   and   s.time_id='09-NOV-00' group by
c.cust_first_name, c.cust_last_name

Plan hash value: 520406099
```

```
-------------------------------------------------------------------
| Id  | Operation                           | Name             | Starts |
E-Rows | A-Rows |   A-Time   | Buffers |  OMem |  1Mem | Used-Mem |
-------------------------------------------------------------------
|   0 | SELECT STATEMENT                    |                  |      1 |    |
     0 |00:00:00.02 |    1568 |  |      |       |
|   1 |  HASH GROUP BY                      |                  |      1 |   1042 |
     0 |00:00:00.02 |    1568 |   909K|   909K|         |
|*  2 |   HASH JOIN                         |                  |      1 |   1042 |
     0 |00:00:00.02 |    1568 |  1817K|  1817K| 1609K (0)|
|   3 |    TABLE ACCESS BY INDEX ROWID BATCHED| SALES          |      1 |
1260 |   1076 |00:00:00.01 |      47 |  |      |       |
|   4 |     BITMAP CONVERSION TO ROWIDS     |                  |      1 |    |
1076 |00:00:00.01 |       2 |    |      |       |
|*  5 |      BITMAP INDEX SINGLE VALUE  | SALES_TIME_BIX |      1 |      |
     1 |00:00:00.01 |       2 |  |      |       |
|*  6 |    TABLE ACCESS FULL                | CUSTOMERS        |      1 |
955 |    932 |00:00:00.01 |    1521 |   |      |       |
-------------------------------------------------------------------

Predicate Information (identified by operation id):
---------------------------------------------------

   2 - access("C"."CUST_ID"="S"."CUST_ID")
   5 - access("S"."TIME_ID"='09-NOV-00')
   6 - filter(("C"."CUST_CITY"='Los Angeles' AND
"C"."CUST_STATE_PROVINCE"='CA' AND "C"."COUNTRY_ID"=52790))

Note
-----
   - dynamic statistics used: dynamic sampling (level=2)
   - 1 Sql Plan Directive used for this statement


35 rows selected.

SQL>
```

7. Check that a new child cursor was created:

```
SQL> select CHILD_NUMBER, USE_FEEDBACK_STATS
"USE_FEEDBACK_STATS"
     from v$sql_shared_cursor
     where SQL_ID = 'bkc4p9hd7g3cj' ;
  2    3
CHILD_NUMBER USE_FEEDBACK_STATS
------------ ------------------
           0 Y
           1 Y
           2 N
```

```
SQL>
```

The third child cursor created, because it already used feedback stats, is set to "N;" it will not be reparsed.

8. Force the SQL plan directive to be flushed and check to see it was persisted into the data dictionary:

```
SQL> connect / as sysdba
Connected.
SQL> col state format a5
SQL> col subobject_name format a11
SQL> col col_name format a20
SQL> col object_name format a20
SQL> col dir_id format a23
SQL> col owner format a5
SQL> col state format A20
SQL> set echo on
SQL>
SQL> exec dbms_spd.flush_sql_plan_directive

PL/SQL procedure successfully completed.

SQL> select to_char(d.directive_id) dir_id,
            o.object_name, o.subobject_name col_name,
            o.object_type, d.type, d.state, d.reason
     from   dba_sql_plan_directives d,
            dba_sql_plan_dir_objects o
     where  d.DIRECTIVE_ID=o.DIRECTIVE_ID
     and    o.owner in ('SH1')
     order by 1,2,3,4;
  2    3    4    5    6    7    8
```

```
DIR_ID               OBJECT_NAME  COL_NAME           OBJECT
TYPE            STATE    REASON
-------------------- ------------ ------------------ ------
---------------- -------- -----------------------------------
6718791204543937877  CUSTOMERS    COUNTRY_ID          COLUMN
DYNAMIC_SAMPLING USABLE   SINGLE TABLE CARDINALITY MISESTIMATE
6718791204543937877  CUSTOMERS    CUST_CITY           COLUMN
DYNAMIC_SAMPLING USABLE   SINGLE TABLE CARDINALITY MISESTIMATE
6718791204543937877  CUSTOMERS    CUST_STATE_PROVINCE COLUMN
DYNAMIC_SAMPLING USABLE   SINGLE TABLE CARDINALITY MISESTIMATE
6718791204543937877  CUSTOMERS                        TABLE
DYNAMIC_SAMPLING USABLE   SINGLE TABLE CARDINALITY MISESTIMATE
```

```
SQL>
```

9. Drop `OE1` and `SH1` accounts.

```
SQL> DROP USER oe1 CASCADE;

User dropped.

SQL> DROP USER sh1 CASCADE;

User dropped.

SQL> EXIT
$
```

Practices for Lesson 20: Resource Manager and Other Performance Enhancements

Chapter 20

Practices for Lesson 20: Overview

Practices Overview

In this practice, you create two CDB Resource Manager plans and associated directives to limit CPU resources used by two PDBs.

Practice 20-1: Using CDB Resource Manager Plans and Directives

Overview

In this practice, you create two CDB Resource Manager plans and associated directives to limit CPU resources used by two PDBs.

Tasks

1. Connect to the root of `cdb2` as `SYSDBA` and cleanup your environment by executing the `rsrc_cleanup.sql` script. The script will close all PDBs except `PDB1_1` and `PDB2_2`.

   a. Make sure you are in the `~/labs/RM` directory and your environment points to the `cdb2` instance.

```
$ cd ~/labs/RM
$ . oraenv
ORACLE_SID = [orcl] ? cdb2
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$
```

   b. Execute the `rsrc_cleanup.sql` script.

      1) Start up the multitenant container database instance if not already done.

```
$ sqlplus / as sysdba

Connected to an idle instance.

SQL> STARTUP
```

```
ORACLE instance started.

Total System Global Area 4697620480 bytes
Fixed Size                  2924848 bytes
Variable Size             989859536 bytes
Database Buffers         3690987520 bytes
Redo Buffers               13848576 bytes
Database mounted.
Database opened.
SQL> @rsrc_cleanup.sql

Pluggable database altered.

Pluggable database altered.

NAME                           CON_ID OPEN_MODE
------------------------------ ---------- ----------
PDB$SEED                            2 READ ONLY
PDB1_1                              6 READ WRITE
PDB2                                3 MOUNTED
PDB2_2                              4 READ WRITE
PDB_ORCL2                           5 MOUNTED

System altered.

NAME
--------------------------------
DEFAULT_MAINTENANCE_PLAN

System altered.

PL/SQL procedure successfully completed.

PL/SQL procedure successfully completed.

BEGIN
DBMS_Resource_Manager.Delete_CDB_Plan_Directive('fairplan',
'pdb1_1'); END;

*
ERROR at line 1:
ORA-29358: resource plan FAIRPLAN does not exist
ORA-06512: at "SYS.DBMS_RMIN_SYS", line 3158
```

```
ORA-06512: at "SYS.DBMS_RESOURCE_MANAGER", line 1526
ORA-06512: at line 1


BEGIN
DBMS_Resource_Manager.Delete_CDB_Plan_Directive('fairplan',
'pdb2_2'); END;

*
ERROR at line 1:
ORA-29358: resource plan FAIRPLAN does not exist
ORA-06512: at "SYS.DBMS_RMIN_SYS", line 3158
ORA-06512: at "SYS.DBMS_RESOURCE_MANAGER", line 1526
ORA-06512: at line 1


BEGIN DBMS_Resource_Manager.Delete_CDB_Plan('fairplan'); END;

*
ERROR at line 1:
ORA-29358: resource plan FAIRPLAN does not exist
ORA-06512: at "SYS.DBMS_RMIN_SYS", line 2851
ORA-06512: at "SYS.DBMS_RESOURCE_MANAGER", line 1372
ORA-06512: at line 1


BEGIN
DBMS_Resource_Manager.Delete_CDB_Plan_Directive('unfairplan',
'pdb1_1'); END;

*
ERROR at line 1:
ORA-29358: resource plan UNFAIRPLAN does not exist
ORA-06512: at "SYS.DBMS_RMIN_SYS", line 3158
ORA-06512: at "SYS.DBMS_RESOURCE_MANAGER", line 1526
ORA-06512: at line 1


BEGIN
DBMS_Resource_Manager.Delete_CDB_Plan_Directive('unfairplan',
'pdb2_2'); END;

*
ERROR at line 1:
ORA-29358: resource plan UNFAIRPLAN does not exist
ORA-06512: at "SYS.DBMS_RMIN_SYS", line 3158
ORA-06512: at "SYS.DBMS_RESOURCE_MANAGER", line 1526
```

```
ORA-06512: at line 1

BEGIN DBMS_Resource_Manager.Delete_CDB_Plan('unfairplan'); END;

*
ERROR at line 1:
ORA-29358: resource plan UNFAIRPLAN does not exist
ORA-06512: at "SYS.DBMS_RMIN_SYS", line 2851
ORA-06512: at "SYS.DBMS_RESOURCE_MANAGER", line 1372
ORA-06512: at line 1

PL/SQL procedure successfully completed.

PL/SQL procedure successfully completed.

SQL> EXIT
$
```

2. Open a terminal window (it will be referred to as window1) to connect to `pdb1_1` in `cdb2` and create a PL/SQL procedure that burns CPU in `PDB1_1` as the `SYSTEM` user. You can use the `create_burn_cpu.sql` script to create the procedure after connecting to `PDB1_1`.

```
$ cd ~/labs/RM
$ . oraenv
ORACLE_SID = [orcl] ? cdb2
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$
$ sqlplus system@pdb1_1

Enter password: ******

Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
64bit Production
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testing and Unified Auditing options

SQL> @create_burn_cpu.sql

Procedure created.

SQL>
```

3. Open a second terminal window (it will be referred to as window2) to connect to `pdb2_2` in `cdb2` and create a PL/SQL procedure that burns CPU in `PDB2_2` as the `SYSTEM` user. You can use the `create_burn_cpu.sql` script to create the procedure after connecting to `PDB2_2`.

```
$ cd ~/labs/RM
$ . oraenv
ORACLE_SID = [cdb1] ? cdb2
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$ sqlplus system@pdb2_2

Enter password: ******

Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
64bit Production
```

```
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testing and Unified Auditing options

SQL> @create_burn_cpu.sql

Procedure created.

SQL>
```

4. From window1, execute the `$HOME/labs/RM/plan.sql` to create two new CDB plans called `FAIRPLAN` and `UNFAIRPLAN`.
`FAIRPLAN` should give one share to both `PDB1_1` and `PDB2_2`, and `UNFAIRPLAN` should give one share to `PDB1_1` and five shares to `PDB2_2`.

```
SQL> alter session set container = CDB$Root;

Session altered.

SQL> @plan

PL/SQL procedure successfully completed.

PL/SQL procedure successfully completed.

PL/SQL procedure successfully completed.

PL/SQL procedure successfully completed.

PL/SQL procedure successfully completed.

PL/SQL procedure successfully completed.

PL/SQL procedure successfully completed.

PL/SQL procedure successfully completed.

PL/SQL procedure successfully completed.

PL/SQL procedure successfully completed.

SQL>
```

5. Still from window1, make sure both plans and associated directives were created correctly. Execute the `$HOME/labs/RM/dir.sql` script.

```
SQL> @dir

PLAN
------------------------------------------------------------------
FAIRPLAN
UNFAIRPLAN

PLAN                 PLUGGABLE_DATABASE     SHARES
-------------------- ------------------  ---------
FAIRPLAN             PDB1_1                      1
FAIRPLAN             PDB2_2                      1
UNFAIRPLAN           PDB1_1                      1
UNFAIRPLAN           PDB2_2                      5

SQL>
```

6. From window1, activate the CDB plan `FAIRPLAN`.

```
SQL> CONNECT / AS SYSDBA
Connected.
SQL> alter system set resource_manager_plan = fairplan;

System altered.

SQL> select Name from v$Rsrc_Plan where Con_ID = 1;

NAME
--------------------------------
FAIRPLAN

SQL>
```

7. From window1, connect as the `SYSTEM` user in `PDB1_1` and set `SERVEROUPUT` variable to `ON`.

```
SQL> CONNECT system@pdb1_1
Enter password: ******
Connected.
SQL> set serveroutput on
SQL>
```

8. From window2, connect as the SYSTEM user in PDB2_2 and set SERVEROUPUT variable to ON.

```
SQL> CONNECT system@pdb2_2
Enter password: ******
Connected.
SQL> set serveroutput on
SQL>
```

9. **DO NOT WAIT AND GO TO STEP 10 RIGHT AFTER:** From window1, execute the CPU burner procedure you created at step 2.

```
SQL> EXEC Burn_CPU_For_RM_Demo()

CPU:   109.6 Wall:  222.6 k: 2000000000
PL/SQL procedure successfully completed.

SQL>
```

10. From window2, execute the CPU burner procedure you created at step 3.

```
SQL> EXEC Burn_CPU_For_RM_Demo()

CPU:   109.9 Wall:  227.1 k: 2000000000
PL/SQL procedure successfully completed.

SQL>
```

11. What do you observe?
    Both procedures finish their execution almost at the same time, and have both consumed almost the same CPU and wall-clock time during their execution.
    This is expected because each PDB is receiving one share of CPU.

12. From window1, connect as user `SYS` in the root, and change the Resource Manager plan to `UNFAIRPLAN`.

```
SQL> CONNECT / AS SYSDBA
Connected.
SQL>
SQL> alter system set resource_manager_plan = unfairplan;

System altered.

SQL> select Name from v$Rsrc_Plan where Con_ID = 1;

NAME
--------------------------------
UNFAIRPLAN

SQL>
```

13. **DO NOT WAIT AND GO TO STEP 14 RIGHT AFTER:** From window1, connect as user SYSTEM in PDB1_1 and execute the CPU burner procedure you created at step 2.

```
SQL> CONNECT system@pdb1_1
Enter password: ******
Connected.
SQL>
SQL> set serveroutput on
SQL>
SQL> execute Burn_CPU_For_RM_Demo();
CPU:   109.0 Wall:  226.5 k: 2000000000

PL/SQL procedure successfully completed.

SQL>
```

14. From window2 execute the CPU burner procedure you created at step 3.

```
SQL> execute Burn_CPU_For_RM_Demo();
CPU:   109.8 Wall:  135.7 k: 2000000000

PL/SQL procedure successfully completed.

SQL> EXIT
$
```

15. What do you observe?
    Now, execution of the CPU burner procedure takes much longer to execute in PDB1_1 than in PDB2_2.
    This is expected because PDB2_2 is assigned five shares while PDB1_1 only one.
    However, the difference is not five times slower simply because once the procedure executed in PDB2_2, all CPU cycles goes to PDB1_1.

16. From window1, connect as user SYS in the root, and change the CDB Resource Manager plan back to its default and open all the pluggable databases.

```
SQL> CONNECT / as sysdba
Connected.

SQL> alter system set resource_manager_plan = '';

System altered.

SQL> select Name from v$Rsrc_Plan where Con_ID = 1;

NAME
--------------------------------
ORA$INTERNAL_CDB_PLAN

SQL> alter pluggable database all open;

Pluggable database altered.

SQL> EXIT
$
```

Practice 20-2: Using Multi-Process Multi-Threaded Architecture

Overview

In this practice, you switch `cdb2` to use the multi-process multi-threaded architecture.

1. From a terminal window, connected as the `oracle` user, list all processes and threads used to run your `cdb2` instance.

```
$ ps -eLo "pid tid comm args" |grep cdb2
 2463  2463 ora_pmon_cdb2   ora_pmon_cdb2
 2465  2465 ora_psp0_cdb2   ora_psp0_cdb2
 2467  2467 ora_vktm_cdb2   ora_vktm_cdb2
 2471  2471 ora_gen0_cdb2   ora_gen0_cdb2
 2473  2473 ora_mman_cdb2   ora_mman_cdb2
 2477  2477 ora_diag_cdb2   ora_diag_cdb2
 2479  2479 ora_dbrm_cdb2   ora_dbrm_cdb2
 2481  2481 ora_vkrm_cdb2   ora_vkrm_cdb2
 2483  2483 ora_dia0_cdb2   ora_dia0_cdb2
 2485  2485 ora_dbw0_cdb2   ora_dbw0_cdb2
 2487  2487 ora_lgwr_cdb2   ora_lgwr_cdb2
 2489  2489 ora_ckpt_cdb2   ora_ckpt_cdb2
 2491  2491 ora_lg00_cdb2   ora_lg00_cdb2
 2493  2493 ora_smon_cdb2   ora_smon_cdb2
 2495  2495 ora_lg01_cdb2   ora_lg01_cdb2
 2497  2497 ora_reco_cdb2   ora_reco_cdb2
 2499  2499 ora_lreg_cdb2   ora_lreg_cdb2
 2501  2501 ora_pxmn_cdb2   ora_pxmn_cdb2
 2503  2503 ora_mmon_cdb2   ora_mmon_cdb2
 2505  2505 ora_mmnl_cdb2   ora_mmnl_cdb2
 2507  2507 ora_d000_cdb2   ora_d000_cdb2
 2509  2509 ora_s000_cdb2   ora_s000_cdb2
 2526  2526 ora_rvwr_cdb2   ora_rvwr_cdb2
 2529  2529 ora_tmon_cdb2   ora_tmon_cdb2
 2531  2531 ora_arc0_cdb2   ora_arc0_cdb2
 2533  2533 ora_arc1_cdb2   ora_arc1_cdb2
 2535  2535 ora_arc2_cdb2   ora_arc2_cdb2
 2537  2537 ora_arc3_cdb2   ora_arc3_cdb2
 2539  2539 ora_tt00_cdb2   ora_tt00_cdb2
 2541  2541 ora_smco_cdb2   ora_smco_cdb2
 2543  2543 ora_w000_cdb2   ora_w000_cdb2
 2545  2545 ora_w001_cdb2   ora_w001_cdb2
 2560  2560 ora_aqpc_cdb2   ora_aqpc_cdb2
 2564  2564 ora_p000_cdb2   ora_p000_cdb2
```

```
 2566  2566 ora_p001_cdb2   ora_p001_cdb2
 2568  2568 ora_p002_cdb2   ora_p002_cdb2
 2570  2570 ora_p003_cdb2   ora_p003_cdb2
 2572  2572 ora_p004_cdb2   ora_p004_cdb2
 2574  2574 ora_p005_cdb2   ora_p005_cdb2
 2576  2576 ora_p006_cdb2   ora_p006_cdb2
 2578  2578 ora_p007_cdb2   ora_p007_cdb2
 2580  2580 ora_qm02_cdb2   ora_qm02_cdb2
 2584  2584 ora_q002_cdb2   ora_q002_cdb2
 2586  2586 ora_q003_cdb2   ora_q003_cdb2
 2768  2768 ora_cjq0_cdb2   ora_cjq0_cdb2
 2803  2803 ora_p008_cdb2   ora_p008_cdb2
 2805  2805 ora_p009_cdb2   ora_p009_cdb2
 2809  2809 ora_p00a_cdb2   ora_p00a_cdb2
 2811  2811 ora_p00b_cdb2   ora_p00b_cdb2
 2813  2813 ora_p00c_cdb2   ora_p00c_cdb2
 2815  2815 ora_p00d_cdb2   ora_p00d_cdb2
 2817  2817 ora_p00e_cdb2   ora_p00e_cdb2
 2819  2819 ora_p00f_cdb2   ora_p00f_cdb2
 3625  3625 ora_w002_cdb2   ora_w002_cdb2
 3715  3715 ora_w003_cdb2   ora_w003_cdb2
 3733  3733 ora_w004_cdb2   ora_w004_cdb2
 5053  5053 ora_w005_cdb2   ora_w005_cdb2
11400 11400 oracle_11400_cd oraclecdb2 (LOCAL=NO)
11689 11689 ora_j000_cdb2   ora_j000_cdb2
11693 11693 ora_j001_cdb2   ora_j001_cdb2
11821 11821 grep            grep cdb2
$
```

2. What do you observe?
   Each Oracle process is running into a different OS process.

3. Do the same as in step 1, but using Oracle Database dictionary views. Use the `$HOME/labs/RM/MPMT.sql` script.

```
$ sqlplus / as sysdba

Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
64bit Production
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testing and Unified Auditing options
SQL> @MPMT

SPID  STID  PNAME USERNAME   PROGRAM
----- ----- ----- ---------- ------------------------------
11832 11832       SYS      sqlplus@<YOUR_SERVER_NAME> (TNS V1-V3)
12119 12119 J000  SYS           oracle@<YOUR_SERVER_NAME> (J000)
12135 12135 J001  SYS           oracle@<YOUR_SERVER_NAME> (J001)
12137 12137 J002  SYS           oracle@<YOUR_SERVER_NAME> (J002)
12139 12139 J003  SYS           oracle@<YOUR_SERVER_NAME> (J003)
12141 12141 J004  SYS           oracle@<YOUR_SERVER_NAME> (J004)
12143 12143 J005  SYS           oracle@<YOUR_SERVER_NAME> (J005)
12145 12145 J006  SYS           oracle@<YOUR_SERVER_NAME> (J006)
12147 12147 J007  SYS           oracle@<YOUR_SERVER_NAME> (J007)
12149 12149 J008  SYS           oracle@<YOUR_SERVER_NAME> (J008)
12151 12151 J009  SYS           oracle@<YOUR_SERVER_NAME> (J009)
12153 12153 J010  SYS           oracle@<YOUR_SERVER_NAME> (J010)
12155 12155 J011  SYS           oracle@<YOUR_SERVER_NAME> (J011)
12157 12157 J012           oracle@<YOUR_SERVER_NAME> (J012)
12161 12161 J013  SYS           oracle@<YOUR_SERVER_NAME> (J013)
12163 12163 J014           oracle@<YOUR_SERVER_NAME> (J014)
12165 12165 J015  SYS           oracle@<YOUR_SERVER_NAME> (J015)
12167 12167 J016           oracle@<YOUR_SERVER_NAME> (J016)
12169 12169 J017  SYS           oracle@<YOUR_SERVER_NAME> (J017)
12171 12171 J018  SYS           oracle@<YOUR_SERVER_NAME> (J018)
12173 12173 J019  SYS           oracle@<YOUR_SERVER_NAME> (J019)
12175 12175 J020  SYS           oracle@<YOUR_SERVER_NAME> (J020)
12195 12195 J021  SYS           oracle@<YOUR_SERVER_NAME> (J021)
12197 12197 J022  SYS           oracle@<YOUR_SERVER_NAME> (J022)
12205 12205 J023           oracle@<YOUR_SERVER_NAME> (J023)
12207 12207 J024  SYS           oracle@<YOUR_SERVER_NAME> (J024)
12211 12211 J025  SYS           oracle@<YOUR_SERVER_NAME> (J025)
12213 12213 J026  SYS           oracle@<YOUR_SERVER_NAME> (J026)
12215 12215 J027  SYS           oracle@<YOUR_SERVER_NAME> (J027)
```

```
12219 12219 J028          oracle@<YOUR_SERVER_NAME> (J028)
12221 12221 M000          oracle@<YOUR_SERVER_NAME> (M000)
2463  2463  PMON          oracle@<YOUR_SERVER_NAME> (PMON)
2465  2465  PSP0          oracle@<YOUR_SERVER_NAME> (PSP0)
2467  2467  VKTM          oracle@<YOUR_SERVER_NAME> (VKTM)
2471  2471  GEN0          oracle@<YOUR_SERVER_NAME> (GEN0)
2473  2473  MMAN          oracle@<YOUR_SERVER_NAME> (MMAN)
2477  2477  DIAG          oracle@<YOUR_SERVER_NAME> (DIAG)
2479  2479  DBRM          oracle@<YOUR_SERVER_NAME> (DBRM)
2481  2481  VKRM          oracle@<YOUR_SERVER_NAME> (VKRM)
2483  2483  DIA0          oracle@<YOUR_SERVER_NAME> (DIA0)
2485  2485  DBW0          oracle@<YOUR_SERVER_NAME> (DBW0)
2487  2487  LGWR          oracle@<YOUR_SERVER_NAME> (LGWR)
2489  2489  CKPT          oracle@<YOUR_SERVER_NAME> (CKPT)
2491  2491  LG00          oracle@<YOUR_SERVER_NAME> (LG00)
2493  2493  SMON          oracle@<YOUR_SERVER_NAME> (SMON)
2495  2495  LG01          oracle@<YOUR_SERVER_NAME> (LG01)
2497  2497  RECO          oracle@<YOUR_SERVER_NAME> (RECO)
2499  2499  LREG          oracle@<YOUR_SERVER_NAME> (LREG)
2501  2501  PXMN          oracle@<YOUR_SERVER_NAME> (PXMN)
2503  2503  MMON          oracle@<YOUR_SERVER_NAME> (MMON)
2505  2505  MMNL          oracle@<YOUR_SERVER_NAME> (MMNL)
2526  2526  RVWR          oracle@<YOUR_SERVER_NAME> (RVWR)
2529  2529  TMON          oracle@<YOUR_SERVER_NAME> (TMON)
2531  2531  ARC0          oracle@<YOUR_SERVER_NAME> (ARC0)
2533  2533  ARC1          oracle@<YOUR_SERVER_NAME> (ARC1)
2535  2535  ARC2          oracle@<YOUR_SERVER_NAME> (ARC2)
2537  2537  ARC3          oracle@<YOUR_SERVER_NAME> (ARC3)
2539  2539  TT00          oracle@<YOUR_SERVER_NAME> (TT00)
2541  2541  SMCO          oracle@<YOUR_SERVER_NAME> (SMCO)
2543  2543  W000          oracle@<YOUR_SERVER_NAME> (W000)
2545  2545  W001          oracle@<YOUR_SERVER_NAME> (W001)
2560  2560  AQPC          oracle@<YOUR_SERVER_NAME> (AQPC)
2580  2580  QM02          oracle@<YOUR_SERVER_NAME> (QM02)
2584  2584  Q002          oracle@<YOUR_SERVER_NAME> (Q002)
2586  2586  Q003          oracle@<YOUR_SERVER_NAME> (Q003)
2768  2768  CJQ0          oracle@<YOUR_SERVER_NAME> (CJQ0)
3625  3625  W002          oracle@<YOUR_SERVER_NAME> (W002)
3715  3715  W003          oracle@<YOUR_SERVER_NAME> (W003)
3733  3733  W004          oracle@<YOUR_SERVER_NAME> (W004)
5053  5053  W005          oracle@<YOUR_SERVER_NAME> (W005)
```

```
70 rows selected.

SQL>
```

4. Modify your SPFILE to prepare for MPMT architecture.

```
SQL> alter system set threaded_execution=true scope=spfile;

System altered.

SQL>
```

5. Still connected from the same session, shut down your cdb2 instance, and restart it again.

```
SQL> shutdown immediate
Database closed.
Database dismounted.
ORACLE instance shut down.
SQL>
SQL> startup
ORA-01017: invalid username/password; logon denied

SQL>
```

6. Why are you getting the "ORA-01017: invalid username/password; logon denied" error?

   The reason is that when using MPMT architecture, you have to use password authentication for SYSDBA operations.

7. Start up your cdb2 instance.

```
SQL> connect sys as sysdba
Enter password: ******
Connected.
SQL> startup
ORA-01081: cannot start already-running ORACLE - shut it down
first
SQL> alter database mount;

Database altered.

SQL> alter database open;

Database altered.

SQL>
```

8. Still connected from your SQL*Plus session, list the OS processes and OS threads used to run your cdb2 instance using OS commands.

```
SQL> ! ps -eLo "pid tid comm args" |grep cdb2
12372 12372 ora_pmon_cdb2   ora_pmon_cdb2
12374 12374 ora_psp0_cdb2   ora_psp0_cdb2
12376 12376 ora_vktm_cdb2   ora_vktm_cdb2
12380 12380 ora_scmn_cdb2   ora_u004_cdb2
12380 12381 oracle          ora_u004_cdb2
12380 12382 ora_gen0_cdb2   ora_u004_cdb2
12380 12383 ora_mman_cdb2   ora_u004_cdb2
12380 12389 ora_dbrm_cdb2   ora_u004_cdb2
12380 12394 ora_lgwr_cdb2   ora_u004_cdb2
12380 12395 ora_ckpt_cdb2   ora_u004_cdb2
12380 12396 ora_smon_cdb2   ora_u004_cdb2
12380 12398 ora_lreg_cdb2   ora_u004_cdb2
12380 17754 ora_rvwr_cdb2   ora_u004_cdb2
12386 12386 ora_scmn_cdb2   ora_u005_cdb2
12386 12387 oracle          ora_u005_cdb2
12386 12388 ora_diag_cdb2   ora_u005_cdb2
12386 12390 ora_vkrm_cdb2   ora_u005_cdb2
12386 12391 ora_dia0_cdb2   ora_u005_cdb2
12386 12397 ora_reco_cdb2   ora_u005_cdb2
12386 12399 ora_pxmn_cdb2   ora_u005_cdb2
12386 12400 ora_mmon_cdb2   ora_u005_cdb2
12386 12401 ora_mmnl_cdb2   ora_u005_cdb2
12386 12402 ora_d000_cdb2   ora_u005_cdb2
```

```
12386 12403 ora_s000_cdb2   ora_u005_cdb2
12386 12404 ora_n000_cdb2   ora_u005_cdb2
12386 17649 oracle_17649_cd ora_u005_cdb2
12386 17755 ora_tmon_cdb2   ora_u005_cdb2
12386 17756 ora_arc0_cdb2   ora_u005_cdb2
12386 17757 ora_arc1_cdb2   ora_u005_cdb2
12386 17758 ora_arc2_cdb2   ora_u005_cdb2
12386 17759 ora_arc3_cdb2   ora_u005_cdb2
12386 17760 ora_tt00_cdb2   ora_u005_cdb2
12386 17765 ora_smco_cdb2   ora_u005_cdb2
12386 17766 ora_w000_cdb2   ora_u005_cdb2
12386 17767 ora_w001_cdb2   ora_u005_cdb2
12386 17769 ora_aqpc_cdb2   ora_u005_cdb2
12386 17776 ora_p000_cdb2   ora_u005_cdb2
12386 17777 ora_p001_cdb2   ora_u005_cdb2
12386 17778 ora_p002_cdb2   ora_u005_cdb2
12386 17779 ora_p003_cdb2   ora_u005_cdb2
12386 17970 ora_qm02_cdb2   ora_u005_cdb2
12386 17972 ora_q002_cdb2   ora_u005_cdb2
12386 17973 ora_q003_cdb2   ora_u005_cdb2
12386 17974 ora_q004_cdb2   ora_u005_cdb2
12386 17975 ora_p004_cdb2   ora_u005_cdb2
12386 17976 ora_p005_cdb2   ora_u005_cdb2
12386 18021 ora_p006_cdb2   ora_u005_cdb2
12386 18022 ora_p007_cdb2   ora_u005_cdb2
12386 18057 ora_cjq0_cdb2   ora_u005_cdb2
12386 18065 ora_p008_cdb2   ora_u005_cdb2
12386 18066 ora_p009_cdb2   ora_u005_cdb2
12386 18067 ora_p00a_cdb2   ora_u005_cdb2
12386 18068 ora_p00b_cdb2   ora_u005_cdb2
12386 18070 ora_p00c_cdb2   ora_u005_cdb2
12386 18071 ora_p00d_cdb2   ora_u005_cdb2
12386 18072 ora_p00e_cdb2   ora_u005_cdb2
12386 18073 ora_p00f_cdb2   ora_u005_cdb2
12386 18118 ora_p00g_cdb2   ora_u005_cdb2
12386 18119 ora_p00h_cdb2   ora_u005_cdb2
12386 18120 ora_p00i_cdb2   ora_u005_cdb2
12386 18121 ora_p00j_cdb2   ora_u005_cdb2
12386 18122 ora_p00k_cdb2   ora_u005_cdb2
12386 18123 ora_p00l_cdb2   ora_u005_cdb2
12386 18124 ora_p00m_cdb2   ora_u005_cdb2
12386 18125 ora_p00n_cdb2   ora_u005_cdb2
```

```
12386 18126 ora_j000_cdb2   ora_u005_cdb2
12386 18127 ora_j001_cdb2   ora_u005_cdb2
12386 18128 ora_j002_cdb2   ora_u005_cdb2
12386 18130 ora_j004_cdb2   ora_u005_cdb2
12386 18131 ora_j005_cdb2   ora_u005_cdb2
12386 18132 ora_j006_cdb2   ora_u005_cdb2
12386 18133 ora_j007_cdb2   ora_u005_cdb2
12386 18134 ora_j008_cdb2   ora_u005_cdb2
12386 18135 ora_j009_cdb2   ora_u005_cdb2
12386 18136 ora_j010_cdb2   ora_u005_cdb2
12386 18137 ora_j011_cdb2   ora_u005_cdb2
12386 18138 ora_j012_cdb2   ora_u005_cdb2
12386 18139 ora_j013_cdb2   ora_u005_cdb2
12386 18140 ora_j014_cdb2   ora_u005_cdb2
12386 18141 ora_j015_cdb2   ora_u005_cdb2
12386 18142 ora_j016_cdb2   ora_u005_cdb2
12386 18143 ora_j017_cdb2   ora_u005_cdb2
12386 18144 ora_j018_cdb2   ora_u005_cdb2
12386 18145 ora_j019_cdb2   ora_u005_cdb2
12386 18146 ora_j020_cdb2   ora_u005_cdb2
12386 18147 ora_j021_cdb2   ora_u005_cdb2
12386 18148 ora_j022_cdb2   ora_u005_cdb2
12386 18149 ora_j023_cdb2   ora_u005_cdb2
12386 18150 ora_j024_cdb2   ora_u005_cdb2
12386 18151 ora_j025_cdb2   ora_u005_cdb2
12386 18152 ora_j026_cdb2   ora_u005_cdb2
12386 18153 ora_j027_cdb2   ora_u005_cdb2
12386 18154 ora_j028_cdb2   ora_u005_cdb2
12386 18155 ora_j029_cdb2   ora_u005_cdb2
12386 18156 ora_j030_cdb2   ora_u005_cdb2
12386 18157 ora_j031_cdb2   ora_u005_cdb2
12386 18158 ora_j032_cdb2   ora_u005_cdb2
12386 18159 ora_j033_cdb2   ora_u005_cdb2
12386 18160 ora_j034_cdb2   ora_u005_cdb2
12386 18161 ora_j035_cdb2   ora_u005_cdb2
12386 18162 ora_j036_cdb2   ora_u005_cdb2
12393 12393 ora_dbw0_cdb2   ora_dbw0_cdb2
18269 18269 bash            /bin/bash -c  ps -eLo "pid tid comm
args" |grep cdb2
18271 18271 grep            grep cdb2

SQL>
```

```
SQL> ! pgrep -lf cdb2
12372 ora_pmon_cdb2
12374 ora_psp0_cdb2
12376 ora_vktm_cdb2
12380 ora_u004_cdb2
12386 ora_u005_cdb2
12393 ora_dbw0_cdb2

SQL>
```

9. Do the same using the `$HOME/labs/RM/MPMT.sql` script.

```
SQL> @MPMT

SPID  STID  PNAME USERNAME   PROGRAM
----- ----- ----- ---------- ------------------------------
12372 12372 PMON          oracle@EDRSR41P1 (PMON)
12374 12374 PSP0          oracle@EDRSR41P1 (PSP0)
12376 12376 VKTM          oracle@EDRSR41P1 (VKTM)
12380 12395 CKPT          oracle@EDRSR41P1 (CKPT)
12380 12394 LGWR          oracle@EDRSR41P1 (LGWR)
12380 17754 RVWR          oracle@EDRSR41P1 (RVWR)
12380 12389 DBRM          oracle@EDRSR41P1 (DBRM)
12380 12382 GEN0          oracle@EDRSR41P1 (GEN0)
12380 12380 SCMN          oracle@EDRSR41P1 (SCMN)
12380 12383 MMAN          oracle@EDRSR41P1 (MMAN)
12380 12398 LREG          oracle@EDRSR41P1 (LREG)
12380 12396 SMON          oracle@EDRSR41P1 (SMON)
12386 12401 MMNL          oracle@EDRSR41P1 (MMNL)
12386 12400 MMON          oracle@EDRSR41P1 (MMON)
12386 18057 CJQ0          oracle@EDRSR41P1 (CJQ0)
12386 12397 RECO          oracle@EDRSR41P1 (RECO)
12386 12391 DIA0          oracle@EDRSR41P1 (DIA0)
12386 12390 VKRM          oracle@EDRSR41P1 (VKRM)
12386 12386 SCMN          oracle@EDRSR41P1 (SCMN)
12386 12388 DIAG          oracle@EDRSR41P1 (DIAG)
12386 17649       SYS     sqlplus@EDRSR41P1 (TNS V1-V3)
12386 12399 PXMN          oracle@EDRSR41P1 (PXMN)
12386 17755 TMON          oracle@EDRSR41P1 (TMON)
12386 17756 ARC0          oracle@EDRSR41P1 (ARC0)
12386 17757 ARC1          oracle@EDRSR41P1 (ARC1)
12386 17758 ARC2          oracle@EDRSR41P1 (ARC2)
12386 17759 ARC3          oracle@EDRSR41P1 (ARC3)
```

```
12386 17760 TT00          oracle@EDRSR41P1 (TT00)
12386 17765 SMCO          oracle@EDRSR41P1 (SMCO)
12386 17766 W000          oracle@EDRSR41P1 (W000)
12386 17767 W001          oracle@EDRSR41P1 (W001)
12386 17769 AQPC          oracle@EDRSR41P1 (AQPC)
12386 17970 QM02          oracle@EDRSR41P1 (QM02)
12386 17972 Q002          oracle@EDRSR41P1 (Q002)
12386 17973 Q003          oracle@EDRSR41P1 (Q003)
12386 17974 Q004          oracle@EDRSR41P1 (Q004)
12393 12393 DBW0          oracle@EDRSR41P1 (DBW0)

37 rows selected.

SQL>
```

10. What do you observe?
    Now, many Oracle processes run as threads inside a small amount of OS processes.

11. Establish a remote connection to your `cdb2` instance using SQL*Plus, and list again OS processes and threads used to run all Oracle processes.

```
SQL> connect sys@cdb2 as sysdba
Enter password: ******
Connected.
SQL> @MPMT

SPID  STID  PNAME USERNAME   PROGRAM
----- ----- ----- ---------- ------------------------------
12372 12372 PMON          oracle@EDRSR41P1 (PMON)
12374 12374 PSP0          oracle@EDRSR41P1 (PSP0)
12376 12376 VKTM          oracle@EDRSR41P1 (VKTM)
12380 12394 LGWR          oracle@EDRSR41P1 (LGWR)
12380 12398 LREG          oracle@EDRSR41P1 (LREG)
12380 12382 GEN0          oracle@EDRSR41P1 (GEN0)
12380 17754 RVWR          oracle@EDRSR41P1 (RVWR)
12380 12389 DBRM          oracle@EDRSR41P1 (DBRM)
12380 12395 CKPT          oracle@EDRSR41P1 (CKPT)
12380 12396 SMON          oracle@EDRSR41P1 (SMON)
12380 12380 SCMN          oracle@EDRSR41P1 (SCMN)
12380 12383 MMAN          oracle@EDRSR41P1 (MMAN)
12386 12397 RECO          oracle@EDRSR41P1 (RECO)
12386 12391 DIA0          oracle@EDRSR41P1 (DIA0)
12386 12390 VKRM          oracle@EDRSR41P1 (VKRM)
12386 12386 SCMN          oracle@EDRSR41P1 (SCMN)
12386 12388 DIAG          oracle@EDRSR41P1 (DIAG)
```

```
12386 12399 PXMN          oracle@EDRSR41P1 (PXMN)
12386 18057 CJQ0          oracle@EDRSR41P1 (CJQ0)
12386 18721 W002          oracle@EDRSR41P1 (W002)
12386 12400 MMON          oracle@EDRSR41P1 (MMON)
12386 12401 MMNL          oracle@EDRSR41P1 (MMNL)
12386 17755 TMON          oracle@EDRSR41P1 (TMON)
12386 17756 ARC0          oracle@EDRSR41P1 (ARC0)
12386 17757 ARC1          oracle@EDRSR41P1 (ARC1)
12386 17758 ARC2          oracle@EDRSR41P1 (ARC2)
12386 17759 ARC3          oracle@EDRSR41P1 (ARC3)
12386 17760 TT00          oracle@EDRSR41P1 (TT00)
12386 17765 SMCO          oracle@EDRSR41P1 (SMCO)
12386 17766 W000          oracle@EDRSR41P1 (W000)
12386 17767 W001          oracle@EDRSR41P1 (W001)
12386 17769 AQPC          oracle@EDRSR41P1 (AQPC)
12386 17970 QM02          oracle@EDRSR41P1 (QM02)
12386 17972 Q002          oracle@EDRSR41P1 (Q002)
12386 17973 Q003          oracle@EDRSR41P1 (Q003)
12386 17974 Q004          oracle@EDRSR41P1 (Q004)
12393 12393 DBW0          oracle@EDRSR41P1 (DBW0)
18760 18760       SYS     sqlplus@EDRSR41P1 (TNS V1-V3)

38 rows selected.


SQL>
```

12. What do you observe?
    Your foreground process that runs your SQL*Plus connection is using one OS process, and not threads.
13. How would you make sure foreground processes are using threads?

```
SQL> EXIT
$
```

a. View the `tnsnames.ora` file content.

```
$ cat $ORACLE_HOME/network/admin/tnsnames.ora
# tnsnames.ora Network Configuration File:
/u01/app/oracle/product/12.1.0/dbhome_1/network/admin/tnsnames.o
ra
# Generated by Oracle configuration tools.


LISTENER_CDB2 =
```

```
  (ADDRESS = (PROTOCOL = TCP)(HOST = <your_hostname>)(PORT =
1521))

PDB_ORCL2 =
  (DESCRIPTION =
    (ADDRESS_LIST =
      (ADDRESS = (PROTOCOL = TCP)(HOST = localhost)(PORT =
1521))
    )
    (CONNECT_DATA =
      (SERVICE_NAME = pdb_orcl2)
    )
  )

PDB2_2 =
  (DESCRIPTION =
    (ADDRESS_LIST =
      (ADDRESS = (PROTOCOL = TCP)(HOST = localhost)(PORT =
1521))
    )
    (CONNECT_DATA =
      (SERVICE_NAME = pdb2_2)
    )
  )

PDB2_1 =
  (DESCRIPTION =
    (ADDRESS_LIST =
      (ADDRESS = (PROTOCOL = TCP)(HOST = localhost)(PORT =
1521))
    )
    (CONNECT_DATA =
      (SERVICE_NAME = pdb2_1)
    )
  )

PDB2 =
  (DESCRIPTION =
    (ADDRESS_LIST =
      (ADDRESS = (PROTOCOL = TCP)(HOST = localhost)(PORT =
1521))
    )
    (CONNECT_DATA =
```

```
      (SERVICE_NAME = pdb2)
    )
  )

CDB2 =
  (DESCRIPTION =
    (ADDRESS = (PROTOCOL = TCP)(HOST = <your_hostname>)(PORT =
1521))
    (CONNECT_DATA =
      (SERVER = DEDICATED)
      (SERVICE_NAME = cdb2)
    )
  )


CDB1 =
  (DESCRIPTION =
    (ADDRESS = (PROTOCOL = TCP)(HOST = <your_hostname>)(PORT =
1521))
    (CONNECT_DATA =
      (SERVER = DEDICATED)
      (SERVICE_NAME = cdb1)
    )
  )

ORCL2 =
  (DESCRIPTION =
    (ADDRESS = (PROTOCOL = TCP)(HOST = <your_hostname>)(PORT =
1521))
    (CONNECT_DATA =
      (SERVER = DEDICATED)
      (SERVICE_NAME = orcl2)
    )
  )

PDB1_1 =
  (DESCRIPTION =
    (ADDRESS_LIST =
      (ADDRESS = (PROTOCOL = TCP)(HOST = localhost)(PORT =
1521))
    )
    (CONNECT_DATA =
      (SERVICE_NAME = pdb1_1)
    )
```

```
  )

EM12REP =
  (DESCRIPTION =
    (ADDRESS = (PROTOCOL = TCP)(HOST = <your_hostname>)(PORT =
1521))
    (CONNECT_DATA =
      (SERVICE_NAME = em12rep)
    )
  )
ORCL =
  (DESCRIPTION =
    (ADDRESS = (PROTOCOL = TCP)(HOST = <your_hostname>)(PORT =
1521))
    (CONNECT_DATA =
      (SERVER = DEDICATED)
      (SERVICE_NAME = orcl)
    )
  )
$
```

b. View the `listener.ora` file content.

```
$ cat $ORACLE_HOME/network/admin/listener.ora
# listener.ora Network Configuration File:
/u01/app/oracle/product/12.1.0/dbhome_1/network/admin/listener.o
ra
# Generated by Oracle configuration tools.


LISTENER =
  (DESCRIPTION_LIST =
    (DESCRIPTION =
      (ADDRESS = (PROTOCOL = IPC)(KEY = EXTPROC1521))
      (ADDRESS = (PROTOCOL = TCP)(HOST = <YOURSERVER> )(PORT =
1521))
    )
  )


$
```

c. Keep a copy of the `listener.ora` file.

```
$ cp $ORACLE_HOME/network/admin/listener.ora
$ORACLE_HOME/network/admin/listener.ora.bak
$
```

d. Add the following parameter in the `listener.ora` file.

```
$ echo DEDICATED_THROUGH_BROKER_LISTENER=on >>
$ORACLE_HOME/network/admin/listener.ora
$
```

e. Check that the `listener.ora` file is adequately modified.

```
$ cat $ORACLE_HOME/network/admin/listener.ora
# listener.ora Network Configuration File:
/u01/app/oracle/product/12.1.0/dbhome_1/network/admin/listener.o
ra
# Generated by Oracle configuration tools.

LISTENER =
  (DESCRIPTION_LIST =
    (DESCRIPTION =
      (ADDRESS = (PROTOCOL = IPC)(KEY = EXTPROC1521))
      (ADDRESS = (PROTOCOL = TCP)(HOST = <YOURSERVER>)(PORT =
1521))
    )
  )

DEDICATED_THROUGH_BROKER_LISTENER=on
$
```

f. Restart the listener.

```
$ lsnrctl stop

LSNRCTL for Linux: Version 12.1.0.2.0 - Production on 22-MAY-
2014 08:35:55
Copyright (c) 1991, 2014, Oracle.  All rights reserved.

Connecting to (DESCRIPTION=(ADDRESS=(PROTOCOL=TCP)( HOST =
<YOURSERVER>)(PORT=1521)))
The command completed successfully
$
```

```
$ lsnrctl start

LSNRCTL for Linux: Version 12.1.0.2.0 - Production on 22-MAY-
2014 08:35:59
Copyright (c) 1991, 2014, Oracle.  All rights reserved.
…
(DESCRIPTION=(ADDRESS=(PROTOCOL=tcp)(HOST=<YOURSERVER>)(PORT=152
1)))
(DESCRIPTION=(ADDRESS=(PROTOCOL=ipc)(KEY=EXTPROC1521)))
```

```
The listener supports no services
The command completed successfully
$
```

g. Set the `LOCAL_LISTENER` parameter to `cdb2`.

```
$ sqlplus sys@cdb2 as sysdba

Enter password: ******

Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
64bit Production
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testing and Unified Auditing options

SQL> show parameter local_listener

NAME                                 TYPE        VALUE
------------------------------------ ----------- -------------
local_listener                       string
LISTENER_CDB2

SQL> alter system set local_listener=cdb2 scope=both;

System altered.

SQL> show parameter local_listener

NAME                                 TYPE        VALUE
------------------------------------ ----------- -------------
local_listener                       string      CDB2

SQL>
```

14. Check that what you did is working.
Tip: Looking at the `sqlplus` program, it should be run as a thread in an existing OS process.

```
SQL> connect sys@cdb2 as sysdba
Enter password: ******
Connected.
SQL> @MPMT

SPID  STID  PNAME USERNAME   PROGRAM
----- ----- ----- ---------- ------------------------------
```

```
12372 12372 PMON          oracle@EDRSR41P1 (PMON)
12374 12374 PSP0          oracle@EDRSR41P1 (PSP0)
12376 12376 VKTM          oracle@EDRSR41P1 (VKTM)
12380 12395 CKPT          oracle@EDRSR41P1 (CKPT)
12380 12394 LGWR          oracle@EDRSR41P1 (LGWR)
12380 17754 RVWR          oracle@EDRSR41P1 (RVWR)
12380 12389 DBRM          oracle@EDRSR41P1 (DBRM)
12380 12382 GEN0          oracle@EDRSR41P1 (GEN0)
12380 12380 SCMN          oracle@EDRSR41P1 (SCMN)
12380 12383 MMAN          oracle@EDRSR41P1 (MMAN)
12380 12398 LREG          oracle@EDRSR41P1 (LREG)
12380 12396 SMON          oracle@EDRSR41P1 (SMON)
12386 12401 MMNL          oracle@EDRSR41P1 (MMNL)
12386 12400 MMON          oracle@EDRSR41P1 (MMON)
12386 18721 W002          oracle@EDRSR41P1 (W002)
12386 12397 RECO          oracle@EDRSR41P1 (RECO)
12386 12391 DIA0          oracle@EDRSR41P1 (DIA0)
12386 12390 VKRM          oracle@EDRSR41P1 (VKRM)
12386 12386 SCMN          oracle@EDRSR41P1 (SCMN)
12386 12388 DIAG          oracle@EDRSR41P1 (DIAG)
12386 19428 SYS      sqlplus@EDRSR41P1 (TNS V1-V3)
12386 12399 PXMN          oracle@EDRSR41P1 (PXMN)
12386 17755 TMON          oracle@EDRSR41P1 (TMON)
12386 17756 ARC0          oracle@EDRSR41P1 (ARC0)
12386 17757 ARC1          oracle@EDRSR41P1 (ARC1)
12386 17758 ARC2          oracle@EDRSR41P1 (ARC2)
12386 17759 ARC3          oracle@EDRSR41P1 (ARC3)
12386 17760 TT00          oracle@EDRSR41P1 (TT00)
12386 17765 SMCO          oracle@EDRSR41P1 (SMCO)
12386 17766 W000          oracle@EDRSR41P1 (W000)
12386 17767 W001          oracle@EDRSR41P1 (W001)
12386 17769 AQPC          oracle@EDRSR41P1 (AQPC)
12386 17970 QM02          oracle@EDRSR41P1 (QM02)
12386 17972 Q002          oracle@EDRSR41P1 (Q002)
12386 17973 Q003          oracle@EDRSR41P1 (Q003)
12386 18057 CJQ0          oracle@EDRSR41P1 (CJQ0)
12393 12393 DBW0          oracle@EDRSR41P1 (DBW0)

37 rows selected.

SQL>
```

15. Revert to the non-MPMT architecture. Keep the `cdb2` database closed for the moment so as to preserve resources on the machine.

```
SQL> alter system set threaded_execution=false scope=spfile;

System altered.

SQL> shutdown immediate
Database closed.
Database dismounted.
ORACLE instance shut down.
ERROR:
ORA-12514: TNS:listener does not currently know of service
requested in connect
descriptor


Warning: You are no longer connected to ORACLE.
SQL> EXIT
$
```

16. Restore the original `listener.ora` file.

```
$ cp $ORACLE_HOME/network/admin/listener.ora.bak
$ORACLE_HOME/network/admin/listener.ora
$
```

Practices for Lesson 21: Tables, Indexes and Online Operations

Chapter 21

Practices for Lesson 21: Overview

Practices Overview

In the practice for this lesson, you will use the invisible/visible table columns and the Advanced Row Compression.

Practice 21-1: Using Invisible Table Columns

Overview

In this practice, you will create a table with invisible columns. These columns are not necessarily useful for the current application but might become useful in a later application release.

Tasks

1. Make sure you are in the `~/labs/Tables` directory and your environment points to the `orcl` instance.

```
$ cd ~/labs/Tables
$ . oraenv
ORACLE_SID = [cdb2] ? orcl
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$
```

2. Run the `invisible_setup.sql` script to create a new user `STATS`

```
$ sqlplus / AS SYSDBA
```

```
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SQL> @invisible_setup.sql
Connected.
DROP USER stats CASCADE
         *
ERROR at line 1:
ORA-01918: user 'STATS' does not exist

User created.

Grant succeeded.
SQL>
```

3. The STATS user creates a new table CENSUS. The table structure contains three columns, GENDER, COUNTRY, NUMBER and an invisible column REGION. The REGION column is not used by the application yet, but might become useful in a future application release.

```
SQL> CREATE TABLE stats.census (gender VARCHAR2(10), country
CHAR(2), nb NUMBER, region VARCHAR2(20) INVISIBLE );

Table created.

SQL>
```

4. Describe the structure of the CENSUS table.
   a. You see that the invisible column does not appear.

```
SQL> DESC stats.census
 Name                      Null?    Type
 ------------------------- -------- ----------------------------
 GENDER                             VARCHAR2(10)
 COUNTRY                            CHAR(2)
 NB                                 NUMBER

SQL>
```

b. Describe the structure of the CENSUS table so that the invisible column appears.

```
SQL> SET COLINVISIBLE ON
SQL> DESC stats.census
 Name                          Null?    Type
 ----------------------------- -------- ----------------------------
 GENDER                                 VARCHAR2(10)
 COUNTRY                                CHAR(2)
 NB                                     NUMBER
 REGION (INVISIBLE)                     VARCHAR2(20)

SQL>
```

5. Insert rows into the CENSUS table.

a. You cannot insert a value for the invisible column unless you define it in the projection list.

```
SQL> INSERT INTO stats.census VALUES ('BOY','BR', 10000,
'BAHIA');
INSERT INTO stats.census VALUES ('BOY','BR', 10000, 'BAHIA')
                 *
ERROR at line 1:
ORA-00913: too many values

SQL>
```

b. Insert a row with values for the three visible columns.

```
SQL> INSERT INTO stats.census VALUES ('BOY','BR',100000);

1 row created.

SQL> COMMIT;

Commit complete.

SQL> SELECT * FROM stats.census;

GENDER     CO         NB
---------- -- ----------
BOY        BR     100000

SQL>
```

c. Insert a row with a value for the invisible column.

```
SQL> INSERT INTO stats.census (gender, country, nb, region)
VALUES ('BOY','BR', 35000,'BAHIA');

1 row created.

SQL> COMMIT;

Commit complete.

SQL> SELECT gender, country, nb, region FROM stats.census;

GENDER     CO         NB REGION
---------- -- ---------- --------------------
BOY        BR     100000
BOY        BR      35000 BAHIA

SQL>
```

6. Make the invisible column visible.

```
SQL> ALTER TABLE stats.census MODIFY (region VISIBLE);

Table altered.

SQL> SELECT * FROM stats.census;

GENDER     CO         NB REGION
---------- -- ---------- --------------------
BOY        BR     100000
BOY        BR      35000 BAHIA

SQL>
```

Practice 21-2: Using Advanced Row Compression

Overview

In this practice, you will use the row store advanced compression. You will compare the storage requirements between a compressed table and an uncompressed table and verify the compression ratio between different tables with the same number of rows.

Tasks

1. Connect as SH. You first create two copies of the SH.SALES table, the first being compressed and the second being uncompressed.

```
SQL> CONNECT sh
Enter password: ******
Connected.
SQL> drop table sales_nocompress purge;
drop table sales_nocompress purge
           *
ERROR at line 1:
ORA-00942: table or view does not exist

SQL> drop table sales_advcompress purge;
drop table sales_advcompress purge
           *
ERROR at line 1:
ORA-00942: table or view does not exist

SQL> set echo on
SQL> set timing on
SQL> CREATE TABLE sales_nocompress AS SELECT * FROM sales;

Table created.

Elapsed: 00:00:17.07
SQL> CREATE TABLE sales_advcompress ROW STORE COMPRESS ADVANCED
AS SELECT * FROM sales where 1=0;

Table created.

Elapsed: 00:00:00.12
SQL>

SQL> SELECT count(*) FROM sales_nocompress;

  COUNT(*)
```

```
----------
   1839684

Elapsed: 00:00:00.67
SQL> SELECT count(*) FROM sales_advcompress;

  COUNT(*)
----------
         0

Elapsed: 00:00:00.00
SQL>
```

2. Execute the `$HOME/labs/Tables/load.sql` to load the `SALES_ADVCOMPRESS` table.

```
SQL> @load
SQL> declare
  2  commit_after integer := 0 ;
  3  loop_variable integer ;
  4   cursor c_sales is
  5   select prod_id, cust_id, time_id, channel_id, promo_id,
quantity_sold, amount_sold
  6   from sales ;
  7   begin
  8   for r_sales in c_sales
  9   loop
 10   if commit_after = 0
 11   then
 12   loop_variable := 0 ;
 13   commit_after := round(dbms_random.value(1,1)) ;
 14   end if ;
 15   insert into sales_advcompress
 16   (prod_id, cust_id, time_id, channel_id, promo_id,
quantity_sold, amount_sold)
 17   values
 18   (r_sales.prod_id, r_sales.cust_id, r_sales.time_id,
r_sales.channel_id,
 19    r_sales.promo_id, r_sales.quantity_sold,
r_sales.amount_sold) ;
 20    if loop_variable = commit_after
 21    then
 22    commit ;
 23    commit_after := 0 ;
 24    end if ;
 25    loop_variable := loop_variable + 1 ;
```

```
 26    end loop ;
 27   end ;
 28  /

PL/SQL procedure successfully completed.

Elapsed: 00:02:17.91
SQL>
```

3. Verify the number of rows in the two tables.

```
SQL> SELECT count(*) FROM sales_nocompress;

  COUNT(*)
----------
   1839684

Elapsed: 00:00:00.04
SQL> SELECT count(*) FROM sales_advcompress;

  COUNT(*)
----------
   1839684

Elapsed: 00:00:00.02
SQL>
```

4. Now you can compare the storage requirements between the two tables you just created. Use the `$HOME/labs/Tables/comp1.sql` script.

```
SQL> @comp1
SQL> COL segment_name FORMAT A30
SQL> select segment_name, sum(bytes)/1024/1024 mb
  2         from      dba_segments
  3         where  owner = 'SH' and segment_name in
  4             ('SALES_NOCOMPRESS','SALES_ADVCOMPRESS')
  5         group by segment_name order by segment_name;

SEGMENT_NAME                   MB
------------------------ ----------
SALES_ADVCOMPRESS                28
SALES_NOCOMPRESS                 72

Elapsed: 00:00:00.12
SQL>
```

5. Use the DBMS_COMPRESSION package to get the compression ratio of the SALES_ADVCOMPRESS table. Execute the $HOME/labs/Tables/ratio.sql script.

```
SQL> @ratio
SQL> set serveroutput on
SQL> DECLARE
 blkcnt_cmp pls_integer;
 blkcnt_uncmp pls_integer;
 row_cmp pls_integer;
 row_uncmp pls_integer;
 cmp_ratio pls_integer;
 comptype_str varchar2(100);
 BEGIN
 DBMS_COMPRESSION.GET_COMPRESSION_RATIO (
      'USERS', 'SH', 'SALES_ADVCOMPRESS', NULL,
DBMS_COMPRESSION.COMP_ADVANCED,
      blkcnt_cmp, blkcnt_uncmp, row_cmp, row_uncmp, cmp_ratio,
comptype_str,1000,1);
 DBMS_OUTPUT.PUT_LINE('Table = SH.SALES_ADVCOMPRESS');
 DBMS_OUTPUT.PUT_LINE('Block count compressed = ' ||
blkcnt_cmp);
 DBMS_OUTPUT.PUT_LINE('Block count uncompressed = ' ||
blkcnt_uncmp);
 DBMS_OUTPUT.PUT_LINE('Row count per block compressed = ' ||
row_cmp);
 DBMS_OUTPUT.PUT_LINE('Row count per block uncompressed = ' ||
row_uncmp);
 DBMS_OUTPUT.PUT_LINE('Compression type = ' || comptype_str);
 DBMS_OUTPUT.PUT_LINE('Compression ratio =
'||blkcnt_uncmp/blkcnt_cmp||' to 1');
 DBMS_OUTPUT.PUT_LINE('Compression ratio org= '||cmp_ratio);
 END;
/
Table = SH.SALES_ADVCOMPRESS
Block count compressed = 2105
Block count uncompressed = 5646
Row count per block compressed = 556
Row count per block uncompressed = 207
Compression type = "Compress Advanced"
Compression ratio = 2.68218527315914489311163895486935866983 to
1
Compression ratio org= 3

PL/SQL procedure successfully completed.
```

```
Elapsed: 00:00:16.79
SQL>
```

6. Analyze the tables and note the number of rows compressed in the compressed table and compare the ratio of compression with the non-compressed table.

```
SQL> ANALYZE TABLE sh.sales_nocompress COMPUTE STATISTICS;

Table analyzed.

Elapsed: 00:00:16.79
SQL> ANALYZE TABLE sh.sales_advcompress COMPUTE STATISTICS;

Table analyzed.

Elapsed: 00:00:11.29
SQL>
```

To perform the comparison, execute the `$HOME/labs/Tables/comp2.sql` script.

```
SQL> @comp2
SQL> COL object_name format A18
SQL> CONNECT / AS SYSDBA
Connected.
SQL> SELECT object_name ,  AVGROWSIZE_NC, AVGROWSIZE_C, NBLK_NC,
  2             NBLK_ADVANCED, NROWS_NC, NROWS_ADVANCED
  3         FROM      sys.compression_stat$ c , DBA_OBJECTS o
  4         WHERE  c.obj# = o.object_id
  5         AND  o.object_name = 'SALES_ADVCOMPRESS';

OBJECT_NAME       AVGROWSIZE_NC AVGROWSIZE_C    NBLK_NC
------------------ ------------ ------------ ----------
NBLK_ADVANCED      NROWS_NC NROWS_ADVANCED
------------- ------------- --------------
SALES_ADVCOMPRESS          32.81        10.54          22
         3498        71328        1768356

Elapsed: 00:00:00.21
SQL> SELECT avg_row_len, num_rows FROM dba_tables WHERE
table_name='SALES_NOCOMPRESS';

AVG_ROW_LEN   NUM_ROWS
----------- ----------
         33     1839684

Elapsed: 00:00:00.05
SQL>
```

The non compressed table contains 1839684 uncompressed rows whereas the compressed table contains 1768356 compressed rows and only 71328 uncompressed rows with an average row size 3 times smaller.

7. Clean up the tables.

```
SQL> DROP TABLE sh.sales_nocompress PURGE;

Table dropped.

Elapsed: 00:00:00.07
SQL> DROP TABLE sh.sales_advcompress PURGE;

Table dropped.

Elapsed: 00:00:00.25

SQL> EXIT
$
```

Practices for Lesson 22: Oracle Data Pump, SQL*Loader, and External Tables

Chapter 22

Practices for Lesson 22: Overview

Practices Overview

In these practices, you will perform a FULL TRANSPORTABLE from the non-CDB into the non-CDB `orcl2`.

You will also perform a data load by using SQL*Loader Express Mode.

Practice 22-1: Exporting/Importing Databases in FULL TRANSPORTABLE Mode

Overview

In this practice, you export the `orcl` non-CDB database and import into another non-CDB database `orcl2` using the Oracle Data Pump FULL TRANSPORTABLE feature.

Assumptions

The `orcl` and `orcl2` non-CDBs already exist. They are pre-created during the course setup.

Tasks

1. Make sure you are in the `~/labs/Load` directory.

```
$ cd ~/labs/Load
$
```

2. The `orcl2` non-CDB is the target database. Start the `orcl2` non-CDB.

```
$ . oraenv
ORACLE_SID = [orcl] ? orcl2
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$ sqlplus / as sysdba
Connected to an idle instance.


SQL> startup
ORACLE instance started.


Total System Global Area  503316480 bytes
Fixed Size                  2917144 bytes
Variable Size             272633064 bytes
Database Buffers          222298112 bytes
Redo Buffers                5468160 bytes
Database mounted.
Database opened.
SQL>
```

3. In the "target" `orcl2` database, drop the `EXAMPLE` tablespace. Use the `$HOME/labs/Load/droptbs.sql` script.

```
SQL> @droptbs
```

```
User dropped.

User dropped.

User dropped.

User dropped.

Tablespace dropped.

$
```

4. Prepare the source `orcl` database for FULL TRANSPORTABLE exportation. In another terminal session, connect to the source `orcl` database.

```
$ . oraenv
ORACLE_SID = [orcl2] ? orcl
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle

$ sqlplus / as sysdba

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SQL>
```

5. Put the user-defined tablespaces in the source database `orcl` in read-only mode.

   a. Create new tablespace to be transported with other tablespaces into `orcl2` database.

```
SQL> CREATE TABLESPACE test DATAFILE
'/u01/app/oracle/oradata/orcl/test01.dbf' size 5M;

Tablespace created.

SQL>
```

   b. Create a table `HR.TESTTAB` in the `TEST` tablespace, insert rows, and commit. You will check at the end of the FULL TRANSPORTABLE operation from `orcl` to `orcl2` database if the `HR.TESTTAB` has been transported in a `TEST` tablespace in the `orcl2` database. Execute the `$HOME/labs/Load/testtab.sql` script.

```
SQL> @testtab
```

```
Table created.

1 row created.

1 row created.

Commit complete.

SQL>
```

c. Find the list of user-defined tablespaces to be put in read-only mode.

```
SQL> SELECT tablespace_name FROM dba_tablespaces ORDER BY 1;

TABLESPACE_NAME
------------------------------
EXAMPLE
SYSAUX
SYSTEM
TEMP
TEST
UNDOTBS1
USERS

7 rows selected.

SQL>
```

d. The list may be different from yours according to the tablespaces created during the training session. Make all tablespaces except SYSTEM, SYSAUX, TEMP, and UNDOTBS1 read-only.

```
SQL> ALTER TABLESPACE example READ ONLY;

Tablespace altered.

SQL> ALTER TABLESPACE test READ ONLY;

Tablespace altered.

SQL> ALTER TABLESPACE users  READ ONLY;

Tablespace altered.

SQL>
```

e. Find the list of data files associated to the read-only tablespaces that need to be transported.

```
SQL> SELECT file_name FROM dba_data_files
     WHERE tablespace_name IN
                       ('EXAMPLE','TEST','USERS');
  2    3
FILE_NAME
----------------------------------------------------------------
/u01/app/oracle/oradata/orcl/users01.dbf
/u01/app/oracle/oradata/orcl/example01.dbf
/u01/app/oracle/oradata/orcl/test01.dbf

SQL> EXIT
$
```

6. Export the `orcl` database in full transportable mode.

```
$ rm /u01/app/oracle/admin/orcl/dpdump/expfull.dmp
rm: cannot remove
`/u01/app/oracle/admin/orcl/dpdump/expfull.dmp': No such file or
directory
$ expdp system DUMPFILE=expfull.dmp FULL=Y TRANSPORTABLE=ALWAYS
LOGFILE=exp.log

Export: Release 12.1.0.2.0 - Production on Thu May 22 09:22:32
2014
…
```

```
Starting "SYSTEM"."SYS_EXPORT_FULL_01":  system/********
DUMPFILE=expfull.dmp FULL=Y TRANSPORTABLE=ALWAYS LOGFILE=exp.log
Estimate in progress using BLOCKS method...
Processing object type
DATABASE_EXPORT/PLUGTS_FULL/FULL/PLUGTS_TABLESPACE
Processing object type DATABASE_EXPORT/PLUGTS_FULL/PLUGTS_BLK …
Processing object type
DATABASE_EXPORT/SCHEMA/TABLE/INDEX/DOMAIN_INDEX/SECONDARY_TABLE/
INDEX/INDEX
ORA-39340: unsupported object,
INDEX:"SH"."SYS_IL0000096551C00006$$" will be skipped.
ORA-39340: unsupported object,
INDEX:"SH"."SYS_IL0000096554C00002$$" will be skipped.
…
. . exported "SYSTEM"."SCHEDULER_PROGRAM_ARGS"           9.515
KB      12 rows
. . exported "SYS"."AUDTAB$TBS$FOR_EXPORT"               5.953
KB       2 rows
```

```
. . exported "SYS"."NACL$_ACE_EXP"                          9.929
KB       1 rows
. . exported "SYS"."NACL$_HOST_EXP"                         6.914
KB       1 rows
. . exported "WMSYS"."WM$EXP_MAP"                           7.718
KB       3 rows
. . exported "SYS"."DBA_SENSITIVE_DATA"                         0
KB       0 rows
. . exported "SYS"."DBA_TSDP_POLICY_PROTECTION"                 0
KB       0 rows
. . exported "SYS"."FGA_LOG$FOR_EXPORT"                         0
KB       0 rows
. . exported "SYS"."NACL$_WALLET_EXP"                           0
KB       0 rows
. . exported "SYSTEM"."SCHEDULER_JOB_ARGS"                      0
KB       0 rows
Master table "SYSTEM"."SYS_EXPORT_FULL_01" successfully
loaded/unloaded
******************************************************************
*
Dump file set for SYSTEM.SYS_EXPORT_FULL_01 is:
  /u01/app/oracle/admin/orcl/dpdump/expfull.dmp
******************************************************************
*
Datafiles required for transportable tablespace EXAMPLE:
  /u01/app/oracle/oradata/orcl/example01.dbf
Datafiles required for transportable tablespace TEST:
  /u01/app/oracle/oradata/orcl/test01.dbf
Datafiles required for transportable tablespace USERS:
  /u01/app/oracle/oradata/orcl/users01.dbf
Job "SYSTEM"."SYS_EXPORT_FULL_01" completed with 2 error(s) at
Thu May 22 09:26:26 2014 elapsed 0 00:03:43


$
```

There might be errors during the export. These errors will not impact the import operation.

7. View the log file `exp.log` to get the list of data files to be transported before the full transportable import.

   a. Find the `exp.log` file.

```
$ cd /u01/app/oracle/admin/orcl/dpdump
$ ls -ltr exp*
-rw-r--r-- 1 oracle oinstall    1171 Apr 30 05:51 export.log
-rw-r----- 1 oracle oinstall 7254016 May  2 04:44 expfull.dmp
-rw-r--r-- 1 oracle oinstall   12699 May  2 04:44 exp.log
$
```

b. View the last lines of the `exp.log` file.

```
$ tail -20 exp.log
. . exported "SYSTEM"."SCHEDULER_PROGRAM_ARGS"           9.515
KB      12 rows
. . exported "SYS"."AUDTAB$TBS$FOR_EXPORT"               5.953
KB       2 rows
. . exported "SYS"."DBA_SENSITIVE_DATA"                      0
KB       0 rows
. . exported "SYS"."DBA_TSDP_POLICY_PROTECTION"              0
KB       0 rows
. . exported "SYS"."NACL$_ACE_EXP"                       9.929
KB       1 rows
. . exported "SYS"."NACL$_HOST_EXP"                      6.914
KB       1 rows
. . exported "SYS"."NACL$_WALLET_EXP"                        0
KB       0 rows
. . exported "WMSYS"."WM$EXP_MAP"                        7.718
KB       3 rows
Master table "SYSTEM"."SYS_EXPORT_FULL_01" successfully
loaded/unloaded
******************************************************************
*
Dump file set for SYSTEM.SYS_EXPORT_FULL_01 is:
  /u01/app/oracle/admin/orcl/dpdump/expfull.dmp
******************************************************************
*
Datafiles required for transportable tablespace EXAMPLE:
  /u01/app/oracle/oradata/orcl/example01.dbf
Datafiles required for transportable tablespace TEST:
  /u01/app/oracle/oradata/orcl/test01.dbf
Datafiles required for transportable tablespace USERS:
  /u01/app/oracle/oradata/orcl/users01.dbf
Job "SYSTEM"."SYS_EXPORT_FULL_01" completed with 2 error(s) at
Thu May 22 09:26:26 2014 elapsed 0 00:03:43
$
```

8. Copy the data files to the target locations `/u01/app/oracle/oradata/orcl2` and the export dump file to `/u01/app/oracle/admin/orcl2/dpdump`. Before proceeding, check that there are not any tablespaces in the target `orcl2` database having the same names as the tablespaces in the source `orcl` database.

   a. Set your environment to the target database `orcl2`.

```
$ . oraenv
ORACLE_SID = [orcl] ? orcl2
```

```
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$ sqlplus / as sysdba

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SQL>
```

b. Select the tablespace names.

```
SQL> SELECT tablespace_name FROM dba_tablespaces;

TABLESPACE_NAME
------------------------------
SYSTEM
SYSAUX
UNDOTBS1
TEMP
USERS

SQL>
```

c. Rename the `USERS` tablespace to `USERS_NEW` and the data file `/u01/app/oracle/oradata/orcl2/users01.dbf` to `/u01/app/oracle/oradata/orcl2/users_new01.dbf`.

```
SQL> ALTER TABLESPACE users RENAME TO users_new;

Tablespace altered.

SQL> ALTER TABLESPACE users_new OFFLINE;

Tablespace altered.

SQL> EXIT
$
```

```
$ mv /u01/app/oracle/oradata/orcl2/users01.dbf
/u01/app/oracle/oradata/orcl2/users_new01.dbf
$
```

```
$ sqlplus / as sysdba

Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
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SQL> ALTER DATABASE RENAME FILE
'/u01/app/oracle/oradata/orcl2/users01.dbf' TO
'/u01/app/oracle/oradata/orcl2/users_new01.dbf';

Database altered.

SQL> ALTER TABLESPACE users_new ONLINE;

Tablespace altered.

SQL> SELECT tablespace_name FROM dba_tablespaces ORDER BY 1;

TABLESPACE_NAME
------------------------------
SYSAUX
SYSTEM
TEMP
UNDOTBS1
USERS_NEW

SQL> EXIT
$
```

d. Now you can copy the data files to the target locations `/u01/app/oracle/oradata/orcl2` and the export dump file to `/u01/app/oracle/admin/orcl2/dpdump`.

```
$ cp /u01/app/oracle/oradata/orcl/test01.dbf
/u01/app/oracle/oradata/orcl/example01.dbf
/u01/app/oracle/oradata/orcl/users01.dbf
/u01/app/oracle/oradata/orcl2
$ cp /u01/app/oracle/admin/orcl/dpdump/expfull.dmp
/u01/app/oracle/admin/orcl2/dpdump/expfull.dmp
$
```

9. Import the `orcl` database into the `orcl2` database in full transportable mode. There are many errors due to existing objects in the target `orcl2` database. These errors can be ignored.

```
$ rm /u01/app/oracle/admin/orcl2/dpdump/import.log
rm: cannot remove
`/u01/app/oracle/admin/orcl2/dpdump/import.log': No such file or
directory
$ impdp system FULL=Y dumpfile=expfull.dmp
TRANSPORT_DATAFILES='/u01/app/oracle/oradata/orcl2/test01.dbf','
/u01/app/oracle/oradata/orcl2/users01.dbf','/u01/app/oracle/orad
ata/orcl2/example01.dbf' logfile=import.log
…
Password: ******
…
Master table "SYSTEM"."SYS_IMPORT_FULL_01" successfully
loaded/unloaded
Starting "SYSTEM"."SYS_IMPORT_FULL_01":  system/******** FULL=Y
dumpfile=expfull.dmp
TRANSPORT_DATAFILES=/u01/app/oracle/oradata/orcl2/test01.dbf,/u0
1/app/oracle/oradata/orcl2/users01.dbf,/u01/app/oracle/oradata/o
rcl2/example01.dbf logfile=import.log
…
. . imported "WMSYS"."E$EXP_MAP"                          7.718
KB       3 rows
. . imported "SYS"."DP$DBA_SENSITIVE_DATA"                    0
KB       0 rows
. . imported "SYS"."DP$DBA_TSDP_POLICY_PROTECTION"            0
KB       0 rows
. . imported "SYS"."AMGT$DP$FGA_LOG$FOR_EXPORT"               0
KB       0 rows
. . imported "SYS"."NACL$_WALLET_IMP"                         0
KB       0 rows
. . imported "SYSTEM"."SCHEDULER_JOB_ARGS_TMP"                0
KB       0 rows
Processing object type
DATABASE_EXPORT/NORMAL_POST_INSTANCE_IMPCALLOU/MARKER
Processing object type
DATABASE_EXPORT/SCHEMA/TABLE/PROCACT_INSTANCE
Processing object type DATABASE_EXPORT/SCHEMA/TABLE/TABLE
ORA-39151: Table "SCOTT"."DEPT" exists. All dependent metadata
and data will be skipped due to table_exists_action of skip
ORA-39151: Table "SCOTT"."EMP" exists. All dependent metadata
and data will be skipped due to table_exists_action of skip
…
ORA-39083: Object type
PROCOBJ:"APEX_040200"."ORACLE_APEX_DAILY_MAINTENANCE" failed to
create with error:
```

```
ORA-27477: "APEX_040200"."ORACLE_APEX_DAILY_MAINTENANCE" already
exists
Failing sql is:
BEGIN
dbms_scheduler.create_job('"ORACLE_APEX_DAILY_MAINTENANCE"',
job_type=>'STORED_PROCEDURE', job_action=>
'WWV_FLOW_MAINT.DAILY_MAINTENANCE'
, number_of_arguments=>0,
start_date=>TO_TIMESTAMP_TZ('20-APR-2014 12.38.41.270594000 PM -
07:00','DD-MON-RRRR HH.MI.SSXFF AM
TZR','NLS_DATE_LANGUAGE=english'), repeat_inter
Processing object type
DATABASE_EXPORT/SCHEMA/POST_SCHEMA/PROCACT_SCHEMA
Processing object type
DATABASE_EXPORT/AUDIT_UNIFIED/AUDIT_POLICY_ENABLE
ORA-39083: Object type AUDIT_POLICY_ENABLE:"ORA_SECURECONFIG"
failed to create with error:
ORA-46350: Audit policy ORA_SECURECONFIG already applied with
the BY clause.
Failing sql is:
AUDIT POLICY "ORA_SECURECONFIG" EXCEPT "DBSNMP"
Processing object type
DATABASE_EXPORT/POST_SYSTEM_IMPCALLOUT/MARKER
Job "SYSTEM"."SYS_IMPORT_FULL_01" completed with 37 error(s) at
Thu May 22 09:35:59 2014 elapsed 0 00:03:41
$
```

10. Check in the target `orcl2` database that the tablespaces `TEST`, `EXAMPLE`, and `USERS` have been plugged and that the `HR.TESTTAB` table contains two rows as in the source `orcl` database.

```
$ sqlplus / as sysdba

Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
64bit Production
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testing and Unified Auditing options

SQL> SELECT tablespace_name FROM dba_tablespaces;

TABLESPACE_NAME
------------------------------
SYSTEM
SYSAUX
UNDOTBS1
```

```
TEMP
USERS_NEW
EXAMPLE
TEST
USERS

8 rows selected.

SQL> SELECT name FROM v$datafile;

NAME
--------------------------------------------------------------------
/u01/app/oracle/oradata/orcl2/system01.dbf
/u01/app/oracle/oradata/orcl2/test01.dbf
/u01/app/oracle/oradata/orcl2/sysaux01.dbf
/u01/app/oracle/oradata/orcl2/undotbs01.dbf
/u01/app/oracle/oradata/orcl2/example01.dbf
/u01/app/oracle/oradata/orcl2/users_new01.dbf
/u01/app/oracle/oradata/orcl2/users01.dbf

7 rows selected.

SQL> SELECT * FROM hr.testtab;

        ID LABEL
---------- ----------
        10 Skirt
        20 Trousers

SQL> EXIT
$
```

11. Put the user-defined tablespaces in the source database `orcl` back in read-write mode in order to let users work.

```
$ . oraenv
ORACLE_SID = [orcl2] ? orcl
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$ sqlplus / as sysdba

Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
64bit Production
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testing and Unified Auditing options
```

```
SQL> ALTER TABLESPACE example READ WRITE;

Tablespace altered.

SQL> ALTER TABLESPACE test READ WRITE;

Tablespace altered.

SQL> ALTER TABLESPACE users  READ WRITE;

Tablespace altered.

SQL> EXIT
$
```

Practice 22-2: Loading Data Using SQL*Loader Express Mode *(Optional)*

Overview

In this practice, you will load records from a `tab1.dat` file into the `HR.TAB1` table using SQL*Loader in Express Mode.

Tasks

1. Make sure that you are in the `~/labs/Load` directory and that your environment points to the `orcl` instance.

```
$ cd ~/labs/Load
$ . oraenv
ORACLE_SID = [orcl] ? orcl
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$
```

2. Execute the `$HOME/labs/Load/tab1.sql` to create an `HR.TAB1` table.

```
$ sqlplus / as sysdba

Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
64bit Production
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testing and Unified Auditing options

SQL> @tab1
DROP TABLE hr.tab1 PURGE;
DROP TABLE hr.tab1 PURGE
              *
ERROR at line 1:
ORA-00942: table or view does not exist

Table created.

1 row created.

1 row created.

Commit complete.

$
```

3. Display the `$HOME/labs/Load/tab1.dat` file. It contains five records.

```
$ more tab1.dat
30, Shirt
40, Socks
50, Cap
60, Gloves
70, Tie
$
```

4. Load the five records into the `HR.TAB1` table using SQL*Loader in Express Mode.

```
$ sqlldr hr TABLE=hr.tab1
Password: ******
SQL*Loader: Release 12.1.0.2.0 - Production on Thu May 22
09:45:01 2014

Copyright (c) 1982, 2014, Oracle and/or its affiliates.  All
rights reserved.

Express Mode Load, Table: HR.TAB1
Path used:      External Table, DEGREE_OF_PARALLELISM=AUTO

Table HR.TAB1:
  5 Rows successfully loaded.

Check the log files:
  hr.log
  hr_%p.log_xt
for more information about the load.
$
```

5. Verify the existence of the log files.

```
$ ls -l hr*
-rw-r--r-- 1 oracle oinstall 1036 May  2 05:06 hr_17957.log_xt
-rw-r--r-- 1 oracle oinstall 2240 May  2 05:06 hr.log
$
```

6. View the `hr.log` file.

```
$ more hr.log

SQL*Loader: Release 12.1.0.2.0 - Production on Fri May 2
05:06:28 2014

Copyright (c) 1982, 2014, Oracle and/or its affiliates.  All
rights reserved.

Express Mode Load, Table: HR.TAB1
Data File:      tab1.dat
  Bad File:     tab1.bad
  Discard File:  none specified

 (Allow all discards)

Number to load: ALL
Number to skip: 0
Errors allowed: 50
Continuation:    none specified
Path used:      External Table

Table HR.TAB1, loaded from every logical record.
Insert option in effect for this table: APPEND

   Column Name       Position   Len   Term Encl Datatype
------------------- ---------- ----- ---- ---- -------
ID                         FIRST     *   ,       CHARACTER
PROD_NAME                   NEXT     *   ,       CHARACTER

Generated control file for possible reuse:
OPTIONS(EXTERNAL_TABLE=EXECUTE, TRIM=LRTRIM)
LOAD DATA
INFILE '(null)'
APPEND
INTO TABLE HR.TAB1
FIELDS TERMINATED BY ","
(
  ID,
  PROD_NAME
)
End of generated control file for possible reuse.
```

```
created temporary directory object SYS_SQLLDR_XT_TMPDIR_00000
for path /home/oracle/labs/Load

enable parallel DML: ALTER SESSION ENABLE PARALLEL DML

creating external table "SYS_SQLLDR_X_EXT_TAB1"

CREATE TABLE "SYS_SQLLDR_X_EXT_TAB1"
(
  "ID" NUMBER,
  "PROD_NAME" VARCHAR2(10)
)
ORGANIZATION external
(
  TYPE oracle_loader
  DEFAULT DIRECTORY SYS_SQLLDR_XT_TMPDIR_00000
  ACCESS PARAMETERS
  (
    RECORDS DELIMITED BY NEWLINE CHARACTERSET US7ASCII
    BADFILE 'SYS_SQLLDR_XT_TMPDIR_00000':'tab1.bad'
    LOGFILE 'hr_%p.log_xt'
    READSIZE 1048576
    FIELDS TERMINATED BY "," LRTRIM
    REJECT ROWS WITH ALL NULL FIELDS
    (
      "ID" CHAR(255),
      "PROD_NAME" CHAR(255)
    )
  )
  location
  (
    'tab1.dat'
  )
)REJECT LIMIT UNLIMITED

executing INSERT statement to load database table HR.TAB1

INSERT /*+ append parallel(auto) */ INTO HR.TAB1
(
  ID,
  PROD_NAME
)
```

```
SELECT
  "ID",
  "PROD_NAME"
FROM "SYS_SQLLDR_X_EXT_TAB1"

dropping external table "SYS_SQLLDR_X_EXT_TAB1"

Table HR.TAB1:
  5 Rows successfully loaded.

Run began on Thu May 22 09:45:01 2014
Run ended on Thu May 22 09:45:06 2014

Elapsed time was:     00:00:04.68
CPU time was:         00:00:00.01
$
```

7. View the `hr_17957.log_xt` file.

```
$ more hr_17957.log_xt

LOG file opened at 05/22/14 09:45:06

Field Definitions for table SYS_SQLLDR_X_EXT_TAB1
  Record format DELIMITED BY NEWLINE
  Data in file has same endianness as the platform
  Reject rows with all null fields

  Fields in Data Source:

    ID                              CHAR (255)
      Terminated by ","
      Trim whitespace from left and right
    PROD_NAME                       CHAR (255)
      Terminated by ","
      Trim whitespace from left and right


 LOG file opened at 05/22/14 09:45:06

KUP-05004:   Warning: Intra source concurrency disabled because
parallel select was not requested.

Field Definitions for table SYS_SQLLDR_X_EXT_TAB1
```

```
  Record format DELIMITED BY NEWLINE
  Data in file has same endianness as the platform
  Reject rows with all null fields

  Fields in Data Source:

    ID                              CHAR (255)
      Terminated by ","
      Trim whitespace from left and right
    PROD_NAME                       CHAR (255)
      Terminated by ","
      Trim whitespace from left and right
$
```

8. Verify that the records have been inserted into the `HR.TAB1` table.

```
$ sqlplus / as sysdba

Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
64bit Production
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testing and Unified Auditing options

SQL> SELECT * FROM hr.tab1;

        ID PROD_NAME
---------- ----------
        10 Skirt
        20 Trousers
        30  Shirt
        40  Socks
        50  Cap
        60  Gloves
        70  Tie

SQL>
```

9. Drop the `HR.TAB1` table.

```
SQL> DROP TABLE hr.tab1 PURGE;

Table dropped.

SQL> EXIT
$
```

Practices for Lesson 23: Partitioning Enhancements

Chapter 23

Practices for Lesson 23: Overview

Practices Overview

In this practice, you will familiarize yourself with using partial local and global indexes.

Practice 23-1: Local and Global Partial Indexing on Partitioned Tables

Overview

In this practice, you will create a partitioned table with five partitions: A local partitioned index indexing only two partitions of the table and therefore composed of three index partitions, and a global index indexing the rows of only two partitions of the table.

Tasks

1. Make sure you are in the `~/labs/Part` directory.

```
$ cd ~/labs/Part
$
```

2. Create the partitioned table `HR.TAB_PART1` with five partitions and only three local index partitions.

   a. Connect to the source database `orcl`.

```
$ . oraenv
ORACLE_SID = [orcl] ? orcl
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$ sqlplus / as sysdba


Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
64bit Production
With the Partitioning, OLAP, Advanced Analytics, Real
Application Testing and Unified Auditing options


SQL>
```

   b. To be sure that the segments, tables, partitions and indexes are created without inserting rows, set the `deferred_segment_creation` parameter to `FALSE`.

```
SQL> ALTER SYSTEM SET deferred_segment_creation=FALSE;


System altered.


SQL>
```

   c. Execute the `$HOME/labs/Part/tab_part1.sql` script to create the table.

```
SQL> @tab_part1
DROP TABLE hr.tab_part1 PURGE
               *
ERROR at line 1:
ORA-00942: table or view does not exist
```

```
Table created.

SQL>
```

3. Check the default indexing value of the table created.

```
SQL> SELECT def_indexing FROM dba_part_tables
     WHERE table_name='TAB_PART1';
  2
DEF
---
OFF

SQL>
```

4. Create a partial global index as follows.

```
SQL> CREATE INDEX hr.tab_part1_gidx_ordermode
             ON hr.tab_part1 (order_mode)
             GLOBAL INDEXING PARTIAL;
  2    3
Index created.


SQL>
```

5. Create a partial local partitioned index as follows.

```
SQL> CREATE INDEX hr.tab_part1_lidx_orderdate
             ON hr.tab_part1 (order_date)
             LOCAL INDEXING PARTIAL;
  2    3
Index created.


SQL>
```

6. Check the indexing type and status of the indexes. Use the `$HOME/labs/Part/view.sql` script to display the indexes attributes.

```
SQL> @view

INDEXING INDEX_NAME                 STATUS
-------- -------------------------- --------
PARTIAL  TAB_PART1_LIDX_ORDERDATE   N/A
PARTIAL  TAB_PART1_GIDX_ORDERMODE   VALID

SQL>
```

7. Use the `$HOME/labs/Part/status.sql` script to check the status of the index partitions of the partial local index.

```
SQL> @status

INDEX_NAME                     PARTITION_NAME       STATUS
------------------------------ -------------------- --------
TAB_PART1_LIDX_ORDERDATE       ORD_P5               UNUSABLE
TAB_PART1_LIDX_ORDERDATE       ORD_P4               UNUSABLE
TAB_PART1_LIDX_ORDERDATE       ORD_P3               USABLE
TAB_PART1_LIDX_ORDERDATE       ORD_P2               UNUSABLE
TAB_PART1_LIDX_ORDERDATE       ORD_P1               USABLE

SQL>
```

8. Insert rows into the table. Execute the `$HOME/labs/Part/ins.sql` script

```
SQL> @ins

1 row created.

1 row created.

1 row created.

1 row created.

Commit complete.

SQL>
```

9. Check that the partial global index `TAB_PART1_GIDX_ORDERMODE` is used while performing queries on the highly selective column `ORDER_MODE` to access a single value such as `direct`. The optimizer has to rely on a full scan of the non-indexed partitions for the value such as `online` stored in rows in partitions that are not indexed.

   a. Collect statistics for the table.

```
SQL> EXEC dbms_stats.gather_table_stats ('HR','TAB_PART1')

PL/SQL procedure successfully completed.

SQL>
```

   b. Generate a plan for a query accessing the value `direct` of the `ORDER_MODE` in the table where there are few rows.

```
SQL> EXPLAIN PLAN FOR
     SELECT order_mode, order_status FROM hr.tab_part1
```

```
     WHERE order_mode='direct';
  2    3
Explained.

SQL> select * from table(dbms_xplan.display) ;

PLAN_TABLE_OUTPUT
--------------------------------------------------------------------
Plan hash value: 3230465927
--------------------------------------------------------------------
| Id  | Operation                                          | Name
| Rows  | Bytes | Cost (%CPU)| Time     | Pstart| Pstop |
-----------------------------------------------------------
|   0 | SELECT STATEMENT                                   |
|     2 |    18 |    30   (0)| 00:00:01 |       |       |
|   1 |  VIEW                                              | VW_TE_2
|     3 |    57 |    30   (0)| 00:00:01 |       |       |
|   2 |   UNION-ALL                                        |
|       |       |            |          |       |       |
|*  3 |    TABLE ACCESS BY GLOBAL INDEX ROWID BATCHED| TAB_PART1
|     1 |    17 |     3   (0)| 00:00:01 | ROWID | ROWID |
|*  4 |     INDEX RANGE SCAN                               |
TAB_PART1_GIDX_ORDERMODE
|     2 |       |     1   (0)| 00:00:01 |       |       |
|   5 |    PARTITION RANGE OR                              |
|     2 |    34 |    27   (0)| 00:00:01 |KEY(OR)|KEY(OR)|
|*  6 |     TABLE ACCESS FULL                              | TAB_PART1
|     2 |    34 |    27   (0)| 00:00:01 |KEY(OR)|KEY(OR)|
--------------------------------------------------------------------
Predicate Information (identified by operation id):
---------------------------------------------------


   3 - filter("TAB_PART1"."ORDER_DATE"<TO_DATE(' 1999-10-01
00:00:00', 'syyyy-mm-dd hh24:mi:ss') AND
              "TAB_PART1"."ORDER_DATE">=TO_DATE(' 1999-07-01
00:00:00', 'syyyy-mm-dd hh24:mi:ss') OR
"TAB_PART1"."ORDER_DATE"<TO_DATE('
              1999-03-01 00:00:00', 'syyyy-mm-dd hh24:mi:ss'))
   4 - access("ORDER_MODE"='direct')
   6 - filter("ORDER_MODE"='direct' AND
("TAB_PART1"."ORDER_DATE">=TO_DATE(' 1999-10-01 00:00:00',
'syyyy-mm-dd hh24:mi:ss') AND
```

```
              "TAB_PART1"."ORDER_DATE"<TO_DATE(' 2010-03-01
00:00:00', 'syyyy-mm-dd hh24:mi:ss') OR
"TAB_PART1"."ORDER_DATE"<TO_DATE('
              1999-07-01 00:00:00', 'syyyy-mm-dd hh24:mi:ss')
AND "TAB_PART1"."ORDER_DATE">=TO_DATE(' 1999-03-01 00:00:00',
'syyyy-mm-ddhh24:mi:ss')))

25 rows selected.

SQL>
```

The partial global index is used to access the two partitions of the table where the rows containing the `direct` value in the `ORDER_MODE` column are stored.

10. Load the `ord_p1` partition. This partition is indexed. So both the partial global and local indexes will be updated. Execute the `$HOME/labs/Part/load.sql` script.

```
SQL> @load

1 row created.

2 rows created.

4 rows created.

8 rows created.

16 rows created.

32 rows created.

64 rows created.

128 rows created.

256 rows created.

512 rows created.

1024 rows created.

Commit complete.

SQL>
```

11. Generate the plan for a query by using the key of the partial global index.

```
SQL> EXEC dbms_stats.set_table_prefs('HR','TAB_PART1','CASCADE',
'DBMS_STATS.AUTO_CASCADE')

PL/SQL procedure successfully completed.

SQL> EXEC dbms_stats.gather_table_stats ('HR','TAB_PART1')

PL/SQL procedure successfully completed.

SQL>
```

```
SQL> EXPLAIN PLAN FOR
     SELECT order_mode, order_status FROM hr.tab_part1 WHERE
order_mode='direct';
  2
Explained.

SQL>
```

12. You see that the partial local index is used to access the `ord_p3` partition.

```
SQL> select * from table(dbms_xplan.display) ;


PLAN_TABLE_OUTPUT
--------------------------------------------------------------------
Plan hash value: 1639651856
--------------------------------------------------------------------
| Id  | Operation                                          | Name
| Rows  | Bytes | Cost (%CPU)| Time    | Pstart| Pstop |
--------------------------------------------------------------------
|   0 | SELECT STATEMENT                                   |
|  2050 | 18450 |    43   (0)| 00:00:01 |       |       |
|   1 |  VIEW                                              | VW_TE_2
|  3600 | 68400 |    43   (0)| 00:00:01 |       |       |
|   2 |   UNION-ALL                                        |
|       |       |            |          |       |       |
|   3 |    CONCATENATION                                   |
|       |       |            |          |       |       |
|   4 |     PARTITION RANGE SINGLE                         |
|  2048 | 34816 |    14   (0)| 00:00:01 |     1 |     1 |
|*  5 |      TABLE ACCESS FULL                             |
TAB_PART1               |  2048 | 34816 |    14   (0)| 00:00:01
|     1 |     1 |
```

```
|   6 |     PARTITION RANGE SINGLE                          |
|     1 |    17 |     2   (0)| 00:00:01 |     3 |     3 |
|*  7 |      TABLE ACCESS BY LOCAL INDEX ROWID BATCHED|
TAB_PART1                |     1 |    17 |     2   (0)| 00:00:01
|     3 |     3 |
|*  8 |       INDEX RANGE SCAN                              |
TAB_PART1_LIDX_ORDERDATE |     1 |       |     1   (0)| 00:00:01
|     3 |     3 |
|   9 |    PARTITION RANGE OR                               |
|  1551 | 26367 |    27   (0)| 00:00:01 |KEY(OR)|KEY(OR)|
|* 10 |     TABLE ACCESS FULL                               |
TAB_PART1                |  1551 | 26367 |    27   (0)| 00:00:01
|KEY(OR)|KEY(OR)|
---------------------------------------------------------------------


Predicate Information (identified by operation id):
---------------------------------------------------


   5 - filter("ORDER_MODE"='direct' AND
"TAB_PART1"."ORDER_DATE"<TO_DATE(' 1999-03-01 00:00:00', 'syyyy-
mm-dd hh24:mi:ss'))
   7 - filter("ORDER_MODE"='direct')
   8 - access("TAB_PART1"."ORDER_DATE">=TO_DATE(' 1999-07-01
00:00:00', 'syyyy-mm-dd hh24:mi:ss') AND
              "TAB_PART1"."ORDER_DATE"<TO_DATE(' 1999-10-01
00:00:00', 'syyyy-mm-dd hh24:mi:ss'))
       filter(LNNVL("TAB_PART1"."ORDER_DATE"<TO_DATE(' 1999-03-
01 00:00:00', 'syyyy-mm-dd hh24:mi:ss')))
  10 - filter(("TAB_PART1"."ORDER_DATE">=TO_DATE(' 1999-10-01
00:00:00', 'syyyy-mm-dd hh24:mi:ss') AND
              "TAB_PART1"."ORDER_DATE"<TO_DATE(' 2010-03-01
00:00:00', 'syyyy-mm-dd hh24:mi:ss') OR
"TAB_PART1"."ORDER_DATE"<TO_DATE('
              1999-07-01 00:00:00', 'syyyy-mm-dd hh24:mi:ss')
AND "TAB_PART1"."ORDER_DATE">=TO_DATE(' 1999-03-01 00:00:00',
'syyyy-mm-dd
              hh24:mi:ss')) AND "ORDER_MODE"='direct')


30 rows selected.


SQL>
```

13. Generate the plan for a query on the non-indexed partition `ord_p2`. A table access full is performed on the partition.

```
SQL> EXPLAIN PLAN FOR
     SELECT order_mode, order_status FROM hr.tab_part1
     WHERE order_date >=TO_DATE('1999-03-01 00:00:00','syyyy-mm-
dd hh24:mi:ss')
     AND   order_date <TO_DATE('1999-07-01 00:00:00','syyyy-mm-
dd hh24:mi:ss');
   2    3    4
Explained.

SQL> select * from table(dbms_xplan.display) ;

PLAN_TABLE_OUTPUT
--------------------------------------------------------------------
|   0 | SELECT STATEMENT    |         |     1 |    17 |    14
     (0)| 00:00:01 |       |       |
|   1 |  VIEW               | VW_TE_2   |     2 |    38 |    14
     (0)| 00:00:01 |       |       |
|   2 |   UNION-ALL         |         |       |       |       |
       |       |       |
|*  3 |    FILTER           |         |       |       |       |
       |       |       |
|   4 |     PARTITION RANGE SINGLE|        |     1 |    17 |
14   (0)| 00:00:01 |     2 |     2 |
|   5 |      TABLE ACCESS FULL    | TAB_PART1 |     1 |    17 |
14   (0)| 00:00:01 |     2 |     2 |
|   6 |    PARTITION RANGE SINGLE |        |     1 |    17 |
14   (0)| 00:00:01 |     2 |     2 |
|   7 |     TABLE ACCESS FULL     | TAB_PART1 |     1 |    17 |
14   (0)| 00:00:01 |     2 |     2 |
--------------------------------------------------------------------
-
Predicate Information (identified by operation id):
---------------------------------------------------


   3 - filter(NULL IS NOT NULL)

19 rows selected.

SQL>
```

14. Generate the plan for a query on the indexed partition `ord_p1` and `ord_p3`. A full scan is performed on the large partition `ord_p1` and the partial local index is used to access the `ord_p3` partition rows.

```
SQL> EXPLAIN PLAN FOR
     SELECT order_mode, order_status FROM hr.tab_part1
     WHERE order_date <TO_DATE('1999-03-01 00:00:00','syyyy-mm-
dd hh24:mi:ss')
     OR (order_date between TO_DATE('1999-07-01
00:00:00','syyyy-mm-dd hh24:mi:ss') AND TO_DATE('1999-10-01
00:00:00', 'syyyy-mm-dd hh24:mi:ss'));
  2    3    4
Explained.

SQL> select * from table(dbms_xplan.display) ;

PLAN_TABLE_OUTPUT
--------------------------------------------------------------------
Plan hash value: 2109685904
--------------------------------------------------------------------
| Id  | Operation                                          | Name
| Rows  | Bytes | Cost (%CPU)| Time     | Pstart| Pstop |
--------------------------------------------------------------------
|   0 | SELECT STATEMENT                                   |
|  3337 | 56729 |    30   (0)| 00:00:01 |       |       |
|   1 |  VIEW                                              | VW_TE_2
|  6621 |   122K|    30   (0)| 00:00:01 |       |       |
|   2 |   UNION-ALL                                        |
|       |       |            |          |       |       |
|   3 |    CONCATENATION                                   |
|       |       |            |          |       |       |
|   4 |     PARTITION RANGE SINGLE                         |
|     1 |    17 |     2   (0)| 00:00:01 |     3 |     3 |
|   5 |      TABLE ACCESS BY LOCAL INDEX ROWID BATCHED|
TAB_PART1                |     1 |    17 |     2   (0)| 00:00:01
|     3 |     3 |
|*  6 |       INDEX RANGE SCAN                             |
TAB_PART1_LIDX_ORDERDATE |     1 |       |     1   (0)| 00:00:01
|     3 |     3 |
|   7 |     PARTITION RANGE SINGLE                         |
|  4095 | 69615 |    14   (0)| 00:00:01 |     1 |     1 |
|*  8 |      TABLE ACCESS FULL                             |
TAB_PART1                |  4095 | 69615 |    14   (0)| 00:00:01
|     1 |     1 |
|   9 |    PARTITION RANGE OR                              |
|  2525 | 42925 |    14   (0)| 00:00:01 |KEY(OR)|KEY(OR)|
```

```
|* 10 |     TABLE ACCESS FULL                                  |
TAB_PART1                |  2525 | 42925 |    14   (0)| 00:00:01
|KEY(OR)|KEY(OR)|
---------------------------------------------------------------------
Predicate Information (identified by operation id):
---------------------------------------------------

   6 - access("TAB_PART1"."ORDER_DATE">=TO_DATE(' 1999-07-01
00:00:00', 'syyyy-mm-dd hh24:mi:ss') AND
              "TAB_PART1"."ORDER_DATE"<TO_DATE(' 1999-10-01
00:00:00', 'syyyy-mm-dd hh24:mi:ss'))
       filter("ORDER_DATE"<TO_DATE(' 1999-03-01 00:00:00',
'syyyy-mm-dd hh24:mi:ss') OR "ORDER_DATE">=TO_DATE(' 1999-07-01
              00:00:00', 'syyyy-mm-dd hh24:mi:ss') AND
"ORDER_DATE"<=TO_DATE(' 1999-10-01 00:00:00', 'syyyy-mm-dd
hh24:mi:ss'))
   8 - filter("TAB_PART1"."ORDER_DATE"<TO_DATE(' 1999-03-01
00:00:00', 'syyyy-mm-dd hh24:mi:ss') AND ("ORDER_DATE"<TO_DATE('
              1999-03-01 00:00:00', 'syyyy-mm-dd hh24:mi:ss') OR
"ORDER_DATE">=TO_DATE(' 1999-07-01 00:00:00', 'syyyy-mm-dd
hh24:mi:ss') AND
              "ORDER_DATE"<=TO_DATE(' 1999-10-01 00:00:00',
'syyyy-mm-dd hh24:mi:ss')) AND
(LNNVL("TAB_PART1"."ORDER_DATE">=TO_DATE('
              1999-07-01 00:00:00', 'syyyy-mm-dd hh24:mi:ss'))
OR LNNVL("TAB_PART1"."ORDER_DATE"<TO_DATE(' 1999-10-01
00:00:00', 'syyyy-mm-dd
              hh24:mi:ss'))))
  10 - filter(("TAB_PART1"."ORDER_DATE">=TO_DATE(' 1999-10-01
00:00:00', 'syyyy-mm-dd hh24:mi:ss') AND
              "TAB_PART1"."ORDER_DATE"<TO_DATE(' 2010-03-01
00:00:00', 'syyyy-mm-dd hh24:mi:ss') OR
"TAB_PART1"."ORDER_DATE"<TO_DATE('
              1999-07-01 00:00:00', 'syyyy-mm-dd hh24:mi:ss')
AND "TAB_PART1"."ORDER_DATE">=TO_DATE(' 1999-03-01 00:00:00',
'syyyy-mm-dd
              hh24:mi:ss')) AND ("ORDER_DATE">=TO_DATE(' 1999-
07-01 00:00:00', 'syyyy-mm-dd hh24:mi:ss') AND
"ORDER_DATE"<=TO_DATE(' 1999-10-01
              00:00:00', 'syyyy-mm-dd hh24:mi:ss') OR
"ORDER_DATE"<TO_DATE(' 1999-03-01 00:00:00', 'syyyy-mm-dd
hh24:mi:ss')))

35 rows selected.

SQL> EXIT
$
```

Practices for Lesson 24: SQL Enhancements and Migration Assistant for Unicode

Chapter 24

Practices for Lesson 24: Overview

Practices Overview

In the practice for this lesson, you use the extended data type column to create columns of 32767 bytes long and the row-limiting clause to limit the rows resulting from queries.

Practice 24-1: Using 32K VARCHAR2 Data Type

Overview

In this practice, you create a new table with a column of data type VARCHAR2(32767).

Tasks

1. Connect to the source database orcl.

```
$ . oraenv
ORACLE_SID = [orcl] ? orcl
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$ sqlplus / as sysdba


Connected to:
Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 -
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SQL>
```

2. Create a table LONG_VARCHAR with a column VARCHAR2(32767).

```
SQL> CREATE TABLE long_varchar(id NUMBER,vc VARCHAR2(32767));
CREATE TABLE long_varchar(id NUMBER,vc VARCHAR2(32767))
                                                       *
ERROR at line 1:
ORA-00910: specified length too long for its datatype


SQL>
```

3. Set the instance parameter MAX_STRING_SIZE to EXTENDED.

```
SQL> alter system set MAX_STRING_SIZE =EXTENDED;
alter system set MAX_STRING_SIZE =EXTENDED
*
ERROR at line 1:
ORA-02097: parameter cannot be modified because specified value
is invalid
ORA-14694: database must in UPGRADE mode to begin
MAX_STRING_SIZE migration


SQL>
```

4. Configure the database to be compatible with extended data type columns.
   a. Restart the database instance.

```
SQL> shutdown immediate
Database closed.
Database dismounted.
ORACLE instance shut down.
SQL>
```

```
SQL> startup upgrade
ORACLE instance started.

Total System Global Area  3355443200 bytes
Fixed Size                   2921000 bytes
Variable Size              973082072 bytes
Database Buffers          2365587456 bytes
Redo Buffers                13852672 bytes
Database mounted.
Database opened.
SQL>
```

   b. Set the instance parameter `MAX_STRING_SIZE` to the `EXTENDED` value.

```
SQL> ALTER SYSTEM SET MAX_STRING_SIZE = EXTENDED;

System altered.

SQL>
```

   c. Execute the `$ORACLE_HOME/rdbms/admin/utl32k.sql` script as `SYSDBA`.

```
SQL> @$ORACLE_HOME/rdbms/admin/utl32k.sql

Session altered.

DOC>#####################################################################
#
DOC>#####################################################################
#
DOC>   The following statement will cause an "ORA-01722: invalid
number"
DOC>   error if the database has not been opened for UPGRADE.
DOC>
DOC>   Perform a "SHUTDOWN ABORT"  and
DOC>   restart using UPGRADE.
DOC>#####################################################################
DOC>#####################################################################
```

```
DOC>#

no rows selected

DOC>#############################################################
DOC>#############################################################
DOC>   The following statement will cause an "ORA-01722: invalid
number"
DOC>   error if the database does not have compatible >= 12.0.0
DOC>
DOC>   Set compatible >= 12.0.0 and retry.
DOC>#############################################################
DOC>#############################################################
DOC>#

PL/SQL procedure successfully completed.

Session altered.

2 rows updated.

Commit complete.

System altered.

PL/SQL procedure successfully completed.

Commit complete.

System altered.

Session altered.

PL/SQL procedure successfully completed.

No errors.

Session altered.

PL/SQL procedure successfully completed.

Commit complete.

Package altered.
```

```
Package altered.

SQL>
```

d. Restart the database in normal mode.

```
SQL> shutdown immediate
Database closed.
Database dismounted.
ORACLE instance shut down.
SQL> startup
ORACLE instance started.

Total System Global Area 3355443200 bytes
Fixed Size                  2921000 bytes
Variable Size             973082072 bytes
Database Buffers         2365587456 bytes
Redo Buffers               13852672 bytes
Database mounted.
Database opened.
SQL>
```

e. Verify that the `MAX_STRING_SIZE` is set to `EXTENDED`.

```
SQL> show parameter MAX_STRING_SIZE

NAME                                 TYPE        VALUE
------------------------------------ ----------- --------------
max_string_size                      string      EXTENDED
SQL>
```

5. Create a table with an extended data type column of 32767 bytes.

```
SQL> CREATE TABLE long_varchar(id NUMBER,vc VARCHAR2(32767));

Table created.

SQL> DESC  long_varchar
 Name                           Null?    Type
 ------------------------------ -------- --------------------
 ID                                      NUMBER
 VC                                      VARCHAR2(32767)

SQL>
```

Practice 24-2: Querying a Table Using a SQL Row-Limiting Clause (*Optional*)

Overview

In this practice, you limit the number or rows returned by a query that orders data.

Tasks

1. Create a new `HR.TEST` table and count the number of rows in the `HR.EMPLOYEES` table.

```
SQL> CREATE TABLE hr.test AS SELECT * FROM hr.employees;

Table created.

SQL> select count(*) from hr.test;

  COUNT(*)
----------
        83

SQL>
```

2. Select the `EMPLOYEE_ID` and `LAST_NAME` of the first 10 employees ordered by their hire date.

```
SQL> SELECT employee_id, last_name, hire_date FROM hr.test
     ORDER BY hire_date
     FETCH FIRST 10 ROWS ONLY;
  2    3
EMPLOYEE_ID LAST_NAME                 HIRE_DATE
----------- ------------------------- ---------
        102 De Haan                   13-JAN-01
        203 Mavris                    07-JUN-02
        206 Gietz                     07-JUN-02
        205 Higgins                   07-JUN-02
        204 Baer                      07-JUN-02
        109 Faviet                    16-AUG-02
        108 Greenberg                 17-AUG-02
        114 Raphaely                  07-DEC-02
        122 Kaufling                  01-MAY-03
        115 Khoo                      18-MAY-03

10 rows selected.

SQL>
```

You see the first 10 employees ordered by their hire date.

3. Select the EMPLOYEE_ID, LAST_NAME and HIRE_DATE of the next 5 employees ordered by their hire date.

```
SQL> SELECT employee_id,last_name, hire_date FROM hr.test
     ORDER BY hire_date
     OFFSET 10 ROWS FETCH NEXT 5 ROWS ONLY;

EMPLOYEE_ID LAST_NAME            HIRE_DATE
----------- -------------------- ---------
        100 King                 17-JUN-03
        137 Ladwig               14-JUL-03
        200 Whalen               17-SEP-03
        141 Rajs                 17-OCT-03
        184 Sarchand             27-JAN-04

SQL>
```

You see the next 5 employees ordered by their hire date.

4. Now, you work from two distinct sessions.
   a. In the first session, you retrieved the first 10 employees ordered by their hire date in task 2. In task 3, you retrieved the next five employees still ordered by their hire date. In another terminal session, delete an employee that belongs to the first 10 selected rows in the first session and first selection.

```
$ . oraenv
ORACLE_SID = [orcl2] ? orcl
The Oracle base for
ORACLE_HOME=/u01/app/oracle/product/12.1.0/dbhome_1 is
/u01/app/oracle
$ sqlplus / as sysdba


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SQL> delete hr.test where employee_id=122;

1 row deleted.

SQL> commit;


Commit complete.


SQL>
```

b. Back to the first session, select the EMPLOYEE_ID, LAST_NAME and HIRE_DATE of the next 5 employees ordered by their hire date.

```
SQL> SELECT employee_id,last_name, hire_date FROM hr.test
     ORDER BY hire_date
     OFFSET 10 ROWS FETCH NEXT 5 ROWS ONLY;

EMPLOYEE_ID LAST_NAME                 HIRE_DATE
----------- --------------------- ---------
        137 Ladwig                14-JUL-03
        200 Whalen                17-SEP-03
        141 Rajs                  17-OCT-03
        184 Sarchand              27-JAN-04
        156 King                  30-JAN-04

SQL> EXIT
$
```

Now, the employee 100 is in position 10. So the next 5 rows do not show the employee 100 anymore. It belongs to the first 10 employees.

Practices for Appendix C: Schema and Data Changes Management

Chapter 25

Practices for Appendix C: Overview

Practices Overview

In the practice for this lesson, you will use the Schema Change Plans demonstration to understand and view the steps required during schema change plan usage between two databases to synchronize two databases together.

Appendix C-1: Using Schema Change Plans

Overview

In this practice you use a browser to execute the Schema Change Plans demonstration.

Tasks

1. Launch a browser and enter: file: ////home/oracle/demos/Schema_Change_Plans/Schema_change_plan.html.