Basic Database Security

Creating a password profile

1. Connect to the database as a user who has create profile privilege:

sqlplus un/pw@localhost:1521/fenagodb1

2. Create a password profile:

create profile userprofile limit

f**ailed_login_attempts 4**

pa**ssword_lock_time 2**

password_life_time 180;

3. Alter the user to use a newly created password profile:

alter user scott profile userprofile;

4. Alter the default password profile:

alter profile default limit

failed_login_attempts 4;

Creating password-authenticated users

1. Connect to the database as a user who has create user privilege:

$ sqlplus un/pw@localhost:1521/fenagodb1

2. Create a password-authenticated user (for example, username: jessica, password: oracle_1) as follows:

SQL> create user jessica identified by oracle_1;

3. Create a password-authenticated user with a more complex password:

SQL> create user tom identified by "Qax7UnP!123*";

4. Create a user that uses a specific password profile:

SQL> create user steve identified by test1 profile

userprofile;

5. Create a user and force it to change password upon the first login:

SQL> create user john identified by password1

password expire;

6. Create a user richard, whose default tablespace is users, temporary tablespace is temp, and who has their quota set to unlimited on the users tablespace:

SQL> create user richard identified by oracle_2 default

tablespace users temporary tablespace temp quota unlimited

on users;

Changing a user's password

1. Connect to the database as a user who has alter user privilege:

$ sqlplus un/pw@localhost:1521/fenagodb1

2. Change the password for user jessica:

SQL> password jessica;

3. Enter a new password (for example, oracle_2) on a command line (note that typing will not be visible in the command line):

New password:

4. Retype the new password (for example, oracle_2) on the command line (note that typing will not be visible in the command line):

Retype new password:

5. Connect to the database as any user (for example, tom, to change their own password):

$ sqlplus tom/"Qax7UnP!123*"

6. Change the password using the following code:

SQL> password

7. Enter the old password (for example, Qax7UnP!123*) on the command line (note that typing will not be visible on the command line):

Old password:

8. Enter the new password (for example, oracle_123) on the command line (note that typing will not be visible on the command line):

New password:

9. Retype the new password (for example, oracle_123) on the command line (note that typing will not be visible on the command line):

Retype new password:

Creating a user with the same credentials on another database

1. Connect to the first database as a user who has a DBA role:

$ sqlplus un/pw@localhost:1521/fenagodb1

2. Find a Data Definition Language (DDL) statement (ddl) that is used for user creation (for example, user jessica):

SQL> select dbms_metadata.get_ddl('USER', 'JESSICA') from

dual;

3. Connect to the second database as a user who has create user privilege:

$ sqlplus ernesto@orcl2

4. Create a user using the value you found in step 2:

SQL> create user "JESSICA" identified by values

'S:D82E6EF961F2EA7A878BCDDBC7E5C542BC148C4759D19A7
20A96BBF65658;H:F297A50FD538EF4AB119EB0278C9E72D;
C50B1E9C9AA52EC2';

Locking a user account

1. Connect to the database as a user who has alter user privilege:

$ sqlplus un/pw@localhost:1521/fenagodb1

2. Lock the account of user steve:

SQL> alter user steve account lock;

3. Unlock the account of user steve:

SQL> alter user steve account unlock;

Expiring a user's password

1. Connect to the database as a user who has the alter user privilege:

$ sqlplus un/pw@localhost:1521/fenagodb1

2. Steve's password expires with the following command:

SQL> alter user steve password expire;

Creating and using OS-authenticated users

1. Connect to the database as a user who has a DBA role:

$ sqlplus johndba

2. Find the prefix for operating system authentication:

SQL> show parameter os_authent_prefix

NAME	TYPE	VALUE
os_authent_prefix	string	ops$

3. Create an OS-authenticated user:

SQL> create user ops$ernesto identified externally;

4. Grant this user the create session privilege:

SQL> grant create session to ops$ernesto;

5. Log in to the operating system as the user ernesto:

$ su - ernesto

6. Connect to the database without entering a user name or password:

$ sqlplus un/pw@localhost:1521/fenagodb1

Creating and using proxy users

1. Connect to the database as a user who has a DBA role:

$ sqlplus un/pw@localhost:1521/fenagodb1

2. Create a proxy user named appserver:

SQL> create user appserver identified by oracle_1;

3. Grant create session to the user appserver:

SQL> grant create session to appserver;

4. Alter the user to connect through the proxy user:

SQL> alter user steve grant connect through appserver;

5. Connect to the database through proxy user:

SQL> connect appserver[steve]

6. Enter a password for the appserver user (for example, oracle_1):

Enter password:

7. To revoke connection through the proxy user, first connect to the database as a user who has altered user privilege:

$ sqlplus un/pw@localhost:1521/fenagodb1

8. Revoke connection through the proxy user appserver from user steve:

SQL> alter user steve revoke connect through appserver;

Creating and using database roles

1. Connect to the database as a user who has a dba role:

$ sqlplus un/pw@localhost:1521/fenagodb1

2. Create the role usr_role:

SQL> create role usr_role;

3. Grant system privilege to usr_role:

SQL> grant create session to usr_role;

4. Grant object privileges to usr_role:

SQL> grant select, insert on hr.employees to usr_role;

5. Create another role as follows:

SQL> create role mgr_role;

6. Grant usr_role to mgr_role:

SQL> grant usr_role to mgr_role;

7. Grant system privileges to mgr_role:

SQL> grant create table to mgr_role;

8. Grant object privileges to mgr_role:

SQL> grant update, delete on hr.employees to mgr_role;

9. Grant usr_role to user (steve):

SQL> grant usr_role to steve;

10. Grant mgr_role to user (tom):

SQL> grant mgr_role to tom;

The sysbackup privilege – how, when, and why should you use it?

Database authentication

The instructions for database authentication are as follows:

1. Connect to the database as sysdba (or another user that can grant the sysbackup privilege):

sqlplus un/pw@localhost:1521/fenagodb1as sysdba

2. Grant the sysbackup privilege to user tom:

grant sysbackup to tom;

3. Verify that there is an entry in the password file that grants user tom the sysbackup administrative privilege. Select data from the v$pwfile_users view:

select * from v$pwfile_users;

The following table is the result of the preceding command:

Username	sysdb	sysop	sysas	sysba	sysdg	syskm	con_id
sys	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	0
sysdg	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	0
sysbackup	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	0
syskm	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	0
tom	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	0

4. Test the connection using RMAN:

rman target '"tom/oracle_123 as sysbackup"'

OS authentication

The instructions for OS authentication are as follows:

1. Verify that the OS user (for example, john) is a member of the backupdba OS group:

$ id john

2. Connect to the database using the sysbackup privilege (SQL*Plus or RMAN):

$> sqlplus / as sysbackup

$> rman target '"/ as sysbackup"'

<u>The syskm privilege – how, when, and why should you use it?</u>

Database authentication

The instructions for database authentication are as follows:

1. Connect to the database as sysdba (or another user that can grant the syskm privilege):

sqlplus / as sysdba

2. Grant the syskm privilege to user jessica:

grant syskm to jessica;

3. Connect user jessica to the database as syskm:

SQL> connect jessica/oracle_1 as syskm

4. View privileges:

SQL> select * from user_tab_privs;

SQL> select * from session_privs;

OS authentication

The instructions for OS authentication are as follows:

1. Verify that an OS user (for example, bob) is a member of the kmdba OS group.

$ id bob

2. Connect to the database using syskm privilege:

$ sqlplus / as syskm

<u>The sysdg privilege – how, when, and why should you use it?</u>

Database authentication

The instructions for database authentication are as follows:

1. Connect to the database as sysdba (or another user who can grant the sysdg privilege):

sqlplus / as sysdba

2. Grant SYSDG privilege to user steve:

SQL> grant sysdg to steve;

3. Exit SQL*Plus, connect steve using the dgmgrl command-line interface:

SQL> exit

$ dgmgrl

DGMRRL> connect steve/test_1

OS authentication

The instructions for OS authentication are as follows:

1. Verify that the OS user (for example, kelly) is a member of the dgdba OS group:

$ id kelly

2. Connect using the dgmgrl utility and OS authentication:

$ dgmgrl

DGMGRL> connect /

Security Considerations in Multitenant Environment

Creating a common user

1. Connect to the root container as a common user who has create user privilege granted commonly (for example, c##ernesto or system user):

SQL> connect c##ernesto@fenagodb

2. Create a common user (for example, c##maja):

c##ernesto@FENAGODB> create user c##maja identified by oracle1

container=all;

Creating a local user

1. Connect to PDB (for example, fenagodb1) as a common user or local user who has create userprivilege in that PDB (for example, c##ernesto or system user):

SQL> connect c##ernesto@fenagodb1

2. Create a local user (for example, steve):

c##ernesto@FENAGODB1> create user steve identified by pa3t5brii

container=current;

Creating a common role

1. Connect to the root container as a common user who has create role privilege granted commonly (for example, c##ernesto or system user):

SQL> connect c##ernesto@fenagodb

2. Create a common role (for example, c##role1):

SQL> create role c##role1 container=all;

Creating a local role

1. Connect to PDB (for example, fenagodb1) as a common or local user who has create role privilege in that PDB (for example, c##maja):

SQL> connect c##maja@fenagodb1

2. Create a local role (for example, local_role1):

c##maja@FENAGODB1> create role local_role1 container=current;

<u>Granting privileges and roles commonly</u>

1. You should connect to the root container as a common user who can grant these privileges and roles (for example, c##maja or system user):

SQL> connect c##maja@fenagodb

2. Grant a privilege (for example, create session) to a common user (for example, c##john) commonly:

c##maja@FENAGODB> grant create session to c##john container=all;

3. Grant a privilege (for example, select any table) to a common role (for example, c##role1) commonly:

c##maja@FENAGODB> grant select any table to c##role1 container=all;

4. Grant a common role (for example, c##role1) to a common role (for example, c##role2) commonly:

c##maja@FENAGODB> grant c##role1 to c##role2 container=all;

5. Grant a common role (for example, c##role2) to a common user (for example, c##john) commonly:

c##maja@FENAGODB> grant c##role2 to c##john container=all;

Granting privileges and roles locally

1. You should connect to the container (root or pluggable database) in which you want to grant the privilege as a common or local user who can grant that privilege (for example, c##maja):

SQL> connect c##maja@fenagodb1

2. Grant a privilege (for example, create synonym) to a common user (for example, c##john) locally:

c##maja@FENAGODB1> grant create synonym to c##john container=current;

3. Grant a privilege (for example, create view) to a local user (for example, steve) locally:

c##maja@FENAGODB1> grant create view to steve container=current;

4. Grant a privilege (for example, create table) to a common role (for example, c##role1) locally:

c##maja@FENAGODB1> grant create table to c##role1 container=current;

5. Grant a privilege (for example, create procedure) to a local role (for example, local_role1) locally:

c##maja@FENAGODB1> grant create procedure to local_role1

container=current;

6. Grant a common role (for example, c##role2) to another common role (for example, c##role3) locally:

c##maja@FENAGODB1> grant c##role2 to c##role3 container=current;

7. Grant a common role (for example, c##role3) to a local role (for example, local_role1) locally:

c##maja@FENAGODB1> grant c##role3 to local_role1 container=current;

8. Grant a local role (for example, local_role1) to a common role (for example, c##role4) locally:

c##maja@FENAGODB1> grant local_role1 to c##role4 container=current;

9. Grant a common role (for example, c##role4) to a common user (for example, c##john) locally:

c##maja@FENAGODB1> grant c##role4 to c##john container=current;

<u>Effects of plugging/unplugging operations on users, roles, and privileges</u>

1. Connect to the root container of fenagodb as user sys:

SQL> connect sys@fenagodb as sysdba

2. Unplug fenagodb1 by creating an XML metadata file:

SQL> alter pluggable database fenagodb1 unplug into

'/u02/oradata/fenagodb1.xml';

3. Drop fenagodb1 and keep the datafiles:

SQL> drop pluggable database fenagodb1 keep datafiles;

4. Connect to the root container of cdb2 as user sys:

SQL> connect sys@cdb2 as sysdba

5. Create (plug) fenagodb1 to cdb2 by using the previously created metadata file:

SQL> create pluggable database fenagodb1 using '/u02/oradata/fenagodb1.xml'

nocopy;

PL/SQL Security

Creating and using definer's rights procedures

1. Connect to the database as a user with the DBA role (for example, ernesto)

SQL> connect ernesto

2. Create two users (procowner and procuser) and grant them appropriate privileges:

SQL> create user procowner identified by oracle1;

SQL> create user procuser identified by oracle2;

SQL> grant create session, create procedure to procowner;

SQL> grant create session to procuser;

3. Create a table called ernesto.tbl and grant users privileges on this table:

SQL> create table ernesto.tbl(a number, b varchar2(40));

SQL> insert into ernesto.tbl values(1, 'old_value');

SQL> commit;

SQL> grant select on ernesto.tbl to procuser;

SQL> grant update on ernesto.tbl to procowner;

4. Connect as a user, procowner, create a procedure to update table ernesto.tbl, and grant execute on this procedure to user procuser:

SQL> connect procowner/oracle1

```
CREATE OR REPLACE PROCEDURE UpdateTbl (x IN number,
    y IN varchar2)
  AUTHID DEFINER
   AS
     BEGIN
      UPDATE ERNESTO.TBL
      SET b = y
       WHERE a = x;
    END;
  /
```

SQL> grant execute on UpdateTbl to procuser;

5. Connect as user procuser and try to directly update table ernesto.tbl:

SQL> connect procuser/oracle2

SQL> UPDATE ERNESTO.TBL SET B = 'value1' WHERE A = 1;

UPDATE ERNESTO.TBL SET B = 'value1' WHERE A = 1

*****

ERROR at line 1:

ORA-01031: insufficient privileges

6. When the previous step fails, update table by using the UpdateTbl procedure:

SQL> EXEC procowner.UpdateTbl(1, 'new_value');

PL/SQL procedure successfully completed.

7. Check whether the table is updated:

SQL> select * from ernesto.tbl;

A	B
1	new_value

Creating and using invoker's right procedures

1. Connect to the database as a user with the DBA role (for example, ernesto):

SQL> connect ernesto

2. Create two users (procuser1, procuser2) and grant them privileges:

SQL> create user procuser1 identified by oracle1;

SQL> create user procuser2 identified by oracle2;

SQL> grant create session to procuser1;

SQL> grant create session to procuser2;

3. Create the table table1 and grant select and update privileges on that table to procuser1 and only select privilege to procuser2:

SQL> create table table1(a number, b varchar2(30));

SQL> insert into ernesto.table1 values(1, 'old_value');

SQL> commit;

SQL> grant select on ernesto.table1 to procuser1;

SQL> grant update on ernesto.table1 to procuser1;

SQL> grant select on ernesto.table1 to procuser2;

4. Create an invoker's rights procedure to update table1:

```
CREATE OR REPLACE PROCEDURE UpdateTable1 (x IN number,
    y IN varchar2)
 AUTHID CURRENT_USER
  AS
```

```
    BEGIN
     UPDATE ERNESTO.TABLE1
     SET b = y
      WHERE a = x;
   END;
 /
```

5. Grant execute on that procedure to procuser1 and procuser2:

SQL> grant execute on ernesto.UpdateTable1 to procuser1;

SQL> grant execute on ernesto.UpdateTable1 to procuser2;

6. Connect as user procuser1 and execute the procedure UpdateTable1:

SQL> connect procuser1

SQL> EXEC ernesto.UpdateTable1(1, 'new_value');

PL/SQL procedure successfully completed.

SQL> commit;

7. Check whether the table is updated:

SQL> select * from ernesto.table1;

```
  A         B
---------- ----------------------------------------
  1         new_value
```

8. Connect as the user procuser2 and try to execute the procedure UpdateTable1:

SQL> connect procuser2

SQL> EXEC ernesto.UpdateTable1(1, 'newer_value');

BEGIN ernesto.UpdateTable1(1, 'new_value'); END;

*****

ERROR at line 1:

ORA-01031: insufficient privileges

ORA-06512: at "ERNESTO.UPDATETABLE1", line 5

ORA-06512: at line 1

<u>Using code-based access control</u>

1. Connect to the database as a user with a DBA role (for example, ernesto), create proc_user, and grant him the create session privilege:

SQL> create user proc_user identified by oracle1;

SQL> grant create session to proc_user;

2. Create table tbl1 and insert test data:

SQL> create table tbl1(a number, b varchar2(30));

SQL> insert into tbl1 values (1, 'old_value');

SQL> commit;

3. Create the invoker's rights procedure UpdateTbl1 and grant execute on that procedure to proc_user:

```
CREATE OR REPLACE PROCEDURE UpdateTbl1 (x IN number,
     y IN varchar2)
 AUTHID CURRENT_USER
  AS
   BEGIN
    UPDATE ERNESTO.TBL1
    SET b = y
     WHERE a = x;
  END;
  /
```

SQL> grant execute on ernesto.UpdateTbl1 to proc_user;

4. Create the role proc_role and grant update on tbl1 to proc_role:

SQL> create role proc_role;

SQL> grant update on ernesto.tbl1 to proc_role;

5. Grant proc_role to the procedure UpdateTbl1:

SQL> grant proc_role to procedure ernesto.UpdateTbl1;

6. Connect as a user proc_user:

SQL> connect proc_user

7. Try to directly update the table:

SQL> update ernesto.tbl1 set b = 'value1' where a = 1;

update ernesto.tbl1 set b = 'value1' where a = 1

*****

ERROR at line 1:

ORA-00942: table or view does not exist

8. Execute the procedure UpdateTbl1:

SQL> execute ernesto.UpdateTbl1(1, 'new_value');

PL/SQL procedure successfully completed.

9. Connect as the user ernesto and verify whether the table is updated:

SQL> connect ernesto

SQL> select * from tbl1;

A	B
1	new_value

Restricting access to program units by using accessible by

1. Connect as a user who has the create procedure privilege (for example, ernesto):

SQL> connect ernesto

2. Create the protected_pkg package that is only accessible by public_pkg:

```
CREATE OR REPLACE PACKAGE protected_pkg
  ACCESSIBLE BY (public_pkg)
IS
  PROCEDURE protected_proc;
END;
/
CREATE OR REPLACE PACKAGE BODY protected_pkg
IS
  PROCEDURE protected_proc
  IS
  BEGIN
      DBMS_OUTPUT.PUT_LINE ('This is a Protected Procedure
        that can only be accessed from Public Package');
    END;
END;
/
```

3. Create the public_pkg package:

```
CREATE OR REPLACE PACKAGE public_pkg
IS
    PROCEDURE public_proc;
END;
```

```
/
CREATE OR REPLACE PACKAGE BODY public_pkg
IS
    PROCEDURE public_proc
    IS
    BEGIN
      DBMS_OUTPUT.PUT_LINE ('This is Public Procedure from
         Public Package!');
      protected_pkg.protected_proc;
    END;
END;
/
```

4. Execute the public_proc procedure from public_pkg:

```
SQL> set serveroutput on
SQL> EXEC public_pkg.public_proc;
This is Public Procedure from Public Package!
This is a Protected Procedure that can only be accessed from
     Public Package
PL/SQL procedure successfully completed.
```

5. Try to directly execute protected_proc from protected_pkg and observe the error:

SQL> EXEC protected_pkg.protected_proc;

BEGIN protected_pkg.protected_proc; END;

*****

ERROR at line 1:

ORA-06550: line 1, column 7:

PLS-00904: insufficient privilege to access object

PROTECTED_PKG

ORA-06550: line 1, column 7:

PL/SQL: Statement ignored

6. Try to create another package that accesses protected_proc from protected_pkg:

CREATE OR REPLACE PACKAGE other_pkg

IS

PROCEDURE other_proc;

END;

/

CREATE OR REPLACE PACKAGE BODY other_pkg

IS

PROCEDURE other_proc

IS

BEGIN

DBMS_OUTPUT.PUT_LINE ('This is Other Procedure from

Other Package!');

protected_pkg.protected_proc;

END;

E**ND;**

/

W**arning: Package Body created with compilation errors.**

7. Find the compilation errors, as follows:

SQL> show errors

Errors for PACKAGE BODY OTHER_PKG:

LINE/COL ERROR

-------- --

7/7 PL/SQL: Statement ignored

7/7 PLS-00904: insufficient privilege to access object

PROTECTED_PKG

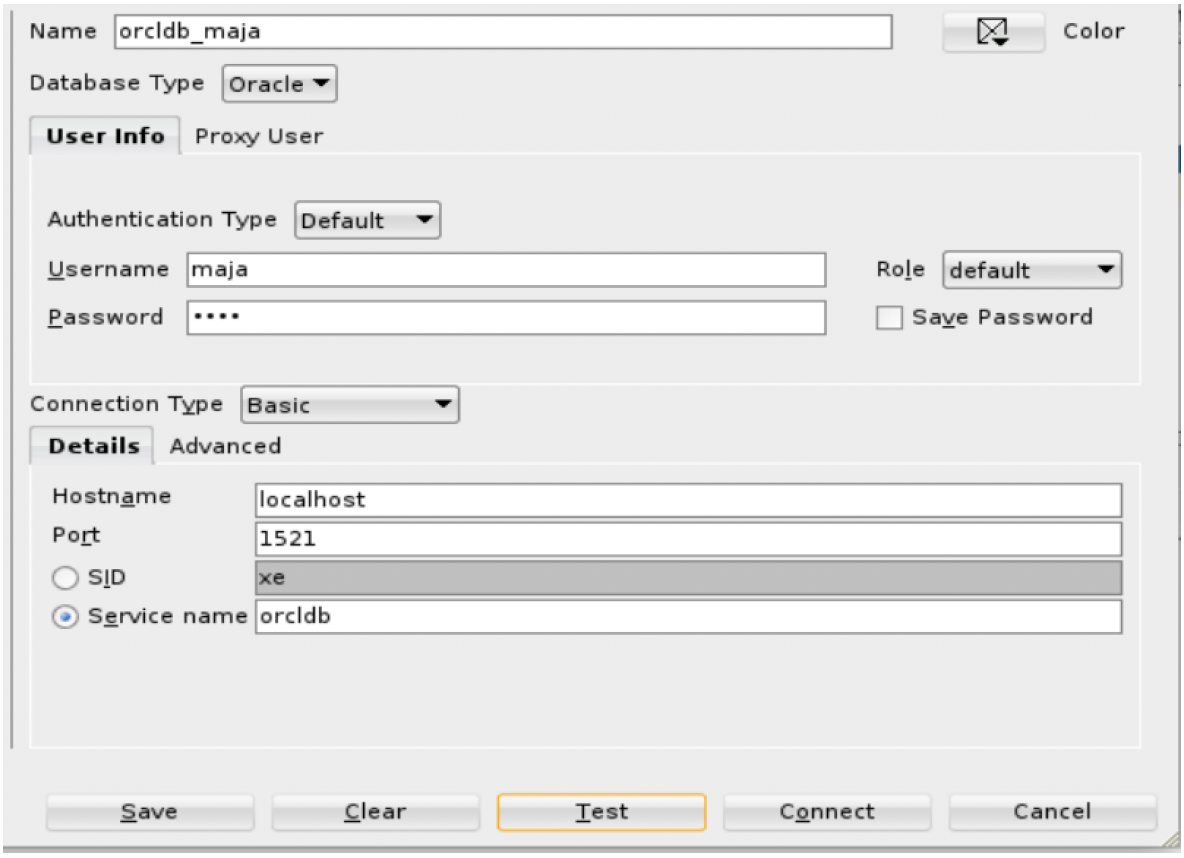
Virtual Private Database

Creating different policy functions

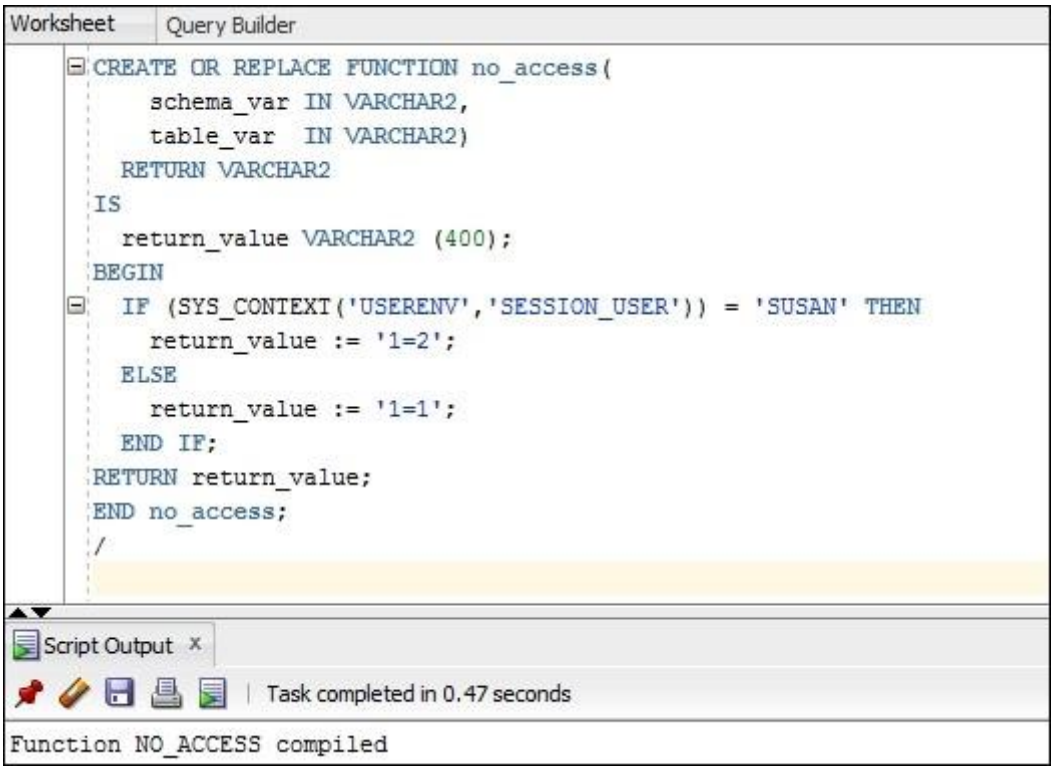
1. ***Connect to the database as a user who has appropriate privileges (for example, user maja):***

```
create user maja identified by maja;
grant dba to maja;
```

$ sqlplus maja/pw@localhost:1521/fenagodb1



2. Create a policy function that satisfies this condition: The user susan can't access data in a table (for example, hr.emp_vpd_test) and other users can access entire data in the table.



3. Create an application context that has the emp_id attribute and the value is emp_id (from the hr.emp_vpd_test) of the connected user or if the connected user is not employee.

Create an application context

Sql>create context hremp_ctx using hremp_ctx_pkg;

Create a PL/SQL package

```
Worksheet  Query Builder
CREATE OR REPLACE PACKAGE hremp_ctx_pkg
IS
  PROCEDURE set_emp_id;
END;
/
CREATE OR REPLACE PACKAGE BODY hremp_ctx_pkg
IS
  PROCEDURE set_emp_id
  IS
    v_emp_id NUMBER;
  BEGIN
    SELECT emp_id
    INTO v_emp_id
    FROM hr.emp_vpd_test
    WHERE UPPER(email) = (SYS_CONTEXT('USERENV','SESSION_USER') || '@COMPANY.EXAMPLE.COM');
    DBMS_SESSION.SET_CONTEXT ('hremp_ctx','emp_id',v_emp_id);
  EXCEPTION
  WHEN no_data_found THEN
    DBMS_SESSION.SET_CONTEXT ('hremp_ctx','emp_id',0);
  END;
END;
/
Script Output
Task completed in 0.115 seconds
Package HREMP_CTX_PKG compiled

Package body HREMP_CTX_PKG compiled
```

Create a logon trigger

```
SQL> CREATE OR REPLACE TRIGGER hremp_ctx_logon
  2  AFTER LOGON ON DATABASE
  3  BEGIN
  4    hremp_ctx_pkg.set_emp_id();
  5  END;
  6  /

Trigger created.
```

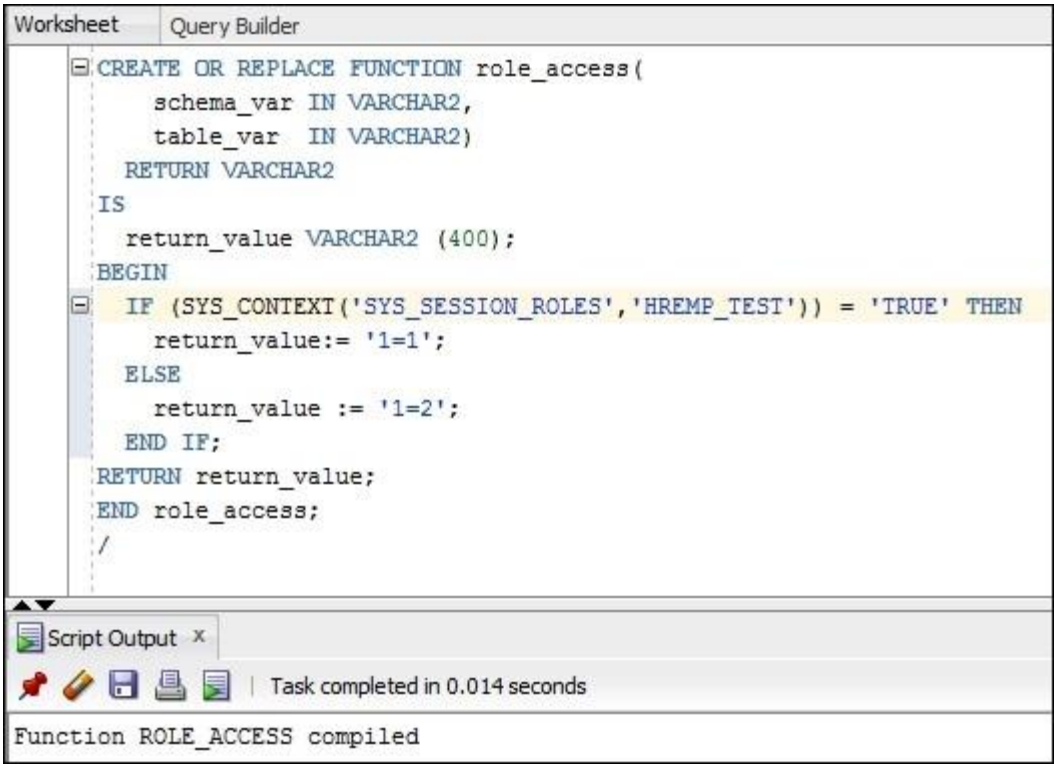
4. Create a policy function (for example, emp_access) that satisfies this condition: a "regular" employee can access only his or her data in a table (for example, hr.emp_vpd_test) and manager users can access his or her data in the table and data for employees he or she directly manages.

```
Worksheet  Query Builder
CREATE OR REPLACE FUNCTION emp_access(
    schema_var IN VARCHAR2,
    table_var  IN VARCHAR2)
  RETURN VARCHAR2
IS
  return_value VARCHAR2 (400);
BEGIN
  return_value:= '(emp_id = SYS_CONTEXT(''hremp_ctx'',''emp_id'')) OR (mgr_id = SYS_CONTEXT(''hremp_ctx'',''emp_id''))';
  RETURN return_value;
END emp_access;
/
Script Output
Task completed in 0.123 seconds
Function EMP_ACCESS compiled
```

The emp_access policy function

5. Create a role (for example, HREMP_TEST).

6. Create a policy function that satisfies this condition: Only users who have the HREMP_TEST role can view data in a table (for example, hr.emp_vpd_test).



The role_access policy function

Creating Oracle Virtual Private Database row-level policies

1. Connect to the database as a user who has appropriate privileges (for example, the user maja):

$ sqlplus maja

2. Create a VPD policy (for example, test_pol1) that protects the hr.emp_vpd_test table in the following way: it restricts SELECT operation based on a policy function (for example, no_access).

```
SQL> exec DBMS_RLS.ADD_POLICY('HR','EMP_VPD_TEST','TEST_POL1','MAJA','NO_ACCESS'
,'SELECT')

PL/SQL procedure successfully completed.
```

3. To test VPD policy created in the previous step, connect as the user susan to the database (keep in mind that she has the SELECT ANY TABLE privilege) and try to access data in the table hr.emp_vpd_test.

```
SQL> connect susan
Enter password:
Connected.
SQL> SELECT * FROM HR.EMP_VPD_TEST;

no rows selected
```

Susan can't access data

4. Connect to the database as a user who can create a VPD policy (for example, user maja). Create a VPD policy (for example, test_pol2) that additionally protects the hr.emp_vpd_test table in the following way: it restricts the SELECT and DELETE operations based on a policy function (for example, emp_access).

SQL> connect maja

```
SQL> exec DBMS_RLS.ADD_POLICY('HR','EMP_VPD_TEST','TEST_POL2','MAJA','EMP_ACCESS
','SELECT,DELETE')

PL/SQL procedure successfully completed.
```

The VPD policy TEST_POL2

5. Connect to the database as the user joel and execute the following query:

SELECT * FROM HR.EMP_VPD_TEST;

The result will show 3 rows, because joel can view his data and data for his direct employees (policy function emp_access).

```
SQL> connect joel
Enter password:
Connected.
SQL> select * from hr.emp_vpd_test;

    EMP_ID FIRST_NAME                     LAST_NAME
---------- ------------------------------ ------------------------------
EMAIL                               SALARY   COMM_PCT     MGR_ID
------------------------------ ---------- ---------- ----------
         1 Maja                           Veselica
maja@company.example.com             11000        .05          3

         2 ernesto                        Pavlovic
ernesto@company.example.com          11500        .02          3

         3 Joel                           Adams
joel@company.example.com             15000        .04
```

Joel can view his data and data for his direct employees

6. Connect to the database as the user emma and execute the following query:

SELECT * FROM HR.EMP_VPD_TEST;

The result will show only 1 row, because emma is a "regular" employee, so she can view only her own data (policy function emp_access).

```
SQL> connect emma
Enter password:
Connected.
SQL> select * from hr.emp_vpd_test;

    EMP_ID FIRST_NAME                     LAST_NAME
---------- ------------------------------ ------------------------------
EMAIL                               SALARY   COMM_PCT     MGR_ID
------------------------------ ---------- ---------- ----------
         4 Emma                           Cole
emma@company.example.com              8000         .1          5
```

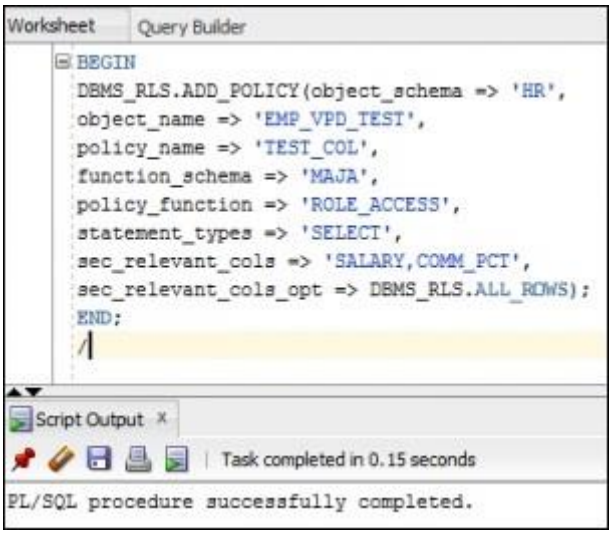
Emma can only view her own data

Creating column-level policies

1. Connect to the database as a user who has appropriate privileges (for example, the user maja):

$ sqlplus maja

2. Create a VPD policy (for example, test_col) that protects the hr.emp_vpd_test table in the following way: it defines that salary and comm_pct are sensitive columns and a user can access them only if he or she has the HREMP_TEST role (the role_access policy function).



3. Grant the role HREMP_TEST to user ernesto:

SQL> grant HREMP_TEST to ernesto;

4. Connect to the database as the user ernesto and view data in the table hr.emp_vpd_test.

```
SQL> grant HREMP_TEST to ernesto

Grant succeeded.

SQL> connect ernesto
Enter password:
Connected.
SQL> select * from hr.emp_vpd_test;

    EMP_ID FIRST_NAME                     LAST_NAME
---------- ------------------------------ ------------------------------
EMAIL                          SALARY   COMM_PCT     MGR_ID
------------------------------ ---------- ---------- ----------
         2 ernesto                        Pavlovic
ernesto@company.example.com           11500        .02          3
```

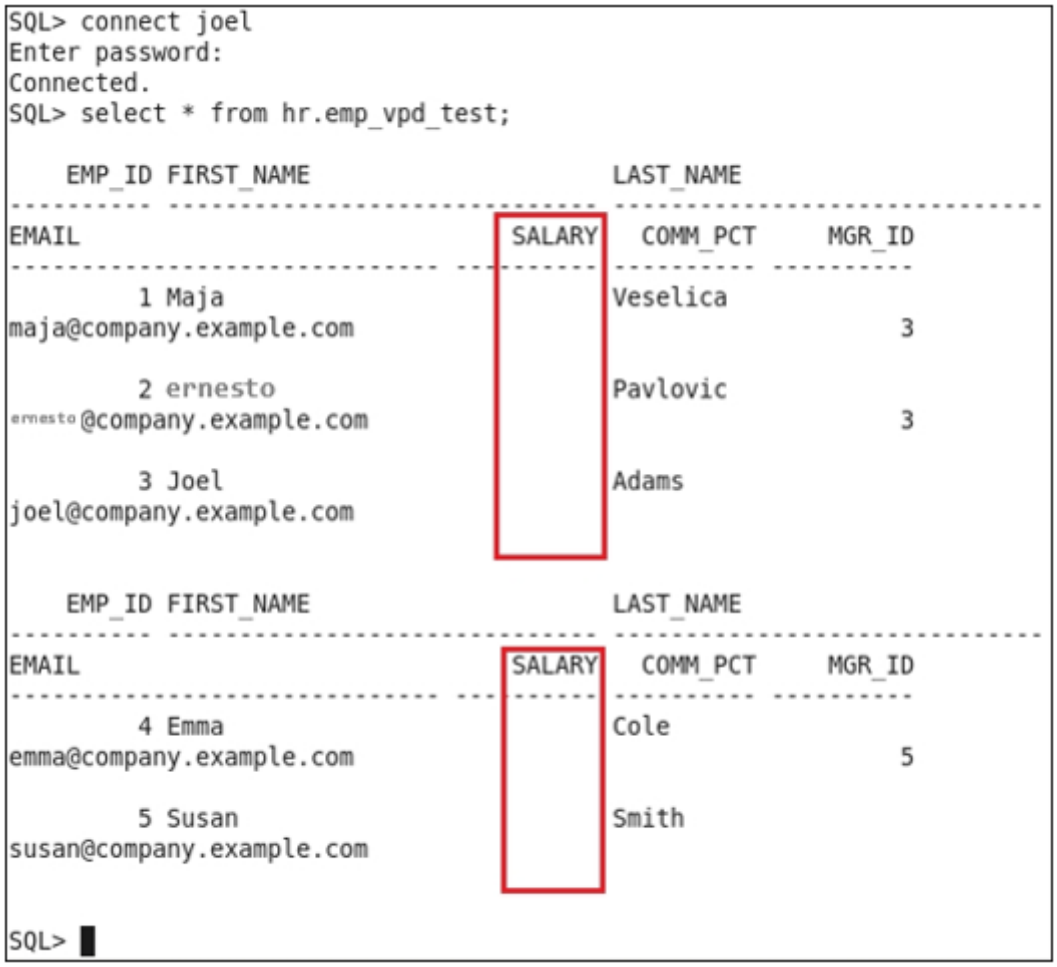
5. Connect to the database as the user maja and disable the VPD policy TEST_POL2.

```
SQL> connect maja
Enter password:
Connected.
SQL> exec DBMS_RLS.ENABLE_POLICY('HR','EMP_VPD_TEST','TEST_POL2',FALSE);

PL/SQL procedure successfully completed.
```

6. Repeat step 4.

```
SQL> connect ernesto
Enter password:
Connected.
SQL> select * from hr.emp_vpd_test;

    EMP_ID FIRST_NAME                     LAST_NAME
---------- ------------------------------ ------------------------------
EMAIL                          SALARY   COMM_PCT     MGR_ID
------------------------------ ---------- ---------- ----------
         1 Maja                           Veselica
maja@company.example.com            11000        .05          3

         2 ernesto                        Pavlovic
ernesto@company.example.com            11500        .02          3

         3 Joel                           Adams
joel@company.example.com            15000        .04


    EMP_ID FIRST_NAME                     LAST_NAME
---------- ------------------------------ ------------------------------
EMAIL                          SALARY   COMM_PCT     MGR_ID
------------------------------ ---------- ---------- ----------
         4 Emma                           Cole
emma@company.example.com             8000         .1          5

         5 Susan                          Smith
susan@company.example.com           16000          0


SQL>
```

7. Connect to the database as the user joel and execute the same statement as in the previous step.



Creating a driving context

1. Connect to the database as a user who has appropriate privileges (for example, the user maja):

$ sqlplus maja

2. Create a driving context (for example, driver_ctx):

SQL> CREATE CONTEXT driver_ctx using driver_ctx_pkg;

3. Set the driving context:

```
SQL> CREATE OR REPLACE PACKAGE driver_ctx_pkg IS
       PROCEDURE set_driver (p_group varchar2);
     END;
     /
SQL> CREATE OR REPLACE PACKAGE BODY driver_ctx_pkg IS
       PROCEDURE set_driver (p_group varchar2)
       IS
       BEGIN
        DBMS_SESSION.SET_CONTEXT('driver_ctx','ACTIVE',p_grou
p);
      END;
    END;
/
```

Creating policy groups

1. Connect to the database as a user who has appropriate privileges (for example, the user maja):

```
$ sqlplus maja
```

2. Create the first policy group (for example, pol_grp_A):

```
SQL> BEGIN
DBMS_RLS.CREATE_POLICY_GROUP(
```

object_schema => 'HR',

object_name => 'EMP_VPD_TEST',

policy_group => 'pol_grp_A');

END;

/

3. Create the second policy group (for example, pol_grp_B):

SQL> BEGIN

DBMS_RLS.CREATE_POLICY_GROUP(

object_schema => 'HR',

object_name => 'EMP_VPD_TEST',

policy_group => 'pol_grp_B');

END;

/

<u>Setting context as a driving context</u>

1. Connect to the database as a user who has appropriate privileges (for example, the user maja):

$ sqlplus maja

2. Make an existing application context a driving context.

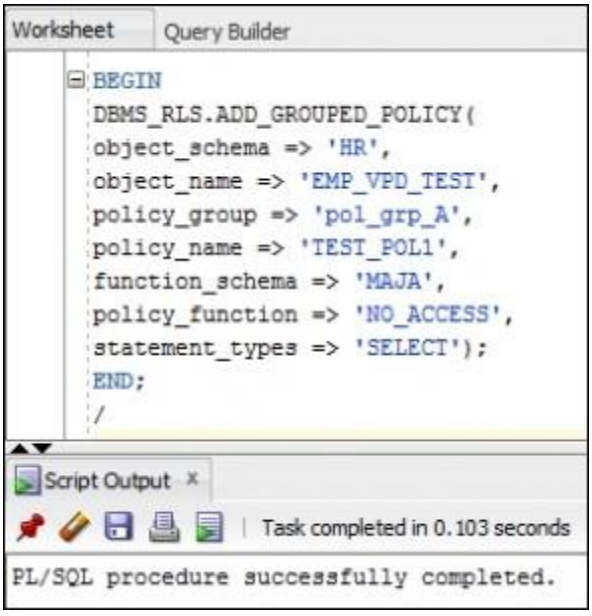
```
SQL> connect maja
Enter password:
Connected.
SQL> BEGIN
  2  DBMS_RLS.ADD_POLICY_CONTEXT('HR','EMP_VPD_TEST','DRIVER_CTX','ACTIVE');
  3  END;
  4  /

PL/SQL procedure successfully completed.
```

Adding policy to a group

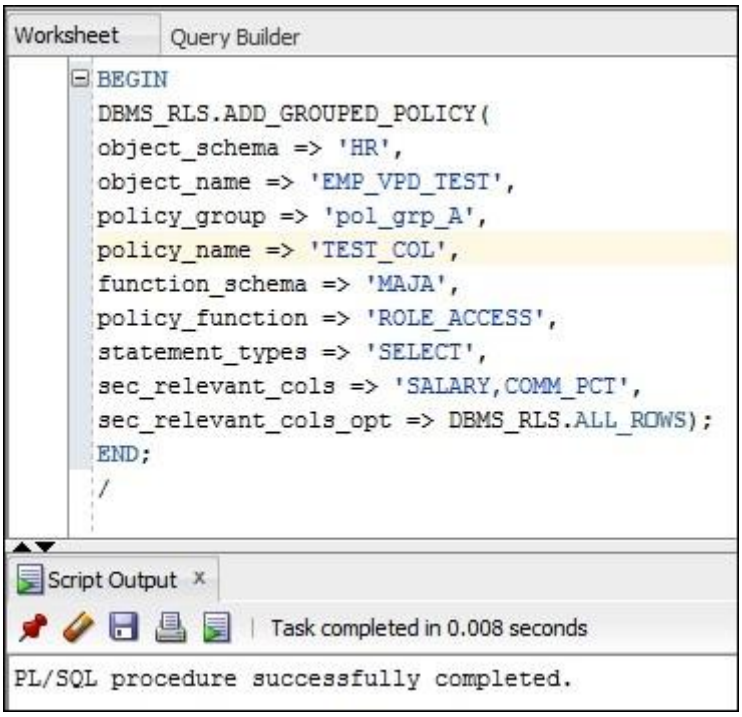
1. Connect to the database as a user who has appropriate privileges (for example, the user maja):

$ sqlplus maja

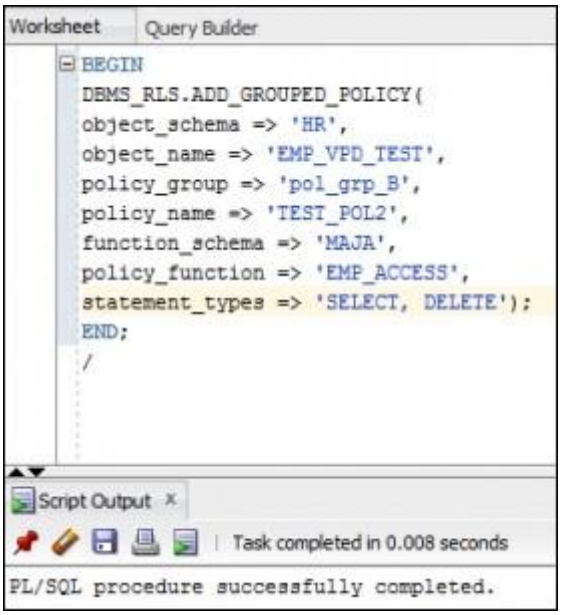
2. Add TEST_POL1 to policy group pol_grp_A.



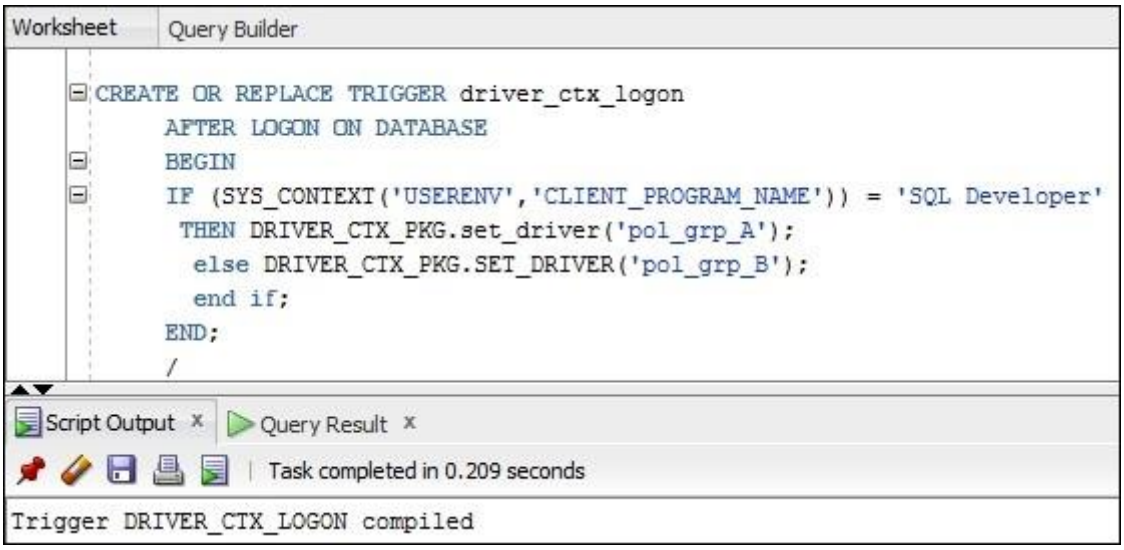
3. Add TEST_COL to policy group pol_grp_A.



4. Add TEST_POL2 to policy group pol_grp_B.



5. Create a logon trigger.



6. Connect to the database as the user joel using SQL*Plus and execute the SELECT statement, as shown:

```
SQL> select sys_context('driver_ctx','ACTIVE') from dual;

SYS_CONTEXT('DRIVER_CTX','ACTIVE')
--------------------------------------------------------------------------------
pol_grp_B
```

7. View data in the table hr.emp_vpd_test.

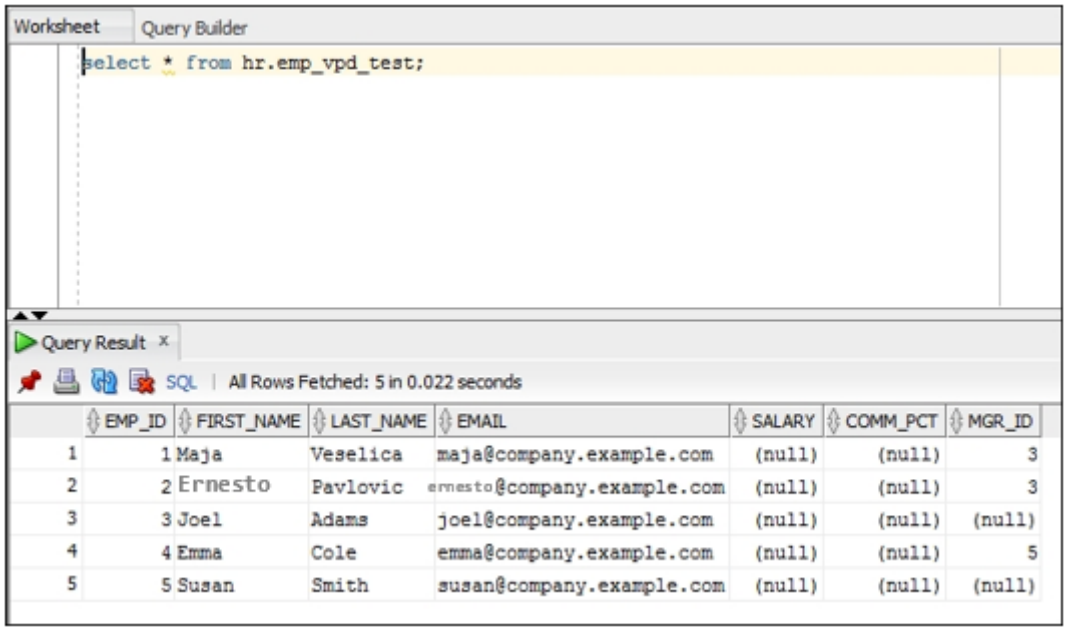
```
SQL> connect joel
Enter password:
Connected.
SQL> select * from hr.emp_vpd_test;

    EMP_ID FIRST_NAME                     LAST_NAME
---------- ------------------------------ -------------------------
EMAIL                              SALARY   COMM_PCT     MGR_ID
-------------------------------- ---------- ---------- ----------
         1 Maja                           Veselica
maja@company.example.com            11000        .05          3

         2 ernesto                        Pavlovic
ernesto@company.example.com         11500        .02          3

         3 Joel                           Adams
joel@company.example.com            15000        .04
```

8. Connect to the database as the user susan using SQL*Plus and view data in the table hr.emp_vpd_test:

SQL> connect susan

```
SQL> connect joel
Enter password:
Connected.
SQL> select * from hr.emp_vpd_test;

    EMP_ID FIRST_NAME                     LAST_NAME
---------- ------------------------------ -------------------------
EMAIL                          SALARY   COMM_PCT     MGR_ID
------------------------------ ---------- ---------- ----------
         1 Maja                           Veselica
maja@company.example.com            11000        .05          3

         2 ernesto                        Pavlovic
ernesto@company.example.com         11500        .02          3

         3 Joel                           Adams
joel@company.example.com            15000        .04
```

9. Connect as the user emma using SQL Developer and view data in the table hr.emp_vpd_test.



Exempting users from VPD policies

1. Connect to the database as SYS user:

$ sqlplus / as sysdba

2. Grant the EXEMPT ACCESS POLICY privilege to an existing user (for example, susan):

SQL> grant EXEMPT ACCESS POLICY to susan;

3. Connect to the database as the user susan and verify that now she can access data in the hr.emp_vpd_test table.

```
SQL> connect susan
Enter password:
Connected.
SQL> select * from hr.emp_vpd_test;

    EMP_ID FIRST_NAME                     LAST_NAME
---------- ------------------------------ ------------------------------
EMAIL                          SALARY   COMM_PCT     MGR_ID
------------------------------ ---------- ---------- ----------
         1 Maja                           Veselica
maja@company.example.com            11000        .05          3

         2 Ernesto                        Pavlovic
ernesto@company.example.com         11500        .02          3

         3 Joel                           Adams
joel@company.example.com            15000        .04


    EMP_ID FIRST_NAME                     LAST_NAME
---------- ------------------------------ ------------------------------
EMAIL                          SALARY   COMM_PCT     MGR_ID
------------------------------ ---------- ---------- ----------
         4 Emma                           Cole
emma@company.example.com             8000         .1          5

         5 Susan                          Smith
susan@company.example.com           16000          0
```

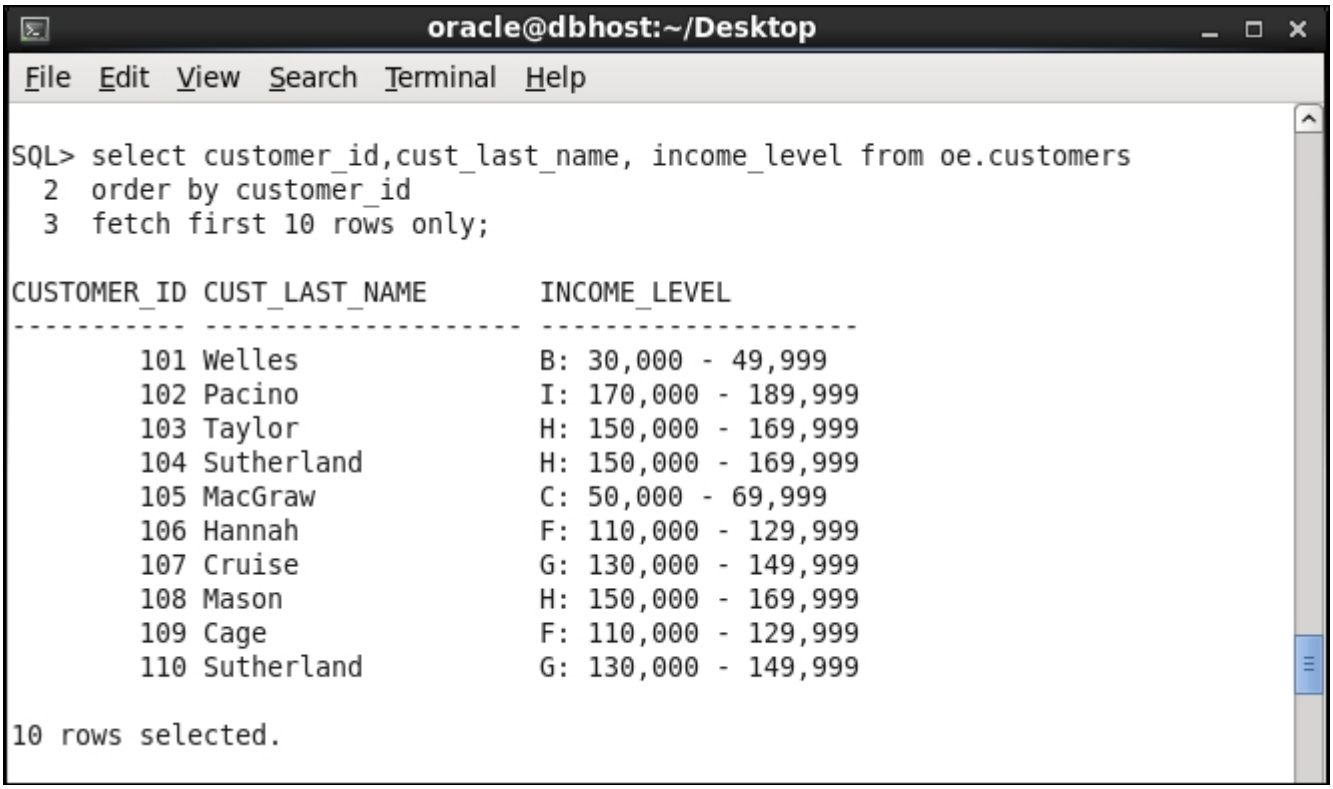
Data Redaction

Creating a redaction policy when using full redaction

1. Connect to the database as a user who has the SELECT privilege on the OE.CUSTOMERS table or the SELECT ANY TABLE privilege (for example, the oe user):
$ sqlplus oe

2. Verify that the user (for example, the user oe) can view data by executing the following query:

select customer_id, cust_last_name, income_level from oe.customers order by customer_id fetch first 10 rows only;



Data in the clear text format (before redaction) in the OE.CUSTOMERS table

3. Connect to the database as a user who can create the user secmgr (who will be responsible for managing redaction policies) and grant him appropriate privileges (for example, SYS):

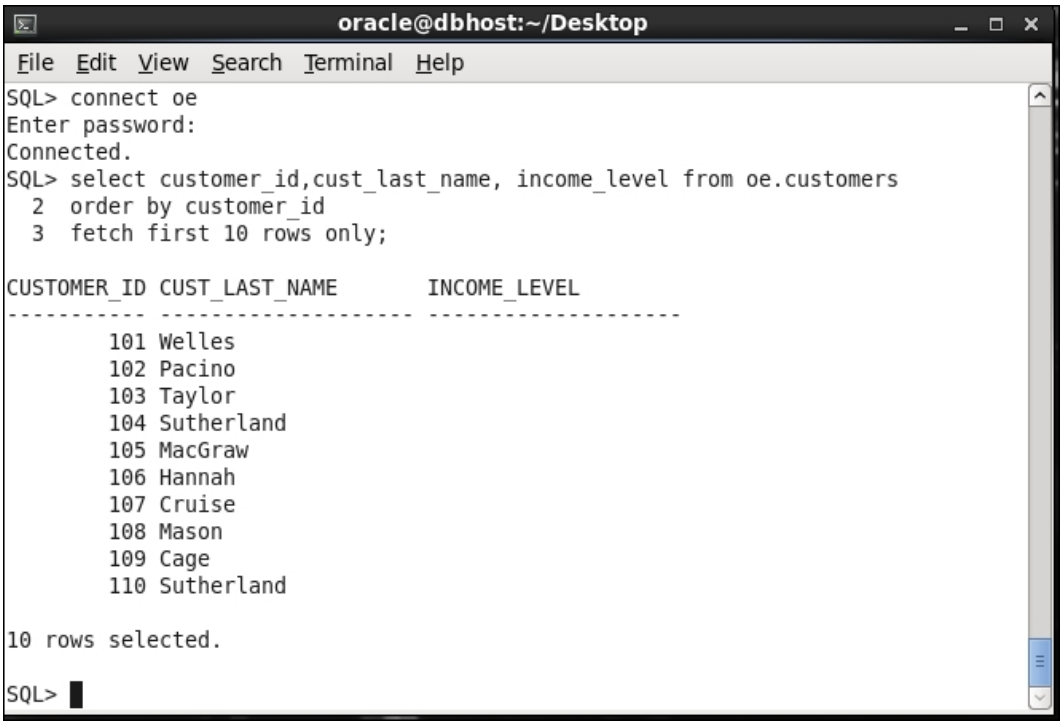
SQL> create user secmgr identified by oracle;
SQL> grant create session to secmgr;
SQL> grant execute on dbms_redact to secmgr;

4. Connect to the database as the secmgr user:
SQL> connect secmgr/oracle

5. Create the redaction policy CUST_POL in such a manner that data in the column income_level (the table oe.customers) is redacted using full redaction:

SQL> begin 2 dbms_redact.add_policy 3 (object_schema => 'OE', 4 object_name => 'CUSTOMERS', 5 policy_name => 'CUST_POL', 6 column_name => 'INCOME_LEVEL', 7 function_type => *DBMS_REDACT.FULL*, 8 expression => '1=1'); 9 end; 10 /
PL/SQL procedure successfully completed.

6. Connect to the database as the same user as in step 1 (for example, oe) and execute the same query as in step 2.



After applying the redaction policy

Creating a redaction policy when using partial redaction

1. Log in to database as a user who has a DBA role (for instance, ernesto):

$ sqlplus ernesto/oracle

2. Create a test table and insert some data in it:

SQL> create table tbl (a number);

SQL> insert into tbl values (123456);

SQL> insert into tbl values (234567);

SQL> insert into tbl values (345678);

SQL> commit;

3. Create role (that is going to be used in redaction policy) and user usr1 as the first test user:

SQL> create role myrole;

SQL> create user usr1 identified by oracle1;

SQL> grant create session to usr1;

4. Grant the select privilege and role to usr1:

SQL> grant select on ernesto.tbl to usr1;

SQL> grant myrole to usr1;

5. Create the second test user and grant him create session and select privilege, but don't grant him the role myrole:

SQL> create user usr2 identified by oracle2;

SQL> grant create session to usr2;

SQL> grant select on ernesto.tbl to usr2;

6. Create redaction policy to redact column a of the type Number using partial redaction (first four digits will be redacted and won't be seen at all). This redaction policy will be applied only to users that don't have role myrole and don't have the EXEMPT REDACTION POLICY privilege:

```
SQL> BEGIN
  2  DBMS_REDACT.ADD_POLICY(
  3  object_schema         => 'ernesto',
  4  object_name          => 'tbl',
  5  column_name           => 'a',
  6  column_description     => 'Sensitive column A',
```

```
  7  policy_name          => 'a_tbl_partial',
  8  policy_description    => 'Redact column A of tbl',
  9  function_type        => DBMS_REDACT.PARTIAL,
 10  function_parameters   => '0,1,4',
 11  expression           => 'SYS_CONTEXT(
''SYS_SESSION_ROLES'',                    ''MYROLE'') =
''FALSE''');  12  END;  13  /
```

7. Connect to database as the user usr1 and select from the table tbl in the schema ernesto:

```
SQL> connect usr1/oracle1

SQL> select a from ernesto.tbl;
     A ----------        123456        234567        345678
```

8. Now, connect to database as the user usr2 and again select from the table tbl in the schema ernesto:

```
SQL> connect usr2/oracle2

usr2@ORA12CR1> select a from ernesto.tbl;
     A ----------        56        67        78
```

9. Log in to database as a user who has a DBA role (for instance, ernesto):

```
$ sqlplus ernesto/oracle
```

10. Create the test table to store credit cards data and insert some data in it:

```
SQL> create table customers (name varchar2(20 CHAR),        credit_card
varchar2(20 CHAR));

SQL> insert into customers values ('tom',        '3455647456589132');

SQL> insert into customers values ('steve',        '3734982321225691');
```

SQL> insert into customers values ('john', '3472586894975806');

SQL> commit;

11. Grant select privilege on table customers in the schema ernesto to usr1:

SQL> grant select on ernesto.customers to usr1;

12. Create a redaction policy to redact column credit_card of type Varchar2 using partial redaction (first 12 values will be redacted with #sign). This redaction policy will be applied to all users, except those who have the EXEMPT REDACTION POLICY privilege (see the Exempting users from data redaction policies recipe):

SQL> BEGIN
2 DBMS_REDACT.ADD_POLICY(
3 object_schema => 'ernesto',
4 object_name => 'customers',
5 column_name => 'credit_card',
6 column_description => 'Credit Card numbers',
7 policy_name => 'CCN_POLICY',
8 policy_description => 'Redact column credit_card of table customers', 9 function_type => DBMS_REDACT.PARTIAL, 10 function_parameters => 'VVVVVVVVVVVVVVV, VVVVVVVVVVVVVVV, #, 1, 12', 11 expression => '1=1'); 12 END; 13 /

13. Connect to database as the user usr1 and select from the table customers in the schema ernesto:

SQL> connect usr1/oracle1

SQL> select * from ernesto.customers;

NAME CREDIT_CARD ---------- ----------

tom ############9132 steve ############5691 john ############5806

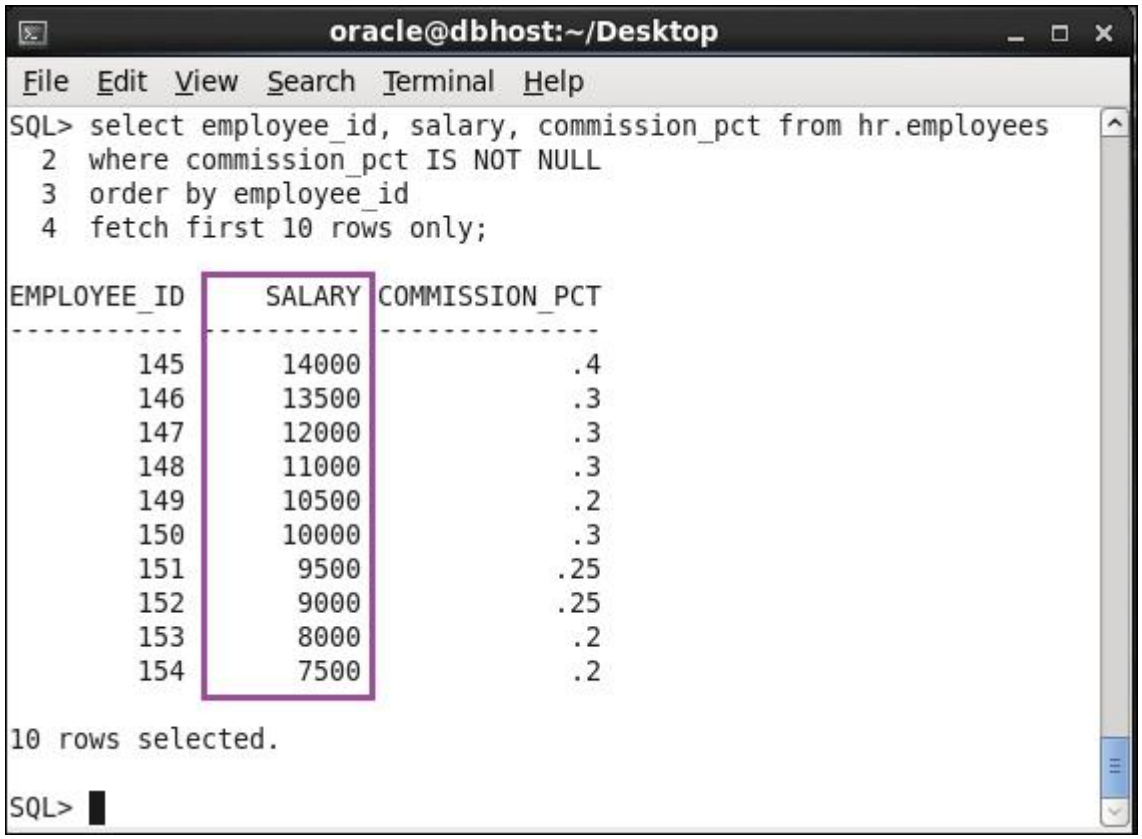
Creating a redaction policy when using random redaction

1. Connect to the database as a user who has the SELECT privilege on the HR.EMPLOYEES table or the SELECT ANY TABLE privilege (for example, hr user):

$ sqlplus hr

2. Verify that the user (for example, hr user) can view data by executing the following query:

select employee_id, salary, commission_pct from hr.employees where commission_pct IS NOT NULL order by employee_id fetch first 10 rows only;



Data in the clear text format in the HR.EMPOYEES table

3. Connect to the database as the secmgr user:

SQL> connect secmgr/oracle

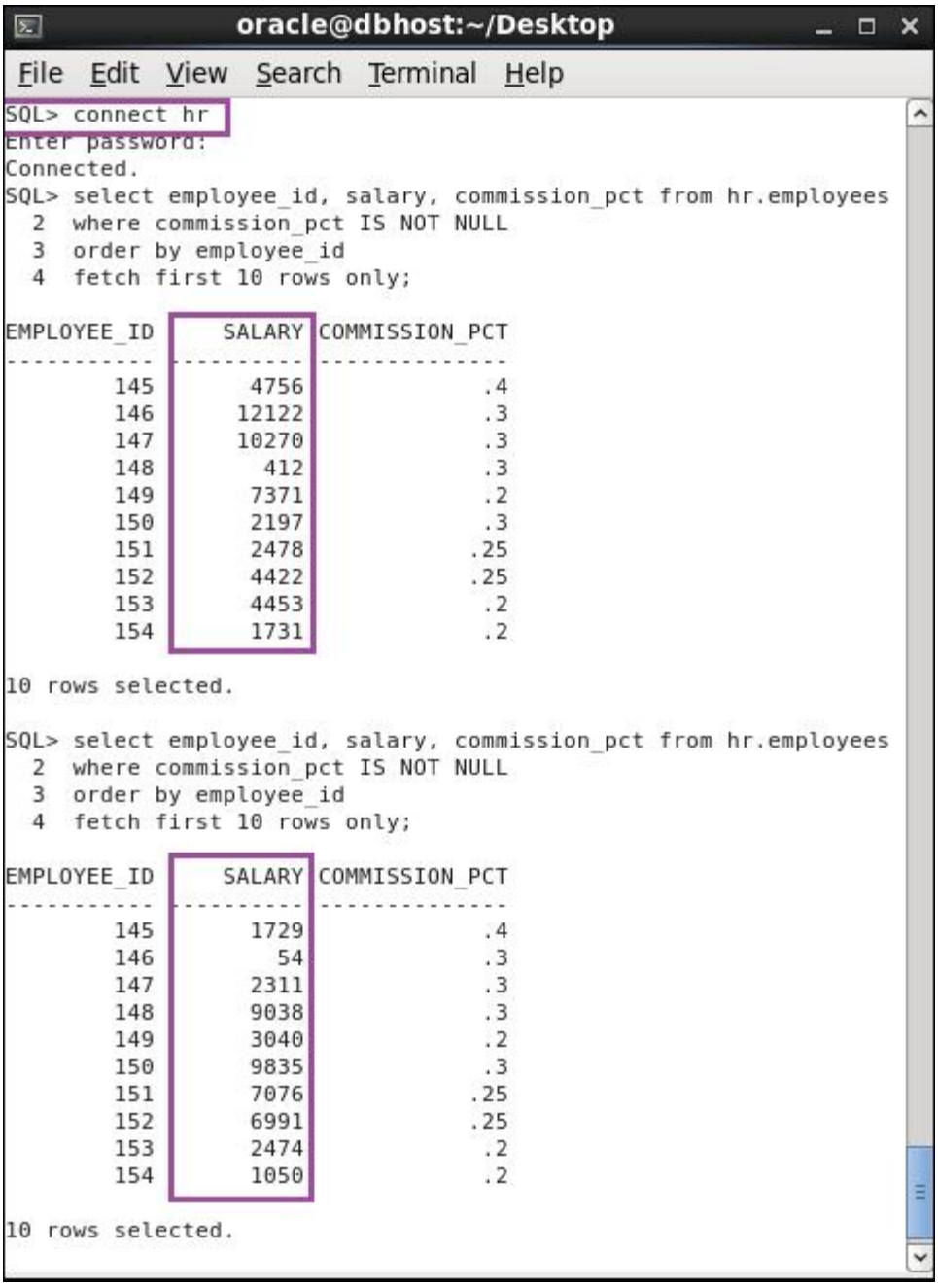
4. Create the redaction policy EMP_POL in such a way that data in column salary (the table hr.employees) is redacted using random redaction only when user in step 1 (for example, hr) tries to view it. If you don't use the hr user, modify line 8 to reflect that change:

SQL> begin
2 dbms_redact.add_policy
3 (object_schema => 'HR',
4 object_name => 'EMPLOYEES',
5 policy_name => 'EMP_POL',
6 column_name => 'SALARY',
7 function_type => DBMS_REDACT.RANDOM,

```
  8  expression => 'SYS_CONTEXT(''USERENV'',
''SESSION_USER'') = ''HR''');
  9  end;
 10  /
```

PL/SQL procedure successfully completed.

5.Connect to the database as the same user as in step 1 (for example, hr) and execute the same query, as in step 2, twice.



After applying redaction policy

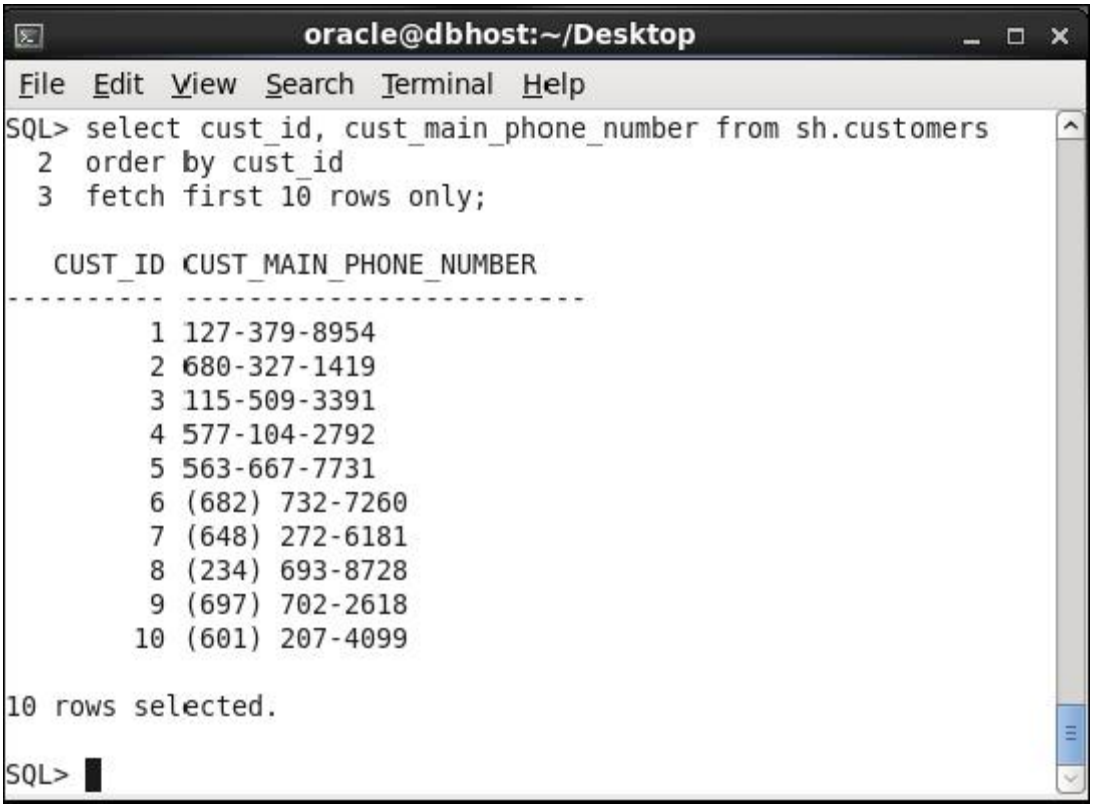
Creating a redaction policy when using regular expression redaction

1. Connect to the database as a user who has the SELECT privilege on the SH.CUSTOMERS table or the SELECT ANY TABLE privilege (for example, the sh user):

$ sqlplus sh

2. Verify that the user (for example, the user sh) can view data by executing the following query:

select cust_id, cust_main_phone_number from sh.customers order by cust_id fetch first 10 rows only;



Data in the clear text format (before redaction) in the SH.CUSTOMERS table

3. Connect to the database as the secmgr user:

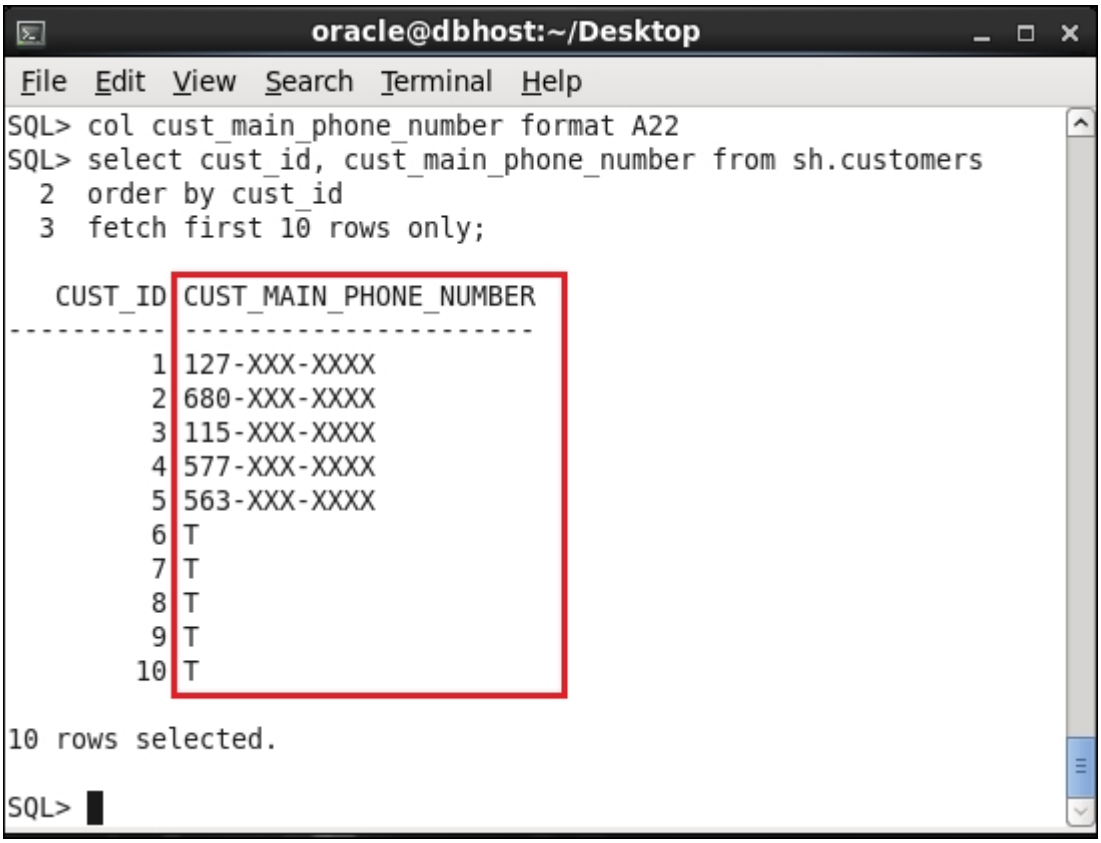
SQL> connect secmgr/oracle

4. Create the redaction policy SHORT_POL in such a manner that data in the column cust_main_phone_number (the table sh.customers) is redacted using regular expression redaction:

```
SQL> begin
  2  dbms_redact.add_policy
  3  (object_schema => 'SH',
  4  object_name => 'CUSTOMERS',
  5  policy_name => 'SHORT_POL',
  6  column_name => 'CUST_MAIN_PHONE_NUMBER',
  7  function_type => DBMS_REDACT.REGEXP,
  8  expression => '1=1',
  9  regexp_pattern => DBMS_REDACT.RE_PATTERN_US_PHONE,
  10 regexp_replace_string => DBMS_REDACT.
RE_REDACT_US_PHONE_L7,
  11 regexp_position => DBMS_REDACT.RE_BEGINNING,
  12 regexp_occurrence => DBMS_REDACT.RE_FIRST);
  13 end;
  14 /
```

PL/SQL procedure successfully completed.

5. Connect to the database as the same user as in step 1 (for example, sh) and execute the same query as in step 2.



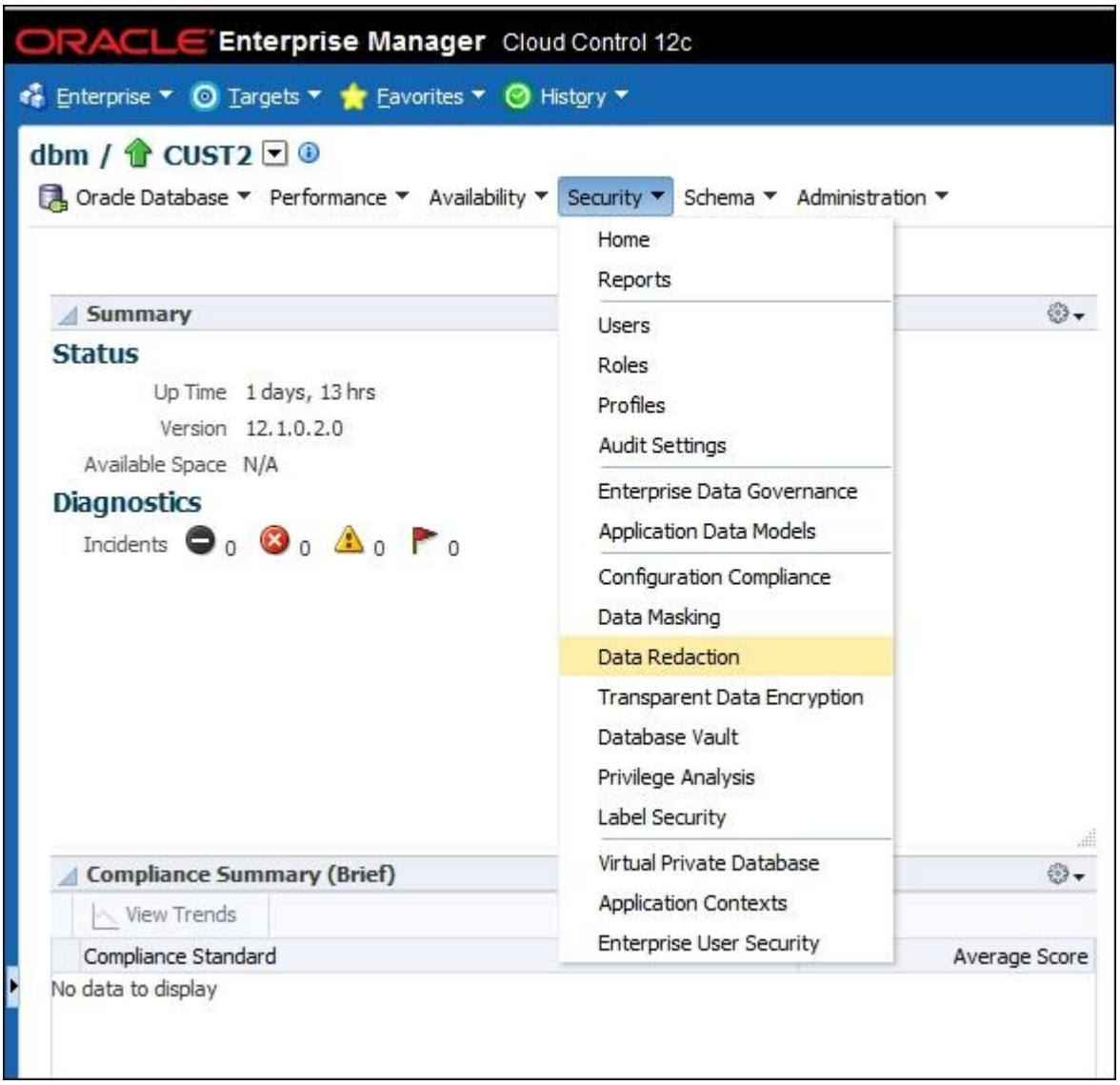
After applying the redaction policy

Using Oracle Enterprise Manager Cloud Control 12c to manage redaction policies

1. Log in to Oracle Enterprise Manager Cloud Control at https://hostname:port/em.

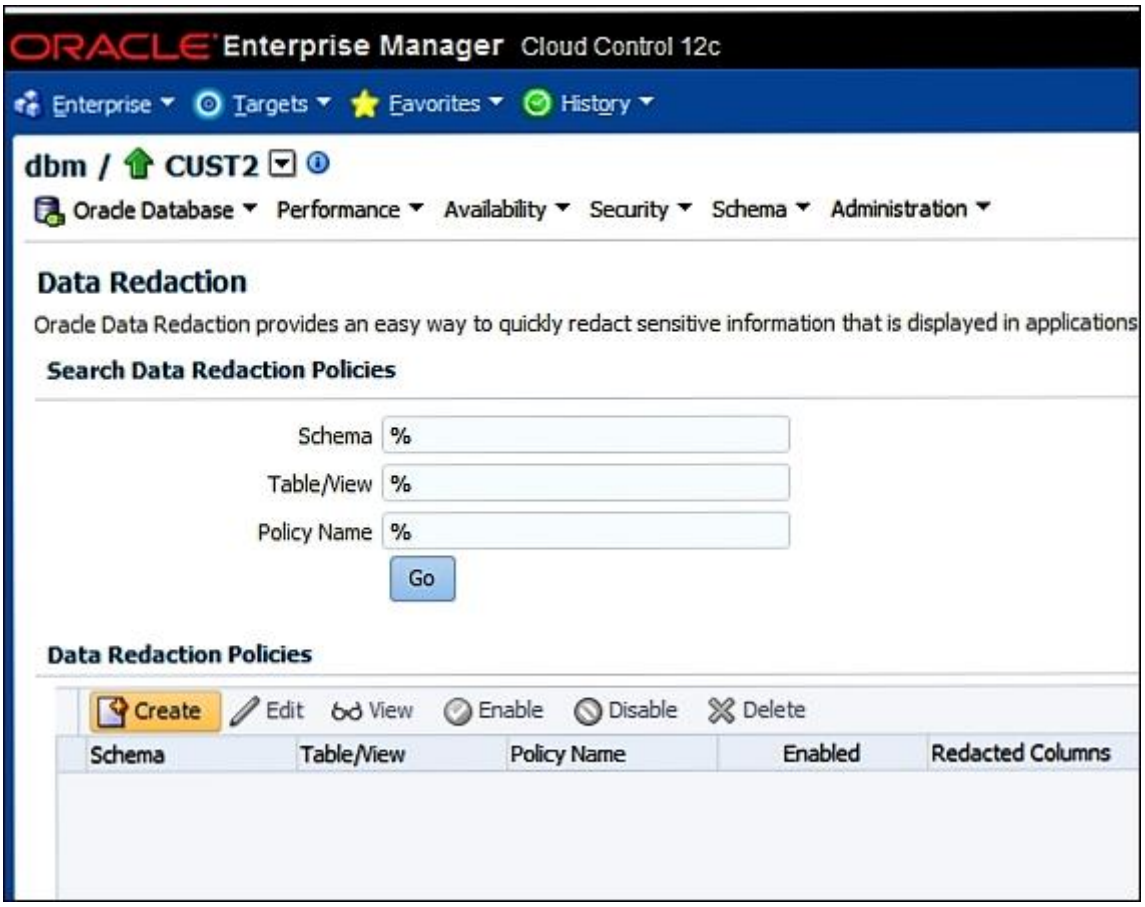
2. Go to a Database home page (if it is a container database, you should go to a home page of PDB that contains sample schemas).

3. On menu, select Security | Data Redaction.



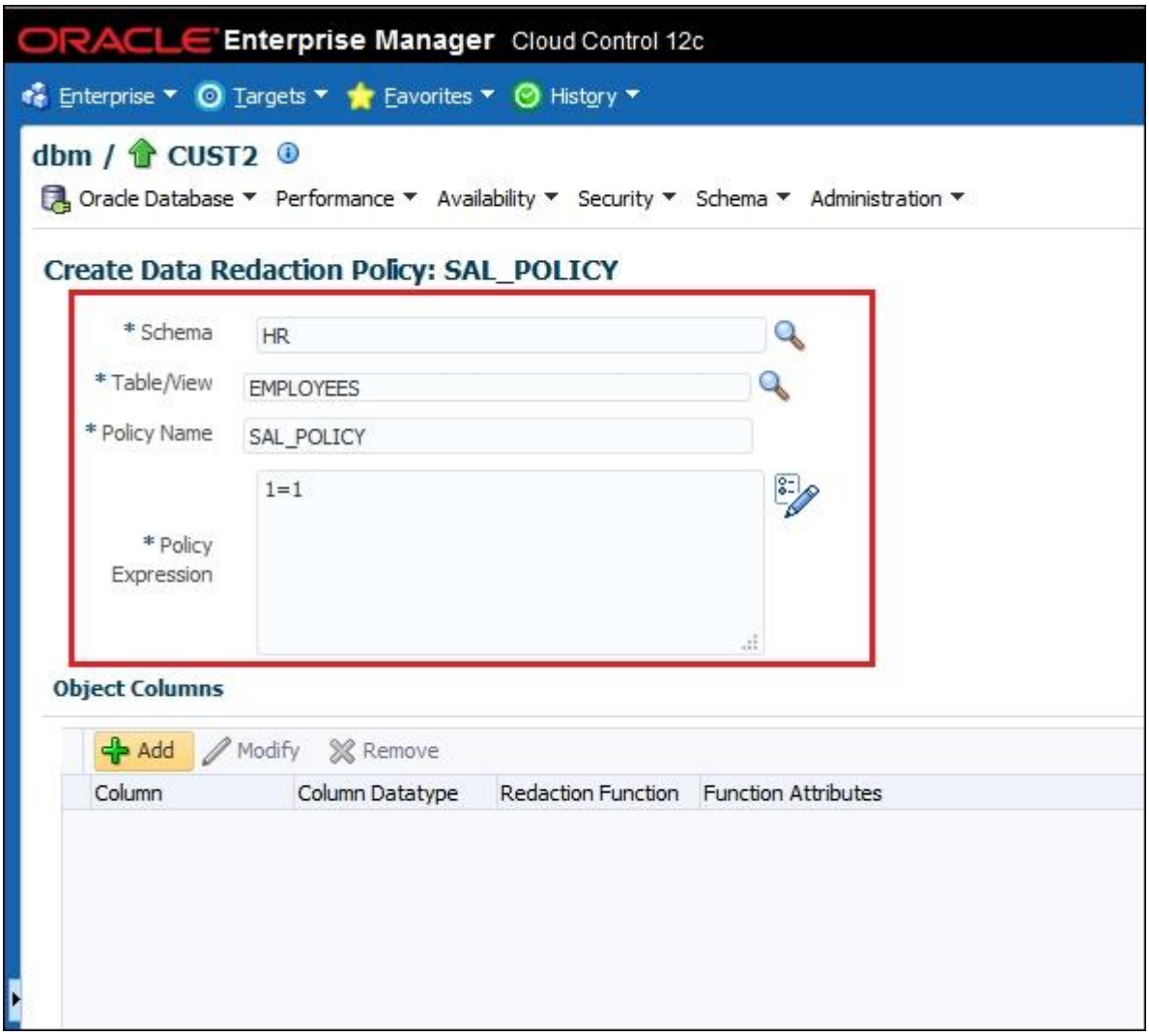
Select Data Redaction.

4. On the Data Redaction screen, select Create



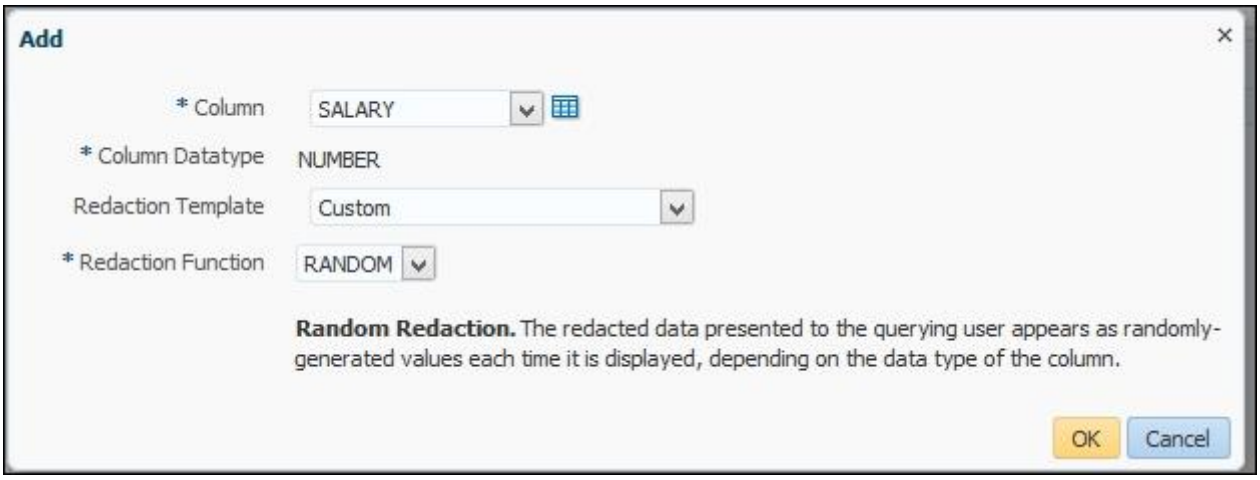
Creating a redaction policy

5. Set Schema as HR and the table as EMPLOYEES . Enter SAL_POLICY as a policy name. Click on the Add button, to add column that is going to be redacted.



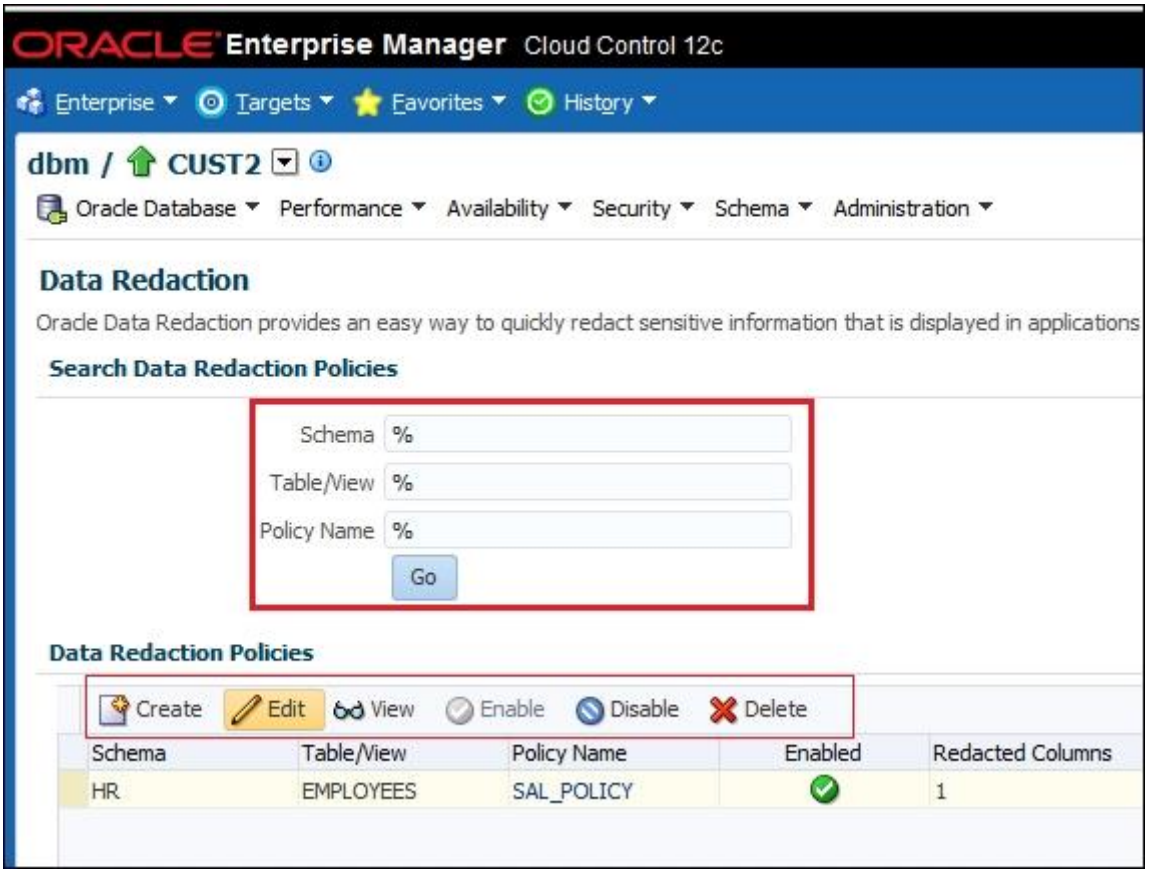
The addition of a column

6. Select the SALARY column and specify RANDOM as a Redaction Function. Click on OK. On the next screen, click on OK at the top-right corner.



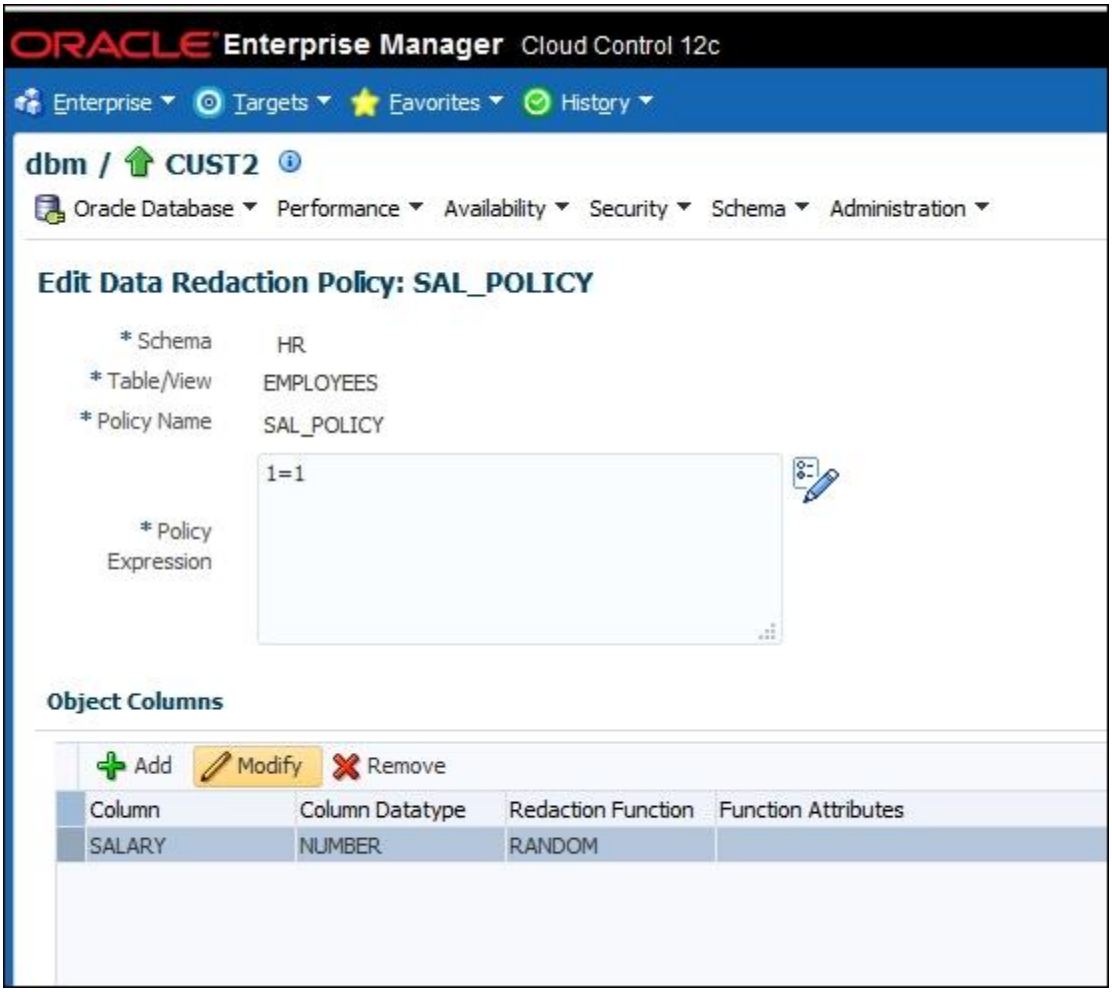
Choose random redaction type

7. To edit SAL_POLICY, select it and click on Edit (you can search for policies by specifying schema, table, or policy name)



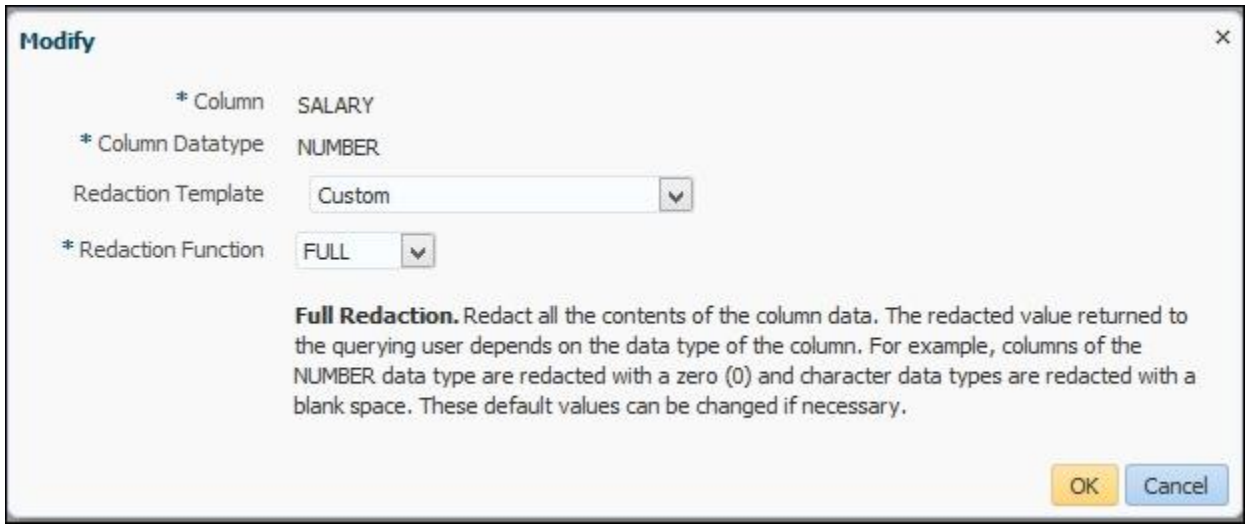
Alter policy

8. Select the SALARY column and click on Modify.



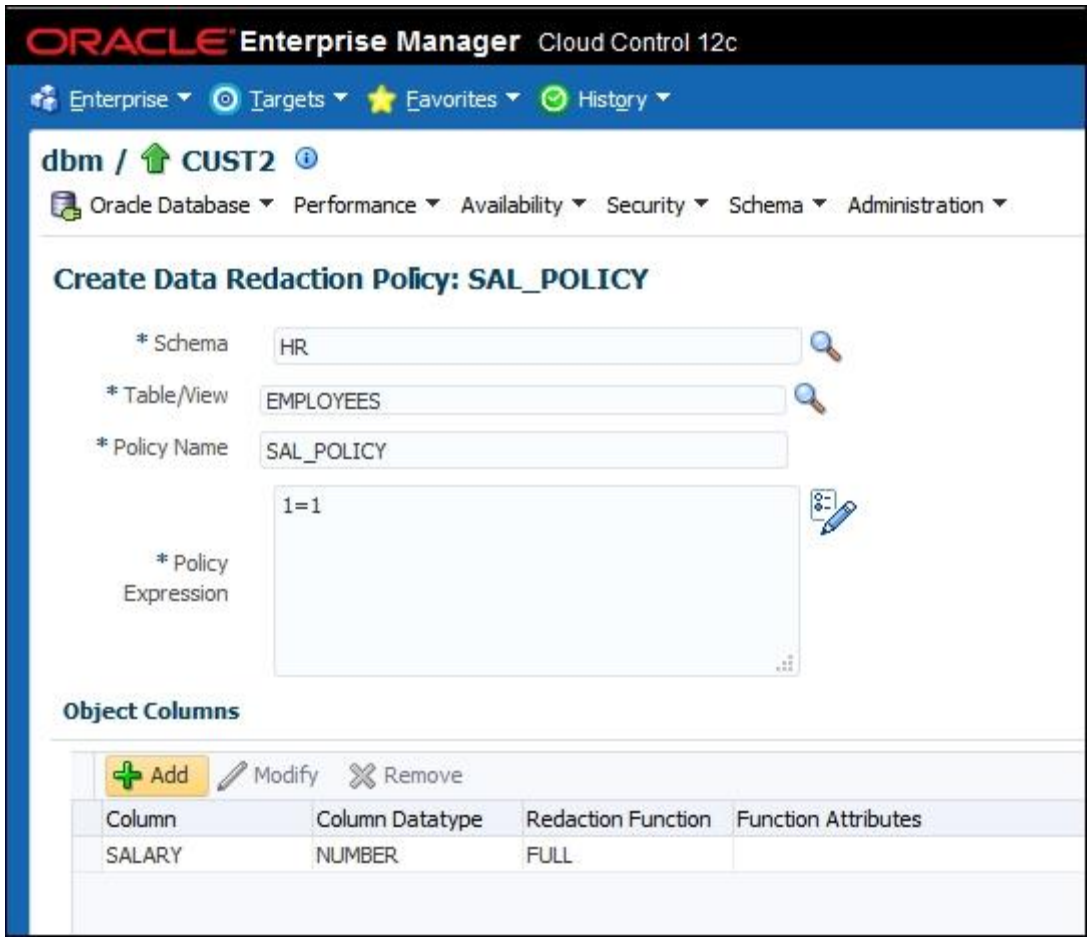
Modifying a column

9. Change Redaction Function from RANDOM to FULL. Click on OK



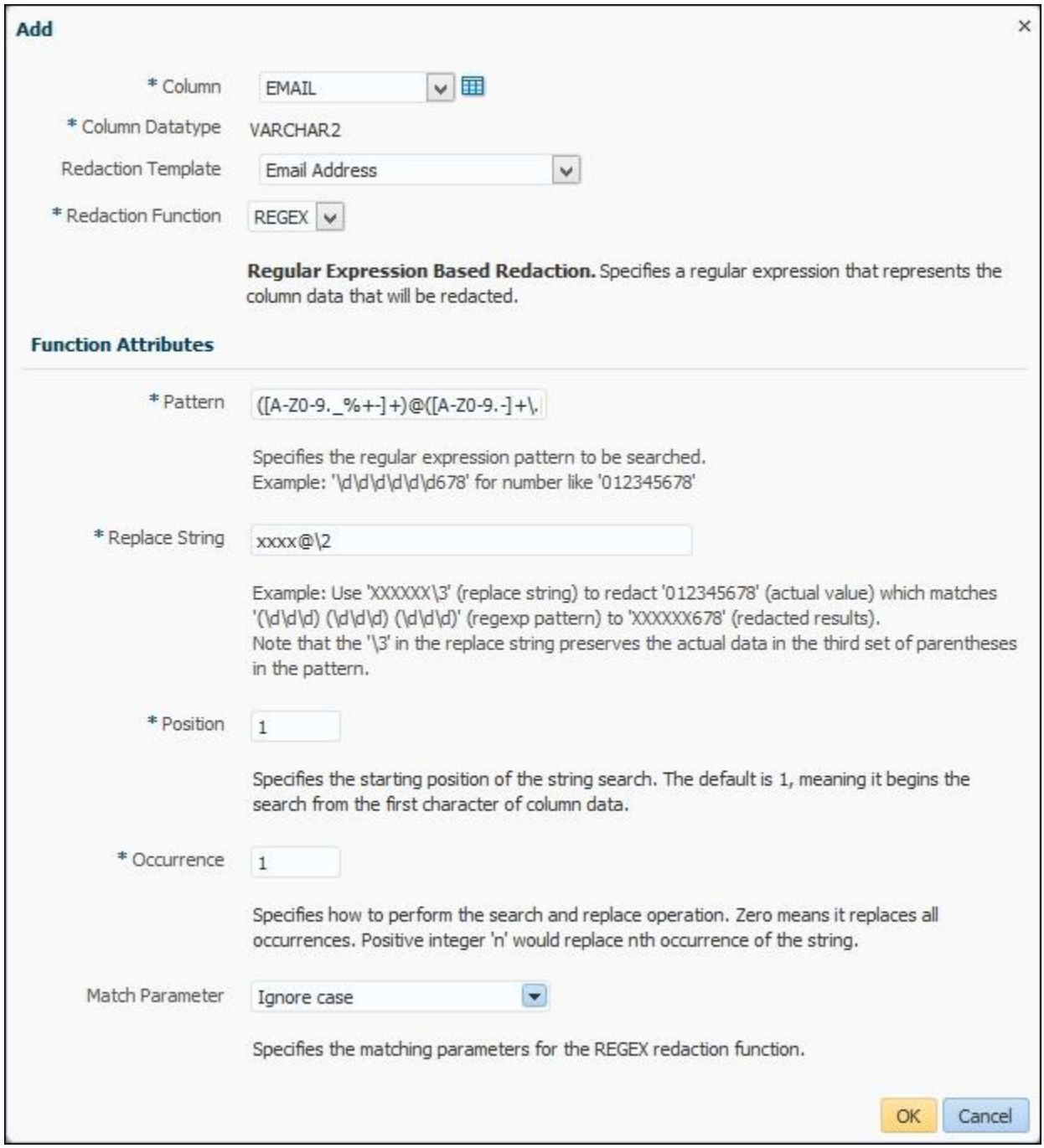
Changing redaction type for salary column

10. Click on Add in order to add one more column to the redaction policy.



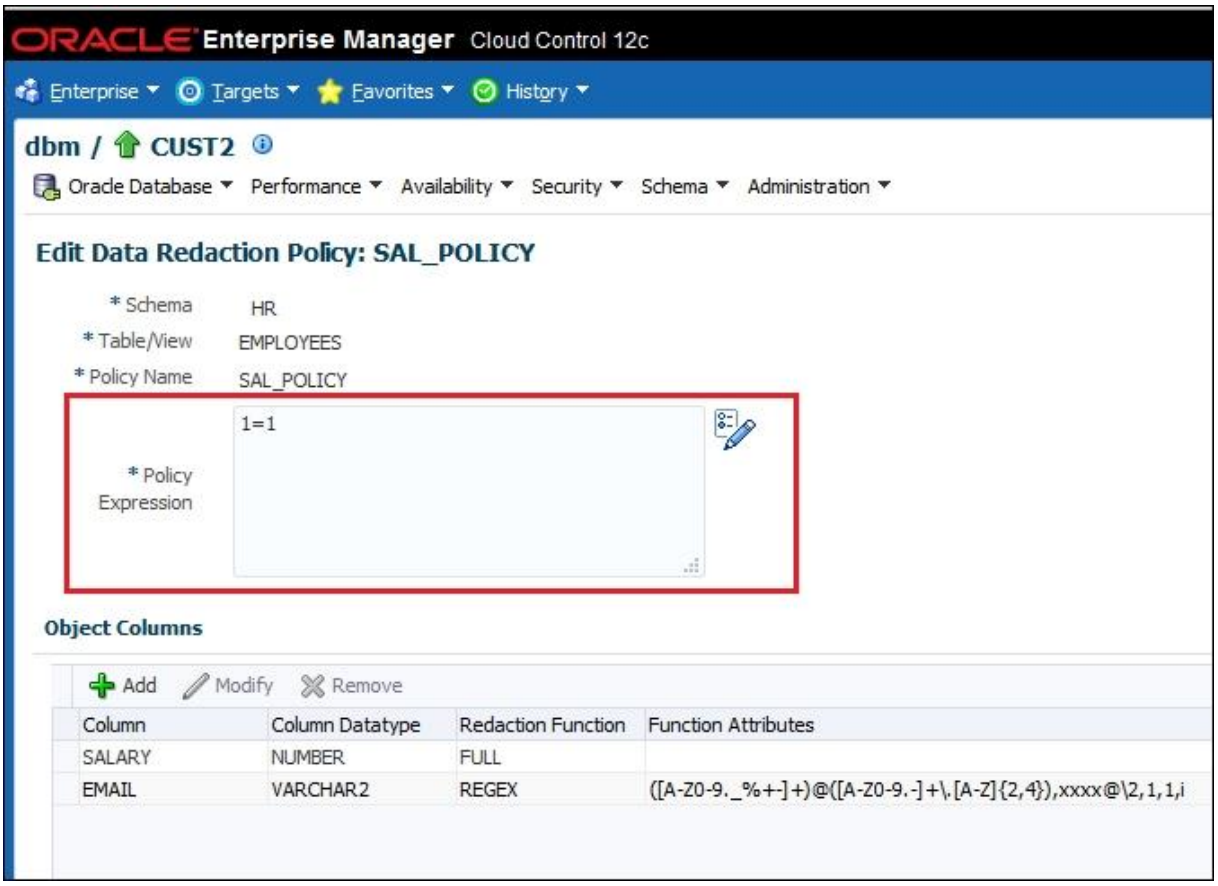
Adding a column to the redaction policy

11. Select the EMAIL column, and as Redaction Template. select Email Address. You can see that this pattern uses Regular expression type of Data Redaction. You can also change any of the parameters. Click on OK.



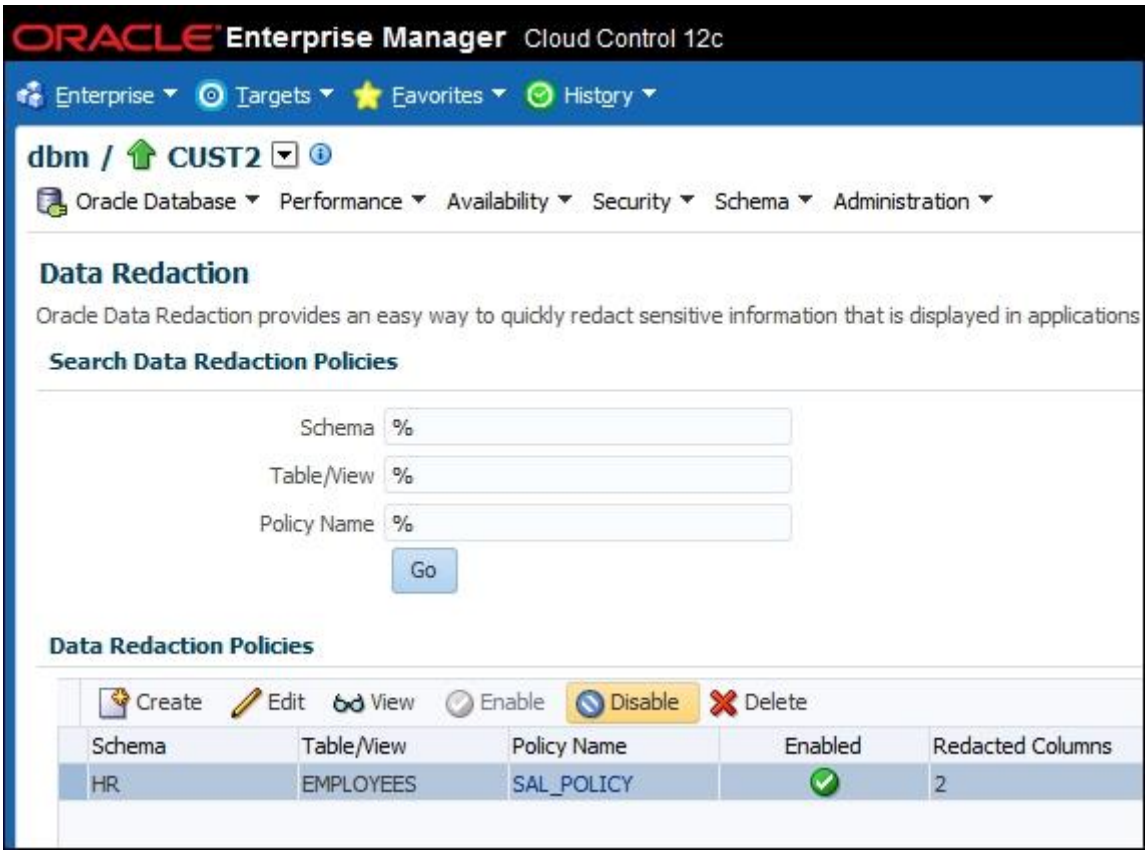
Defining redaction type for email column

12. On next page you can change Policy Expression. Click OK on the top right corner.



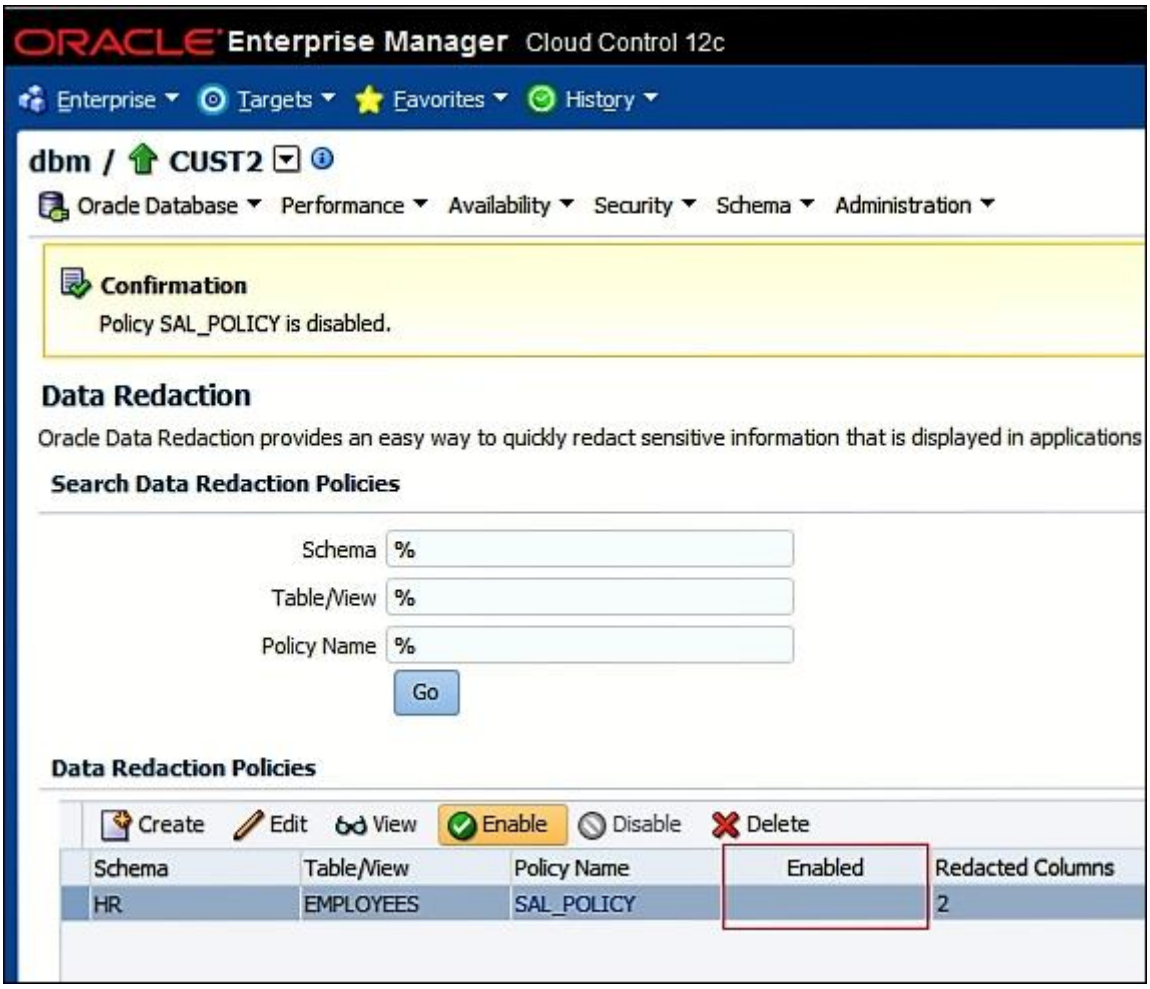
You can change the policy expression

13. To disable SAL_POLICY, select it and click on Disable.



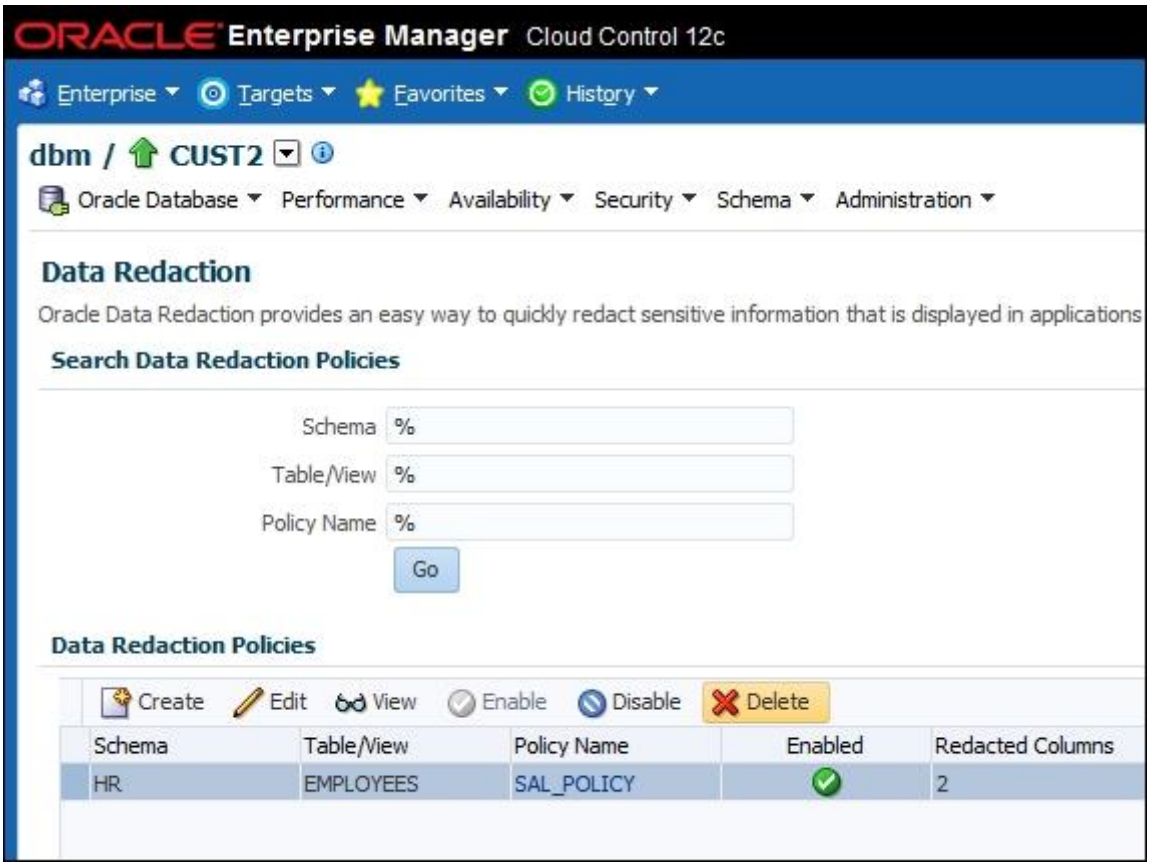
Disabling the sal_policy redaction policy

14. To enable SAL_POLICY, select it and click on Enable.



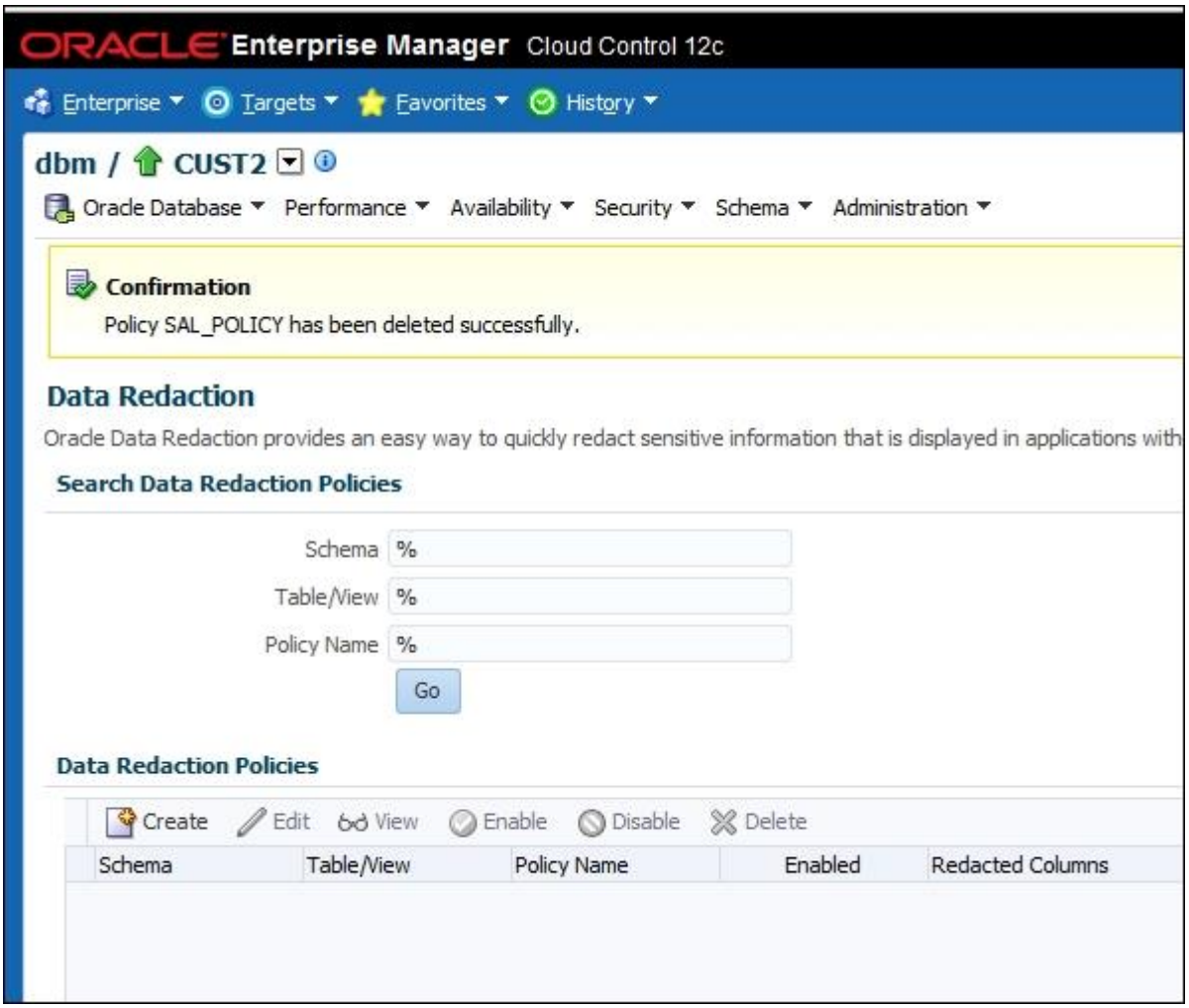
Enabling the sal_policy redaction policy

15. To delete SAL_POLICY, select it and click on Delete.



Deleting the sal_policy redaction policy

16. You should see the Confirmation message.



The SAL_POLICY policy has been successfully deleted

Changing the function parameters for a specified column

1. Connect to the database as the secmgr user and alter the policy EMP_POL:

```
$ sqlplus secmgr
SQL> BEGIN
  2  DBMS_REDACT.ALTER_POLICY(
  3  object_schema   => 'ernesto',
  4  object_name     => 'tbl',
  5  policy_name     => 'a_tbl_partial',
```

```
 6  action          => DBMS_REDACT.MODIFY_COLUMN,
 7  column_name     => 'a',
 8  function_type   => DBMS_REDACT.PARTIAL,
 9  function_parameters    => '9,1,4');
10  END;
11  /
```

2. Connect as the user usr2 to the database and view data in column A in the ernesto.tb1 table:

```
SQL> connect usr2/oracle2
Connected.

SQL> select a from ernesto.tbl;
         A ----------    999956    999967    999978
```

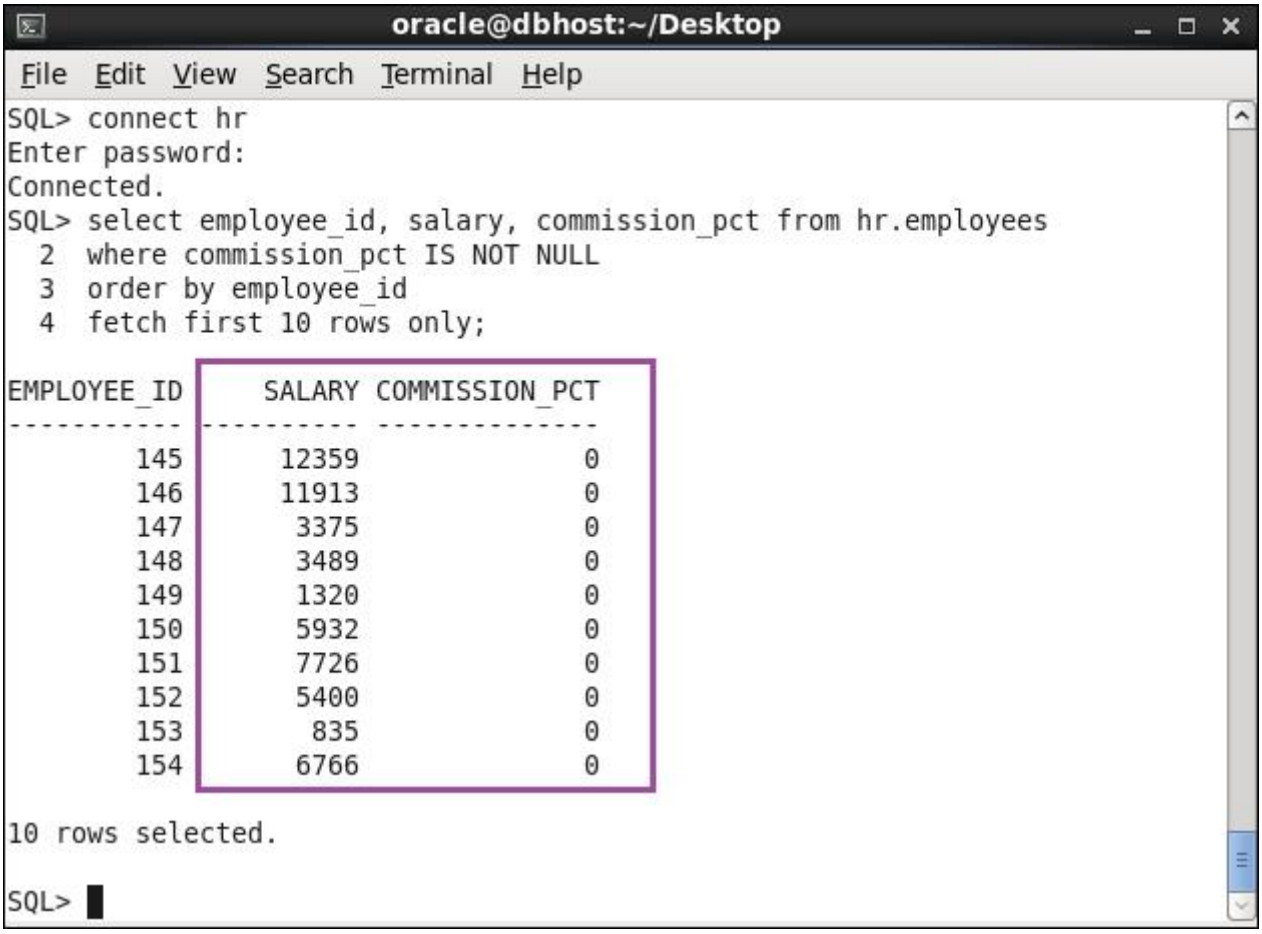
Add a column to the redaction policy

1. Connect to the database as the secmgr user and alter the EMP_POL policy:

```
$ sqlplus secmgr
SQL> BEGIN
  2  DBMS_REDACT.ALTER_POLICY(
  3  object_schema   => 'HR',
  4  object_name     => 'EMPLOYEES',
  5  policy_name     => 'EMP_POL',
  6  action          => DBMS_REDACT.ADD_COLUMN,
  7  column_name     => 'COMMISSION_PCT',
  8  function_type   => DBMS_REDACT.FULL);
  9  END;
 10  /

PL/SQL procedure successfully completed.
```

2. Connect the user hr to the database and execute the following query:

select employee_id, salary, commission_pct from hr.employees where commission_pct IS NOT NULL order by employee_id fetch first 10 rows only;



Two columns are redacted

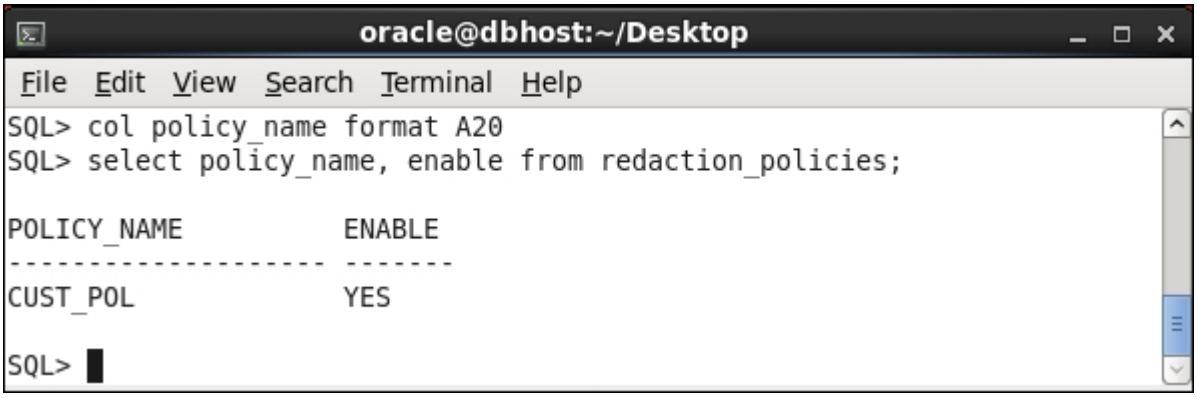
Enabling, disabling, and dropping redaction policy

1. Connect to the database as a user who has an execute privilege on dbms_redact package and select_catalog_role role (for example, secmgr user):

$ sqlplus secmgr

2. Find out which redaction policies exist in the database by querying the redaction_policies view:

SQL> col policy_name format A20
select policy_name, enable from redaction_policies;



Finding defined redaction policies

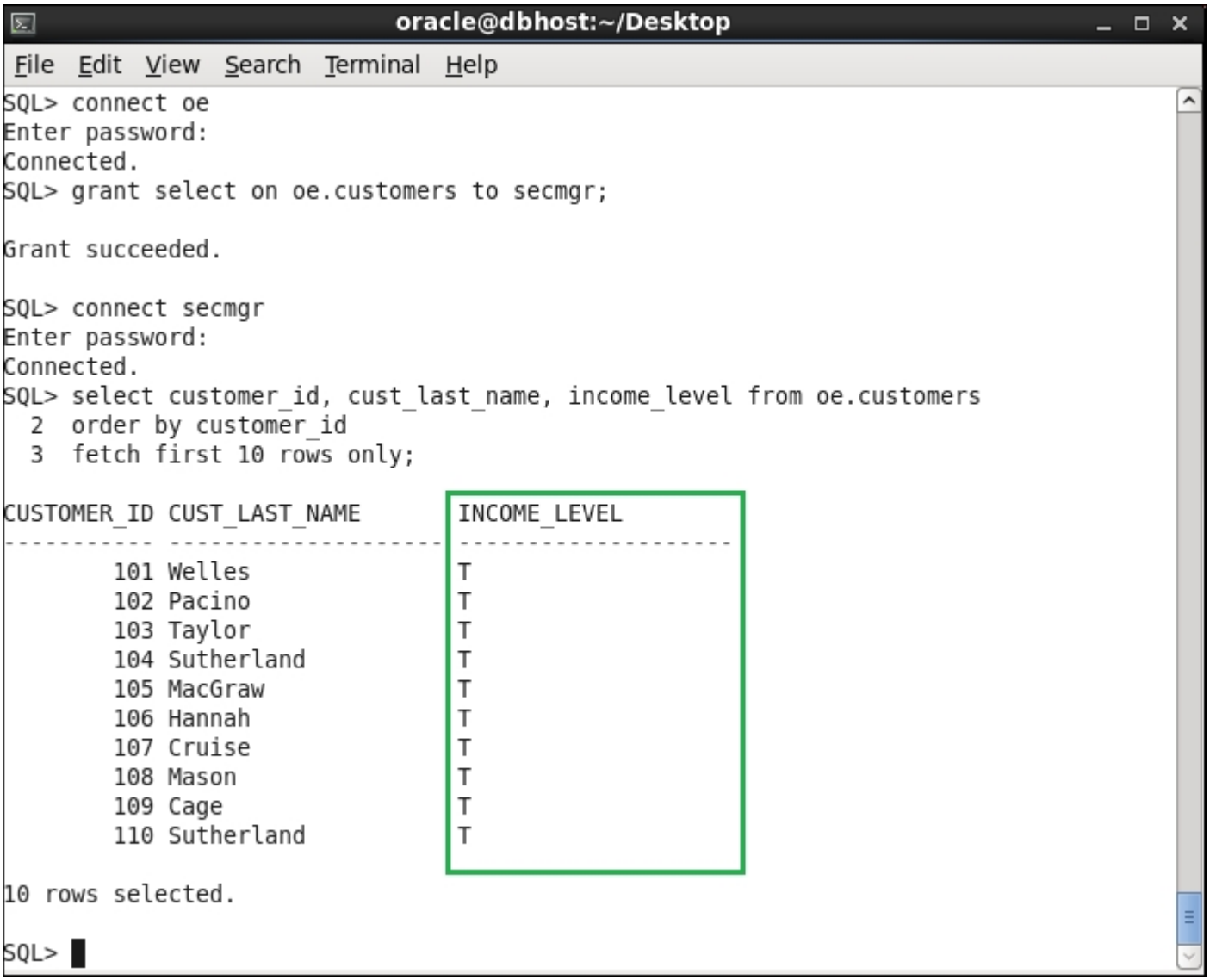
3. Connect to the database as the oe user and grant the SELECT privilege on OE.CUSTOMERS to the secmgr user. Connect to the database as the secmgr user. Verify that the secmgr user can't see original data in the column INCOME_LEVEL:

SQL> connect oe

SQL> grant select on oe.customers to secmgr;

SQL> connect secmgr

SQL> select customer_id, cust_last_name, income_level from oe.customers 2 order by customer_id 3 fetch first 10 rows only;



Redacted data is displayed even to the user who created the policy

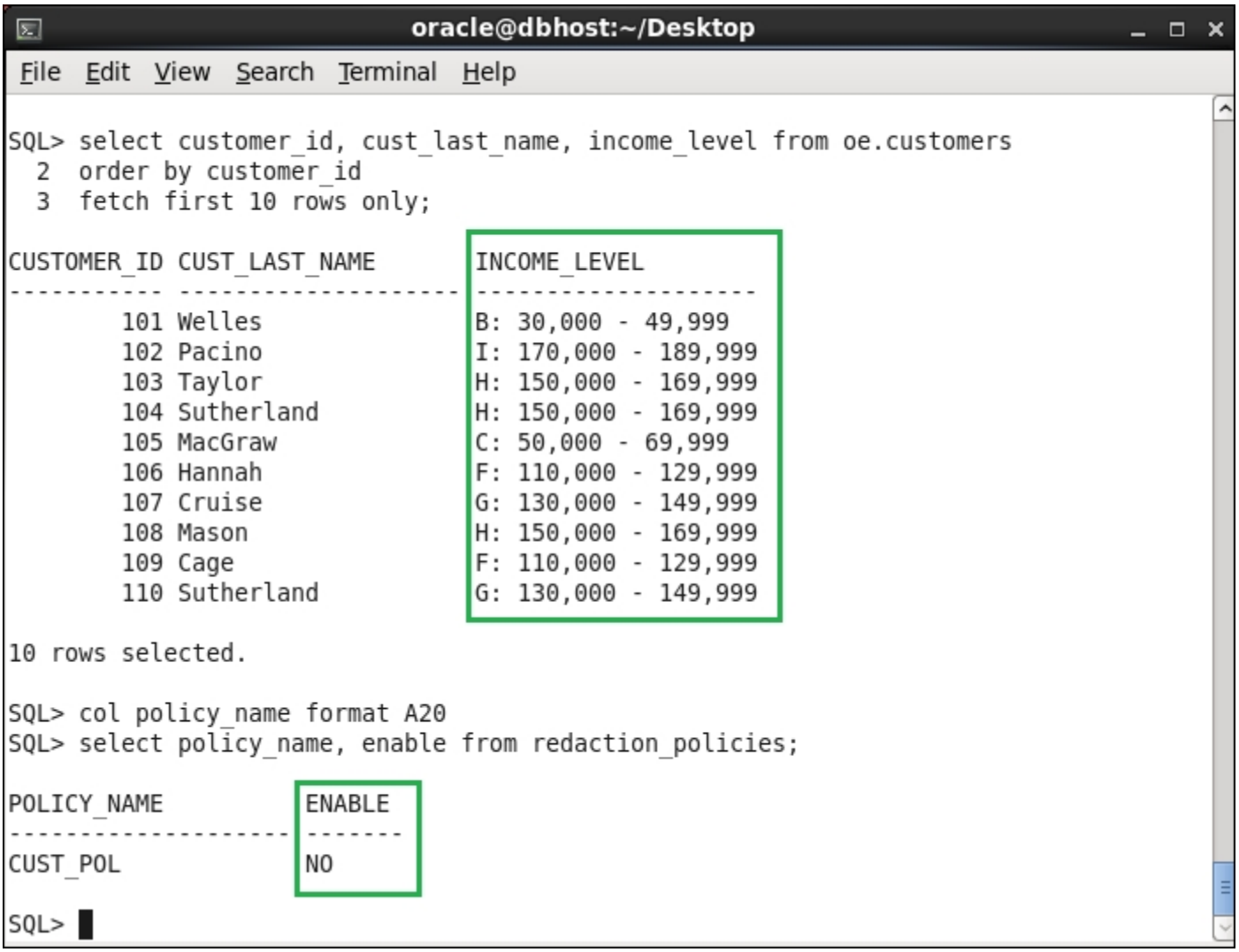
4. Disable the redaction policy CUST_POL (as the secmgr user):

```
SQL> begin
  2  dbms_redact.disable_policy
  3  (object_schema => 'OE',
  4  object_name => 'CUSTOMERS',
  5  policy_name => 'CUST_POL');
  6  end;
  7 /
```

PL/SQL procedure successfully completed.

5. Verify that now the secmgr user can view original data in the column INCOME_LEVEL and query the redaction_policies view by executing the following statements:

- **select customer_id, cust_last_name, income_level from oe.customers order by customer_id fetch first 10 rows only;**
- **col policy_name format A20**
- **select policy_name, enable from redaction_policies;**



secmgr can view unmasked data in the column income_level, because the cust_pol policy is disabled

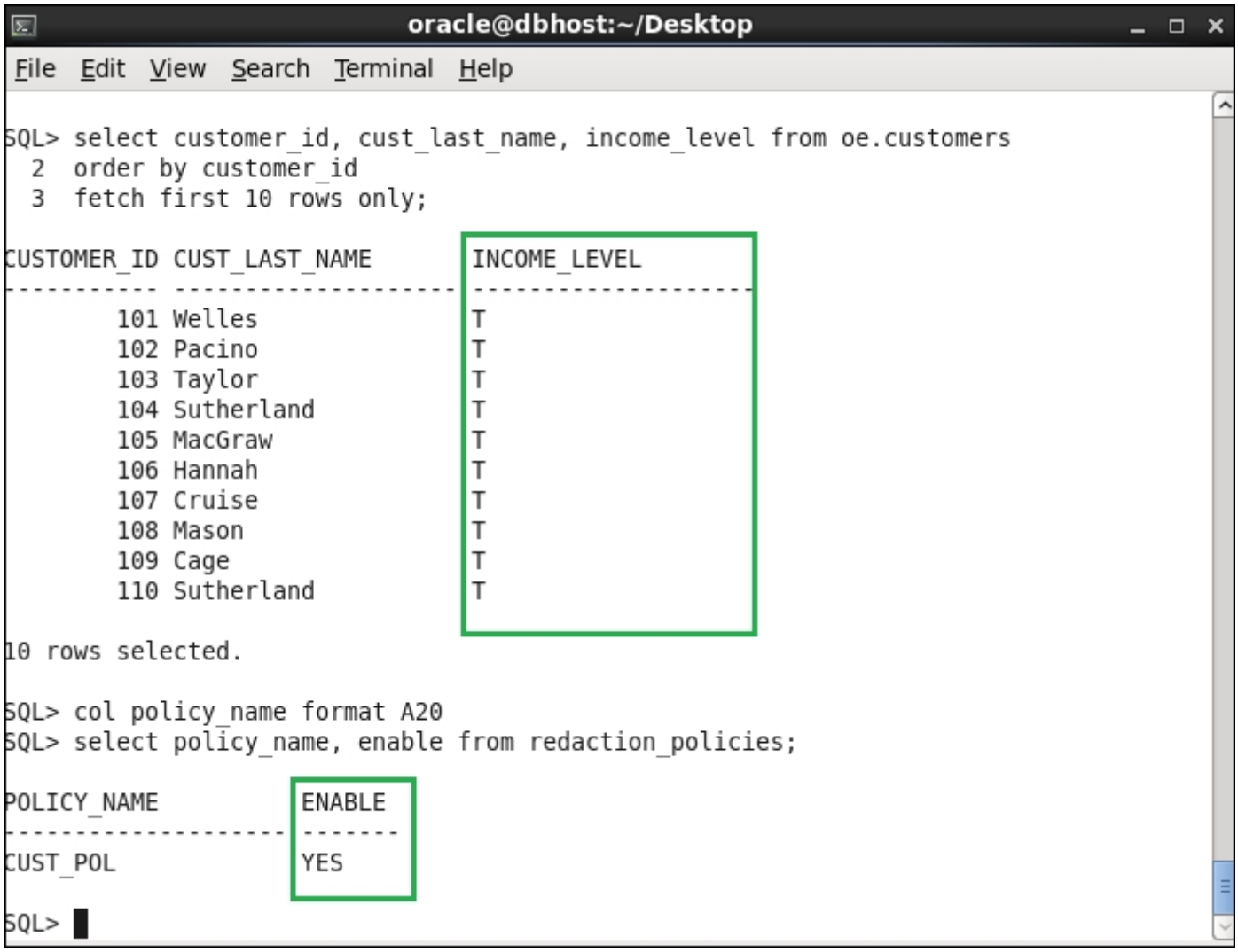
- **Enable the redaction policy CUST_POL:**

  SQL> begin
  2 dbms_redact.enable_policy
  3 (object_schema => 'OE',
  4 object_name => 'CUSTOMERS',
  5 policy_name => 'CUST_POL');
  6 end;
  7 /

  PL/SQL procedure successfully completed.

6. Verify that redaction is working properly by executing the following statements:

- **select customer_id, cust_last_name, income_level from oe.customers order by customer_id fetch first 10 rows only;**
- **col policy_name format A20**
- **select policy_name, enable from redaction_policies;**



Redacted data is displayed to the secmgr user because the cust_pol redaction policy is enabled

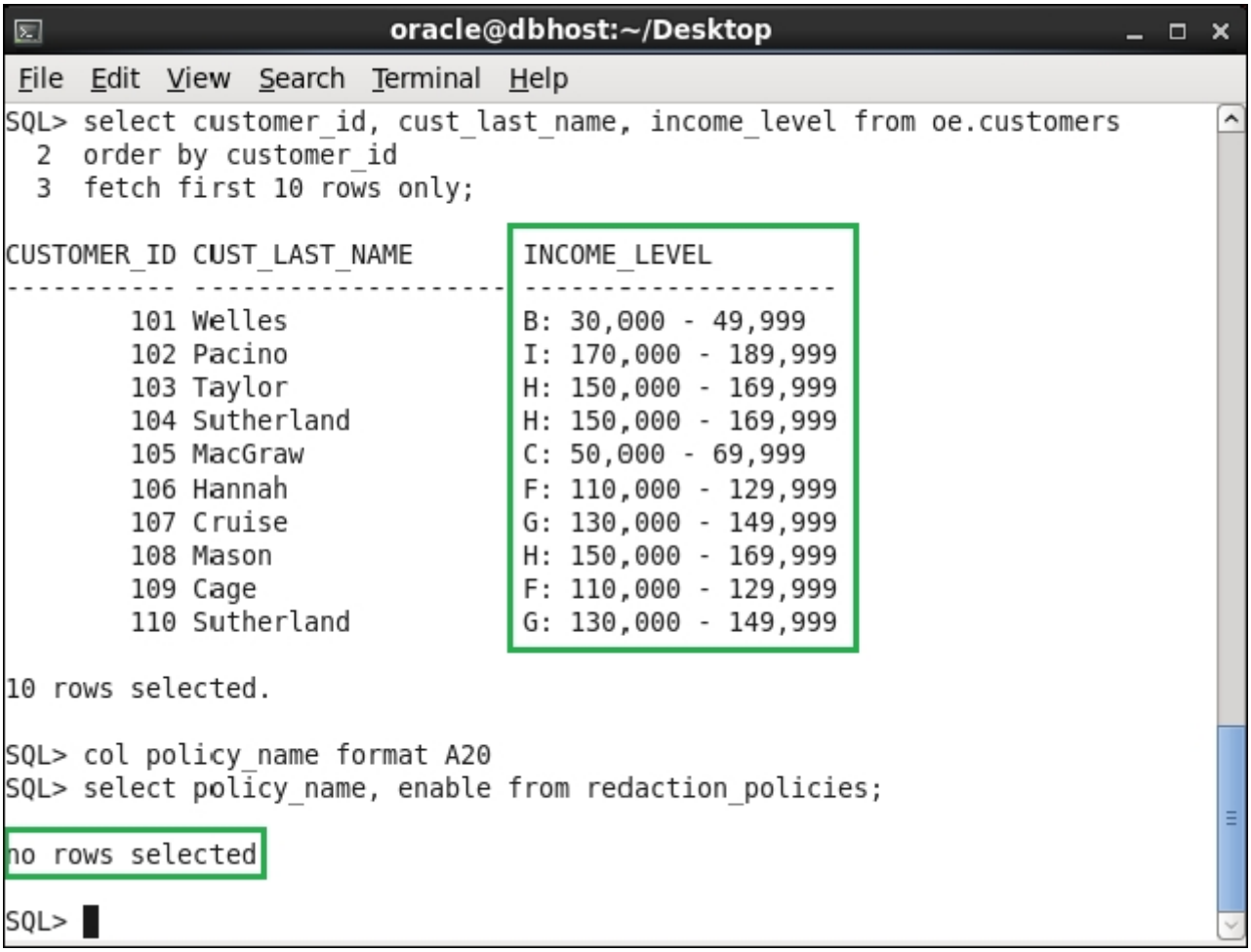
- **Drop the redaction policy CUST_POL:**

  SQL> begin
  2 dbms_redact.drop_policy
  3 (object_schema => 'OE',
  4 object_name => 'CUSTOMERS',
  5 policy_name => 'CUST_POL');
  6 end;
  7 /

  PL/SQL procedure successfully completed.

7. Verify that the redaction policy CUST_POL doesn't exist in the database by executing the following statements:

- **select customer_id, cust_last_name, income_level from oe.customers order by customer_id fetch first 10 rows only;**
- **col policy_name format A20**
- **select policy_name, enable from redaction_policies;**



The redaction policy cust_pol doesn't exist anymore

Exempting users from data redaction policies

1. Connect to the database as a user who has a DBA role (for example, user ernesto):

$ sqlplus ernesto/oracle

2. Create a new user (for example, vipuser) and grant him the create session privilege and select privilege on table customers in schema ernesto:
SQL> create user vipuser identified by oracle;

SQL> grant create session to vipuser;

SQL> grant select on ernesto.customers to vipuser;

3. Connect as a newly created user and try to select from the ernesto.customers table:

SQL> connect vipuser/oracle

SQL> select * from ernesto.customers;

NAME CREDIT_CARD ---------- ----------
tom ############9132 steve ############5691 john
############5806

4. Connect again as the user ernesto, and grant the EXEMPT REDACTION POLICY privilege to the vipuser user:

SQL> connect ernesto/oracle

SQL> grant exempt redaction policy to vipuser;

5. As the user vipuser, now try to select from the table ernesto.customers:

SQL> connect vipuser/oracle

SQL> select * from ernesto.customers;
NAME CREDIT_CARD ---------- ----------
tom 3455647456589132 steve 3734982321225691 john
3472586894975806

Transparent Sensitive Data Protection

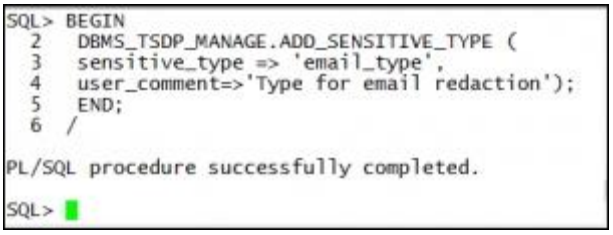
Creating a sensitive type

1. Connect to the database (for example, fenagodb1) as a user who has appropriate privileges (for example, c##ernesto):

$ sqlplus c##ernesto@fenagodb1

2. Create a sensitive type (for example, email_type):

SQL> BEGIN
DBMS_TSDP_MANAGE.ADD_SENSITIVE_TYPE (
sensitive_type => '<your_type>',
user_comment=> '<description>');
END;
/



Creating a sensitive type

Determining sensitive columns

1. Connect to the database (for example, fenagodb1) as a user who has appropriate privileges (for example, c##ernesto user):

$ sqlplus c##ernesto@fenagodb1

2. Associate a sensitive column (for example, schema CHALLENGEERNESTO, table T1, column EMAIL_ADDRESS) with sensitive type you created in the previous recipe (for example, email_type)

```
SQL> BEGIN
  2  DBMS_TSDP_MANAGE.ADD_SENSITIVE_COLUMN (
  3  schema_name => 'CHALLENGEERNESTO',
  4  table_name => 'T1',
  5  column_name => 'EMAIL_ADDRESS',
  6  sensitive_type => 'email_type');
  7  END;
  8  /

PL/SQL procedure successfully completed.
```

Adding sensitive column email_address to email_type sensitive type

3. Associate another sensitive column (for example, schema HR, table EMPLOYEES, column EMAIL) with the same sensitive data type (for example, email_type).

```
SQL> BEGIN
  2  DBMS_TSDP_MANAGE.ADD_SENSITIVE_COLUMN (
  3  schema_name => 'HR',
  4  table_name => 'EMPLOYEES',
  5  column_name => 'EMAIL',
  6  sensitive_type => 'email_type');
  7  END;
  8  /

PL/SQL procedure successfully completed.

SQL>
```

Adding sensitive column email to sensitive type email_type

Creating transparent sensitive data protection policy

1. Connect to the database (for example, fenagodb1) as a user who has appropriate privileges (for example, c##ernesto user):

$ sqlplus c##ernesto@fenagodb1

2. Create TSDP policy using Data Redaction.

```
SQL> DECLARE
  2  redact_feature_options DBMS_TSDP_PROTECT.FEATURE_OPTIONS;
  3  policy_conditions DBMS_TSDP_PROTECT.POLICY_CONDITIONS;
  4  BEGIN
  5  redact_feature_options('expression') :='1=1';
  6  redact_feature_options('function_type') :='DBMS_REDACT.REGEXP';
  7  redact_feature_options('regexp_pattern'):='([A-Za-z0-9._%+-]+)@([A-Za-z0-9.-]+\.[A-Za-z]{2,4})';
  8  redact_feature_options('regexp_replace_string'):='\1@xxxx.com';
  9  policy_conditions(DBMS_TSDP_PROTECT.DATATYPE) := 'VARCHAR2';
 10  DBMS_TSDP_PROTECT.ADD_POLICY ('redact_regexp_email',DBMS_TSDP_PROTECT.REDACT,
 11  redact_feature_options, policy_conditions);
 12  END;
 13  /

PL/SQL procedure successfully completed.

SQL>
```

TSDP policy using Oracle Data Redaction

Associating transparent sensitive data protection policy with sensitive type

1. Connect to the database as a user (for example, fenagodb1) who has appropriate privileges (for example, c##ernesto user):

$ sqlplus c##ernesto@fenagodb1

2. Associate TSDP policy with sensitive type:

```
SQL> BEGIN
  2  DBMS_TSDP_PROTECT.ASSOCIATE_POLICY (
  3  policy_name => 'redact_regexp_email',
  4  sensitive_type => 'email_type',
  5  associate => true);
  6  END;
  7  /

PL/SQL procedure successfully completed.

SQL>
```

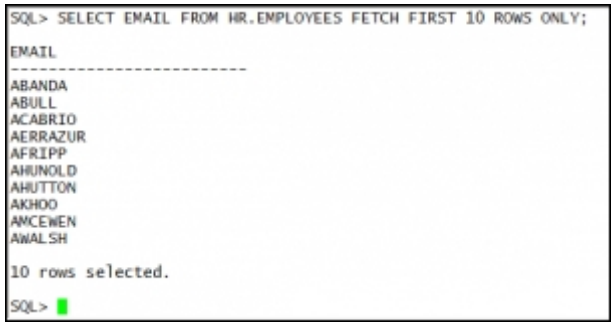
Enabling, disabling, and dropping policy

1. Connect to the database (for example, fenagodb1) as a user who has the SELECT privilege on the HR.EMPLOYEES table and the CHALLE NGEERNESTO.T1 table or the SELECT ANY TABLE privilege (for example, maja).

$ sqlplus maja@fenagodb1

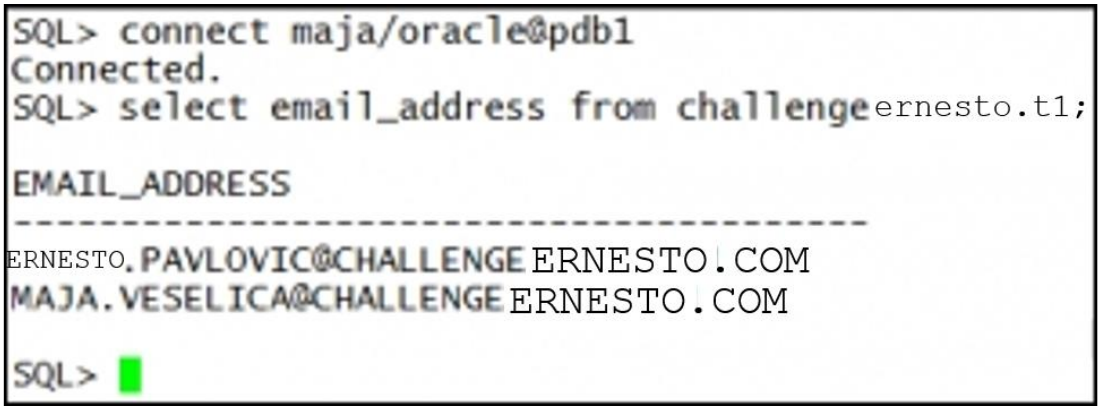
2.View sensitive data by executing the following two queries:

SELECT EMAIL FROM HR.EMPLOYEES FETCH FIRST 10 ROWS ONLY;



Before enabling the policy

SELECT EMAIL_ADDRESS FROM CHALLENGEERNESTO.T1;



Before enabling the policy

3. Connect to the database (for example, fenagodb1) as a user who can manage TSDP policies (for example, c##ernesto). Enable the TSDP policy:

```
SQL> connect c##ERNESTO/oracle@pdb1
Connected.
SQL> BEGIN
  2  DBMS_TSDP_PROTECT.ENABLE_PROTECTION_TYPE (
  3  sensitive_type => 'email_type');
  4  END;
  5  /

PL/SQL procedure successfully completed.

SQL>
```

4. Repeat step 2 as user maja.

```
SQL> select email from hr.employees fetch first 10 rows only;

EMAIL
--------------------------------------------------------------------------------



10 rows selected.
```

Sensitive data is protected

5.Result of the second query is shown:

```
SQL> connect maja/oracle@pdb1
Connected.
SQL> select email_address from challengeernesto.t1;

EMAIL_ADDRESS
--------------------------------------------------------------------------------
ERNESTO.PAVLOVIC@xxxx.com
MAJA.VESELICA@xxxx.com

SQL>
```

After enabling the policy

6. Connect to the database (for example, fenagodb1) as a user who can manage TSDP policies (for example, c##ernesto). Disable the TSDP policy.

```
SQL> BEGIN
  2  DBMS_TSDP_PROTECT.DISABLE_PROTECTION_TYPE (
  3  sensitive_type => 'email_type');
  4  END;
  5  /

PL/SQL procedure successfully completed.

SQL>
```

7. Repeat step 2 as user maja.

```
SQL> SELECT EMAIL FROM HR.EMPLOYEES FETCH FIRST 10 ROWS ONLY;

EMAIL
-------------------------
ABANDA
ABULL
ACABRIO
AERRAZUR
AFRIPP
AHUNOLD
AHUTTON
AKHOO
AMCEWEN
AWALSH

10 rows selected.

SQL>
```

After the policy was disabled

8. The result of the second query is shown:

```
SQL> connect maja/oracle@pdb1
Connected.
SQL> select email_address from challenge.ernesto.t1;

EMAIL_ADDRESS
----------------------------------------
ERNESTO.PAVLOVIC@CHALLENGEZORAN.COM
MAJA.VESELICA@CHALLENGEZORAN.COM

SQL>
```

After the policy was disabled

9. Connect to the database (for example, fenagodb1) as a user who can manage TSDP policies (for example, c##ernesto). Drop both sensitive columns.

```
SQL> BEGIN
  2  DBMS_TSDP_MANAGE.DROP_SENSITIVE_COLUMN (
  3  schema_name => 'CHALLENGE.ERNESTO',
  4  table_name => 'T1',
  5  column_name => 'EMAIL_ADDRESS');
  6  END;
  7  /

PL/SQL procedure successfully completed.

SQL> BEGIN
  2  DBMS_TSDP_MANAGE.DROP_SENSITIVE_COLUMN (
  3  schema_name => 'HR',
  4  table_name => 'EMPLOYEES',
  5  column_name => 'EMAIL');
  6  END;
  7  /

PL/SQL procedure successfully completed.
```

10. Drop the sensitive type.

```
SQL> BEGIN
  2  DBMS_TSDP_MANAGE.DROP_SENSITIVE_TYPE (
  3  sensitive_type => 'email_type');
  4  END;
  5  /

PL/SQL procedure successfully completed.
```

11. Drop the TSDP policy.

```
SQL> BEGIN
  2  DBMS_TSDP_PROTECT.DROP_POLICY (
  3  policy_name => 'redact_regexp_email');
  4  END;
  5  /

PL/SQL procedure successfully completed.

SQL>
```

Altering transparent sensitive data protection policy

1. Connect to the database (for example, fenagodb1) as a user who can manage TSDP policies (for example, c##ernesto):

$ sqlplus c##ernesto@fenagodb1

2. If the policy is enabled, disable it for all columns (for instructions how to disable the TSDP policy, see recipe Enabling, disabling, and dropping policy).

3. Connect to the database (for example, fenagodb1) as a user who can view sensitive data (for example, maja). Execute the following queries:

SELECT EMAIL FROM HR.EMPLOYEES FETCH FIRST 10 ROWS ONLY;

```
SQL> SELECT EMAIL FROM HR.EMPLOYEES FETCH FIRST 10 ROWS ONLY;

EMAIL
-------------------------
ABANDA@example.com
ABULL@example.com
ACABRIO@example.com
AERRAZUR@example.com
AFRIPP@example.com
AHUNOLD@example.com
AHUTTON@example.com
AKHOO@example.com
AMCEWEN@example.com
AWALSH@example.com

10 rows selected.

SQL>
```

Before altering and enabling the policy

SELECT EMAIL_ADDRESS FROM CHALLENGEERNESTO.T1;

```
SQL> SELECT EMAIL_ADDRESS FROM CHALLENGE.T1;

EMAIL_ADDRESS
--------------------------------
ERNESTO.PAVLOVIC@CHALLENGE.COM
MAJA.VESELICA@CHALLENGEZORAN.COM

SQL>
```

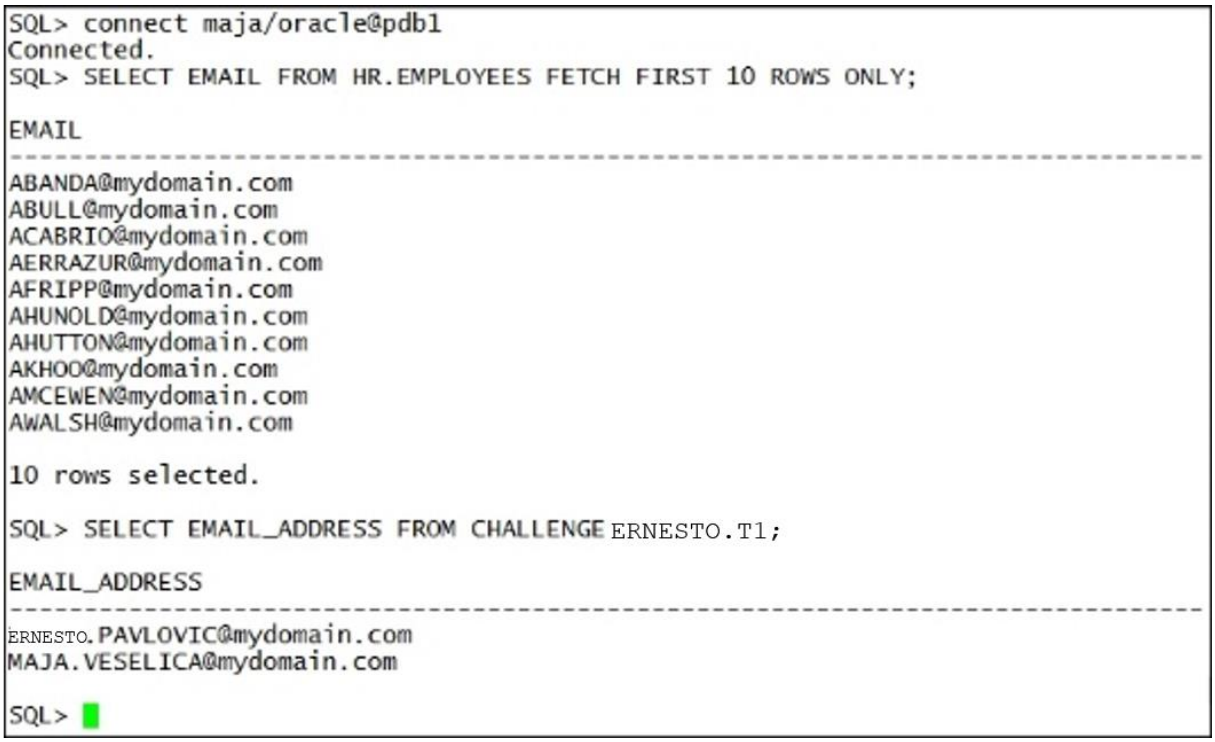
Before altering and enabling the policy

4. Connect to the database (for example, fenagodb1) as a user who can manage TSDP policies (for example, c##ernesto). Alter the TSDP policy and enable it.

```
SQL> connect c##ernesto/oracle@pdb1
Connected.
SQL> DECLARE
  2  redact_feature_options DBMS_TSDP_PROTECT.FEATURE_OPTIONS;
  3  policy_conditions DBMS_TSDP_PROTECT.POLICY_CONDITIONS;
  4  BEGIN
  5  redact_feature_options ('expression') :='1=1';
  6  redact_feature_options ('function_type') :='DBMS_REDACT.REGEXP';
  7  redact_feature_options ('regexp_pattern'):='([A-Za-z0-9._%+-]+)@([A-Za-z0-9.-]+\.[A-Za-z]{2,4})';
  8  redact_feature_options ('regexp_replace_string'):='\1@mydomain.com';
  9  redact_feature_options ('regexp_position'):='1';
 10  redact_feature_options ('regexp_occurrence'):='DBMS_REDACT.RE_FIRST';
 11  policy_conditions(DBMS_TSDP_PROTECT.DATATYPE) := 'VARCHAR2';
 12  DBMS_TSDP_PROTECT.ALTER_POLICY ('redact_regexp_email',redact_feature_options, policy_conditions);
 13  END;
 14  /

PL/SQL procedure successfully completed.

SQL> BEGIN
  2  DBMS_TSDP_PROTECT.ENABLE_PROTECTION_TYPE (
  3  sensitive_type => 'email_type');
  4  END;
  5  /

PL/SQL procedure successfully completed.

SQL>
```

Alter the TSDP policy

5. View sensitive data as the user maja (repeat step 3).



After altering TSDP policy

Privilege Analysis

Creating database analysis policy

1. Connect to the database as system or a user who has appropriate privilege:

$ sqlplus system

2. Create a privilege analysis policy that captures all the used privileges in the database:

SQL> BEGIN SYS.DBMS_PRIVILEGE_CAPTURE.CREATE_CAPTURE(name => '<policy_name>', description => '<your_desc>', type => DBMS_PRIVILEGE_CAPTURE.G_DATABASE); END; /

```
SQL> BEGIN
  2  SYS.DBMS_PRIVILEGE_CAPTURE.CREATE_CAPTURE(
  3  name => 'ALL_PRIV_POL',
  4  description => 'All privileges',
  5  type => DBMS_PRIVILEGE_CAPTURE.G_DATABASE);
  6  END;
  7  /

PL/SQL procedure successfully completed.
```

Database (unconditional) analysis policy

Creating role analysis policy

1. Connect to the database as system or a user who has appropriate privileges:

$ sqlplus system

2. Create a privilege analysis policy that captures all the used privileges granted through roles DBA and P1_ROLE:

SQL> BEGIN SYS.DBMS_PRIVILEGE_CAPTURE.CREATE_CAPTURE(name => '<policy_name>', description => '<your_desc>', type => DBMS_PRIVILEGE_CAPTURE.G_ROLE, roles => role_name_list (<'role1',...,'role10'>)); END; /

```
SQL> BEGIN
  2  SYS.DBMS_PRIVILEGE_CAPTURE.CREATE_CAPTURE(
  3  name => 'ROLE_PRIV_POL',
  4  description => 'Usage of privileges granted through listed roles',
  5  type => DBMS_PRIVILEGE_CAPTURE.G_ROLE,
  6  roles => role_name_list ('DBA','P1_ROLE'));
  7  END;
  8  /

PL/SQL procedure successfully completed.
```

The role analysis policy

Creating context analysis policy

1. Connect to the database as system or a user who has appropriate privileges:

$ sqlplus system

2. Create a privilege analysis policy that captures all the used (and unused) privileges by Steve:

SQL> BEGIN SYS.DBMS_PRIVILEGE_CAPTURE.CREATE_CAPTURE(name => '<policy_name>', description => '<your_desc>', type => DBMS_PRIVILEGE_CAPTURE.G_CONTEXT, condition => '<your_condition>'); END; /

```
SQL> BEGIN
  2  SYS.DBMS_PRIVILEGE_CAPTURE.CREATE_CAPTURE(
  3  name => 'CONT_PRIV_POL',
  4  description => 'Privileges used by Steve',
  5  type => DBMS_PRIVILEGE_CAPTURE.G_CONTEXT,
  6  condition => 'SYS_CONTEXT(''USERENV'',''SESSION_USER'')=''STEVE''');
  7  END;
  8  /

PL/SQL procedure successfully completed.
```

The context analysis policy

Creating combined analysis policy

1. Connect to the database as system or a user who has appropriate privileges:

$ sqlplus system

2. Create a privilege analysis policy that captures the usage of privileges, when using SQL Developer, which are granted through the role P2_ROLE:

SQL> BEGIN SYS.DBMS_PRIVILEGE_CAPTURE.CREATE_CAPTURE(name => '<policy_name>', description => '<your_desc>', type => DBMS_PRIVILEGE_CAPTURE.G_ROLE_AND_CONTEXT, roles => role_name_list (<'role1',...,'role10'>), condition => '<your_condition>'); END; /

```
SQL> BEGIN
  2  SYS.DBMS_PRIVILEGE_CAPTURE.CREATE_CAPTURE(
  3  name => 'COM_PRIV_POL',
  4  description => 'Usage of privileges when using SQL Developer that are grante
d through role P2_ROLE ',
  5  type => DBMS_PRIVILEGE_CAPTURE.G_ROLE_AND_CONTEXT,
  6  roles => role_name_list ('P2_ROLE'),
  7  condition => 'SYS_CONTEXT(''USERENV'',''CLIENT_PROGRAM_NAME'')=''SQL Develop
er''');
  8  END;
  9  /

PL/SQL procedure successfully completed.
```

The combined analysis policy

Starting and stopping privilege analysis

1. Connect to the database as system or a user who has appropriate privileges:

$ sqlplus system

2. List all existing privilege analysis policies by querying DBA_PRIV_CAPTURES.

```
SQL> column name format A20
SQL> select name, type, enabled
  2  from DBA_PRIV_CAPTURES;

NAME                 TYPE              E
-------------------- ----------------- -
ROLE_PRIV_POL        ROLE              N
ALL_PRIV_POL         DATABASE          N
CONT_PRIV_POL        CONTEXT           N
COM_PRIV_POL         ROLE_AND_CONTEXT  N
ORA$DEPENDENCY       DATABASE          N
```

Finding all defined policies

3. Enable a privilege analysis (for example, ALL_PRIV_POL, which you created in the first recipe in this chapter):

SQL> BEGIN SYS.DBMS_PRIVILEGE_CAPTURE.ENABLE_CAPTURE(name => '<policy_name>'); END; /

```
SQL> BEGIN
  2  SYS.DBMS_PRIVILEGE_CAPTURE.ENABLE_CAPTURE(
  3  name => 'ALL_PRIV_POL');
  4  END;
  5  /

PL/SQL procedure successfully completed.
```

Start capturing all privileges

4. Connect to the database as the user alan and view the first names of employees who have salary less than 1000:

```
SQL> connect alan
Enter password:
Connected.
SQL> select first_name from HR.EMPLOYEES
  2  WHERE SALARY < 1000;

no rows selected
```

the first test of select privilege

5. Find first names of employees who earn less than 3 000.

```
SQL> select first_name from HR.EMPLOYEES
  2  WHERE SALARY < 3000;
```

The second test of select privilege

6. Try to delete all employees whose first name is Karen.

```
SQL> DELETE FROM HR.EMPLOYEES
  2  WHERE FIRST_NAME = 'Karen';
DELETE FROM HR.EMPLOYEES
*
ERROR at line 1:
ORA-02292: integrity constraint (HR.EMP_MANAGER_FK) violated - child record
found
```

The test of delete privilege: integrity constraint violation

7. Connect to the database as system or a user who has appropriate privileges. Stop collecting data about privileges:

SQL> connect systemSQL> BEGIN SYS.DBMS_PRIVILEGE_CAPTURE.DISABLE_CAPTURE(name => '<policy_name>'); END; /

```
SQL> BEGIN
  2  SYS.DBMS_PRIVILEGE_CAPTURE.DISABLE_CAPTURE(
  3  name => 'ALL_PRIV_POL');
  4  END;
  5  /

PL/SQL procedure successfully completed.
```

Stop capturing

8. Generate the result:

SQL> BEGIN SYS.DBMS_PRIVILEGE_CAPTURE.GENERATE_RESULT(name => '<policy_name>'); END; /

```
SQL> BEGIN
  2  SYS.DBMS_PRIVILEGE_CAPTURE.GENERATE_RESULT(
  3  name => 'ALL_PRIV_POL');
  4  END;
  5  /

PL/SQL procedure successfully completed.
```

Generating the report

<u>Reporting on used system privileges</u>

1. Connect to the database as system or a user who has appropriate privileges:

$ sqlplus system

2. View system privileges that the user ALAN used:

```
SQL> select username, sys_priv
  2  from DBA_USED_SYSPRIVS
  3  where username='ALAN';

USERNAME   SYS_PRIV
---------- ----------------------
ALAN       CREATE SESSION
```

The used system privileges

3. View grant path for the used system privileges generated by ALL_PRIV_POL for the user ALAN:

```
SQL> column path format A20
SQL> select sys_priv, path
  2  from DBA_USED_SYSPRIVS_PATH
  3  where capture='ALL_PRIV_POL' and username='ALAN';

SYS_PRIV                  PATH
------------------------- --------------------
CREATE SESSION            GRANT_PATH('ALAN')
```

The Grant path

Reporting on used object privileges

1. Connect to the database as system or a user who has appropriate privileges:

$ sqlplus system

2. View which object privileges the user Alan has used while database policy ALL_PRIV_POL has been active.

```
SQL> select username, object_owner, object_name, obj_priv
  2  from DBA_USED_OBJPRIVS
  3  where username='ALAN';

USERNAME   OBJECT_OWN OBJECT_NAME          OBJ_PRIV
---------- ---------- -------------------- ---------------
ALAN       SYS        DUAL                 SELECT
ALAN       SYS        DUAL                 SELECT
ALAN       SYS        DBMS_APPLICATION_INF EXECUTE
                      O

ALAN       HR         EMPLOYEES            DELETE
ALAN       HR         EMPLOYEES            SELECT
ALAN       SYSTEM     PRODUCT_PRIVS        SELECT

6 rows selected.
```

The used object privileges

3. View grant path by querying DBA_USED_OBJPRIVS_PATH:

```
SQL> select username, object_owner, object_name, obj_priv, path
  2  from DBA_USED_OBJPRIVS_PATH
  3  where capture='ALL_PRIV_POL' and username='ALAN';

USERNAME   OBJECT_OWN OBJECT_NAME          OBJ_PRIV        PATH
---------- ---------- -------------------- --------------- --------------------
ALAN       HR         EMPLOYEES            DELETE          GRANT_PATH('ALAN')
ALAN       SYS        DUAL                 SELECT          GRANT_PATH('PUBLIC')
ALAN       SYS        DUAL                 SELECT          GRANT_PATH('PUBLIC')
ALAN       SYS        DBMS_APPLICATION_INF EXECUTE         GRANT_PATH('PUBLIC')
                      O

ALAN       SYSTEM     PRODUCT_PRIVS        SELECT          GRANT_PATH('PUBLIC')
ALAN       HR         EMPLOYEES            SELECT          GRANT_PATH('ALAN')

6 rows selected.
```

Object privileges grant path

<u>Reporting on unused system privileges</u>

1. Connect to the database as system or a user who has appropriate privileges:

$ sqlplus system

2. View that the user Alan has used all system privileges that have been granted to him (there are no unused system privileges):

```
SQL> select username, sys_priv
  2  from DBA_UNUSED_SYSPRIVS
  3  where username='ALAN';

no rows selected
```

The unused system privileges for the user Alan during the database policy ALL_PRIV_POL capture interval

Reporting on unused object privilege

1. Connect to the database as system or a user who has appropriate privileges:

$ sqlplus system

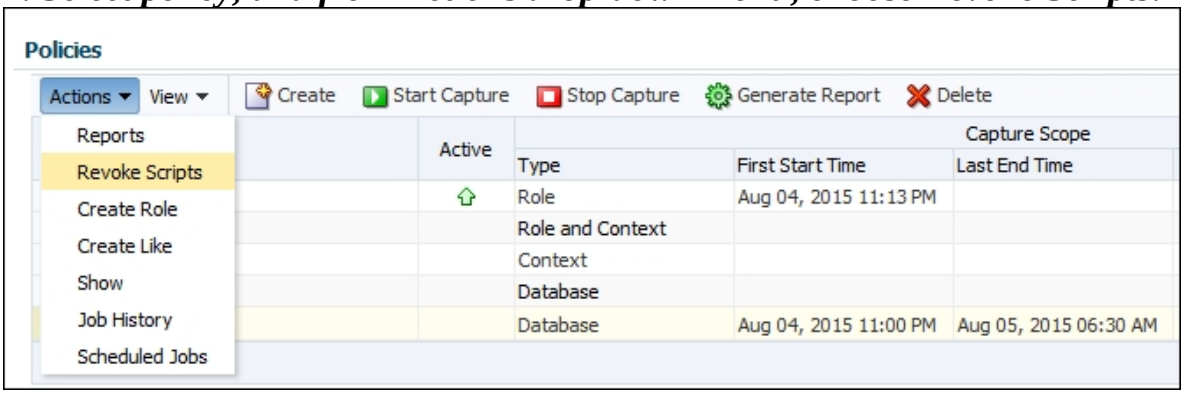
2. View which object privileges the user Alan has used during the database policy capture interval:

```
SQL> select username, object_owner, object_name, obj_priv
  2  from DBA_UNUSED_OBJPRIVS
  3  where username='ALAN';

USERNAME   OBJECT_OWN OBJECT_NAME          OBJ_PRIV
---------- ---------- -------------------- ---------------
ALAN       HR         EMPLOYEES            UPDATE
ALAN       HR         EMPLOYEES            INSERT
```

The unused object privileges

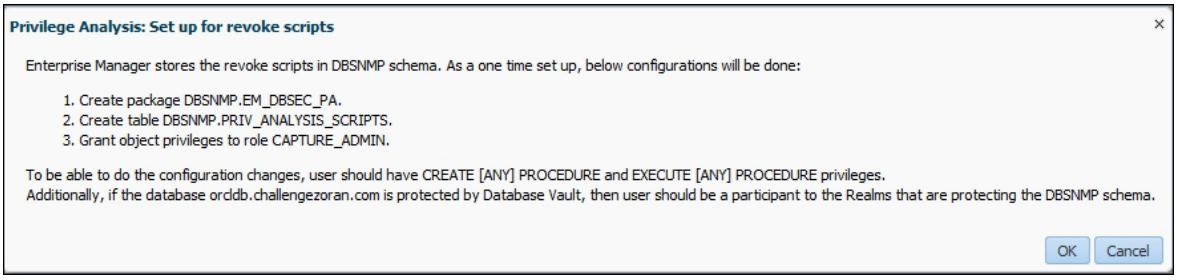
How to revoke unused privileges

1. Select policy, and from Actions drop-down menu, choose Revoke Scripts:



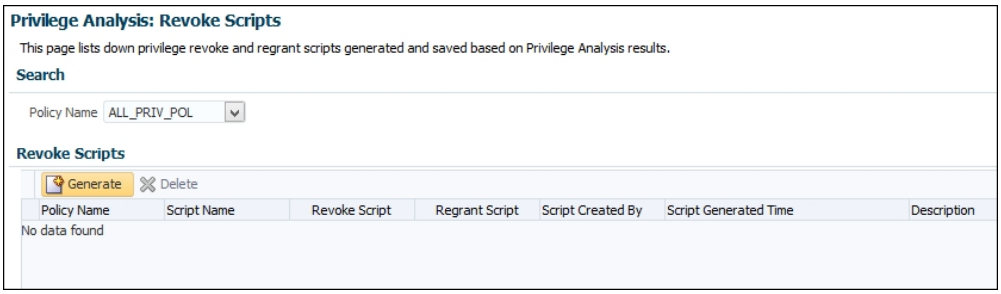
Create revoke scripts

2. You'll see a message about required privileges. Click on the OK button.



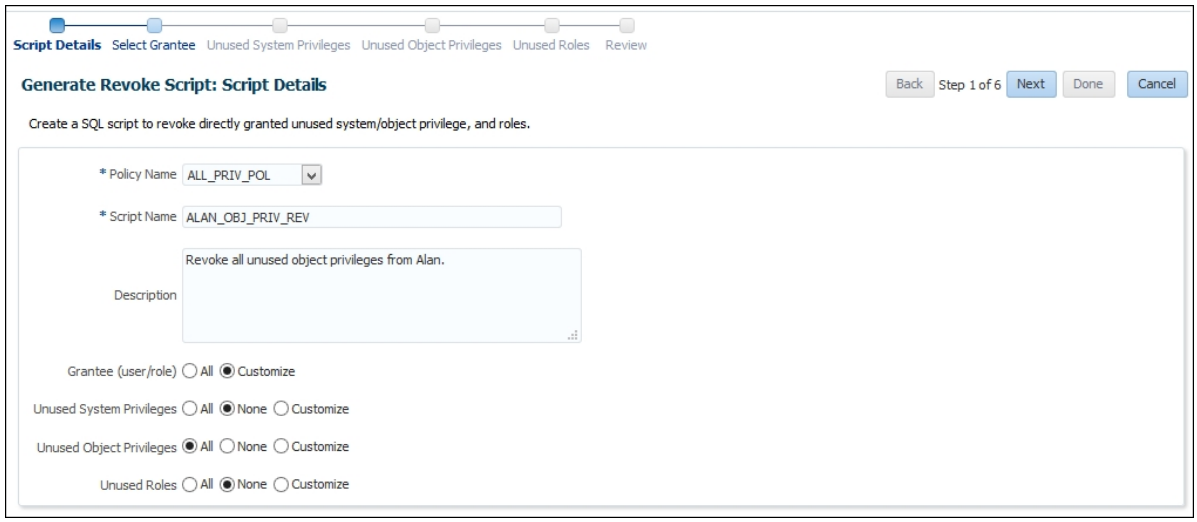
The info message

3. Select policy (Policy Name) and click on the Generate button:



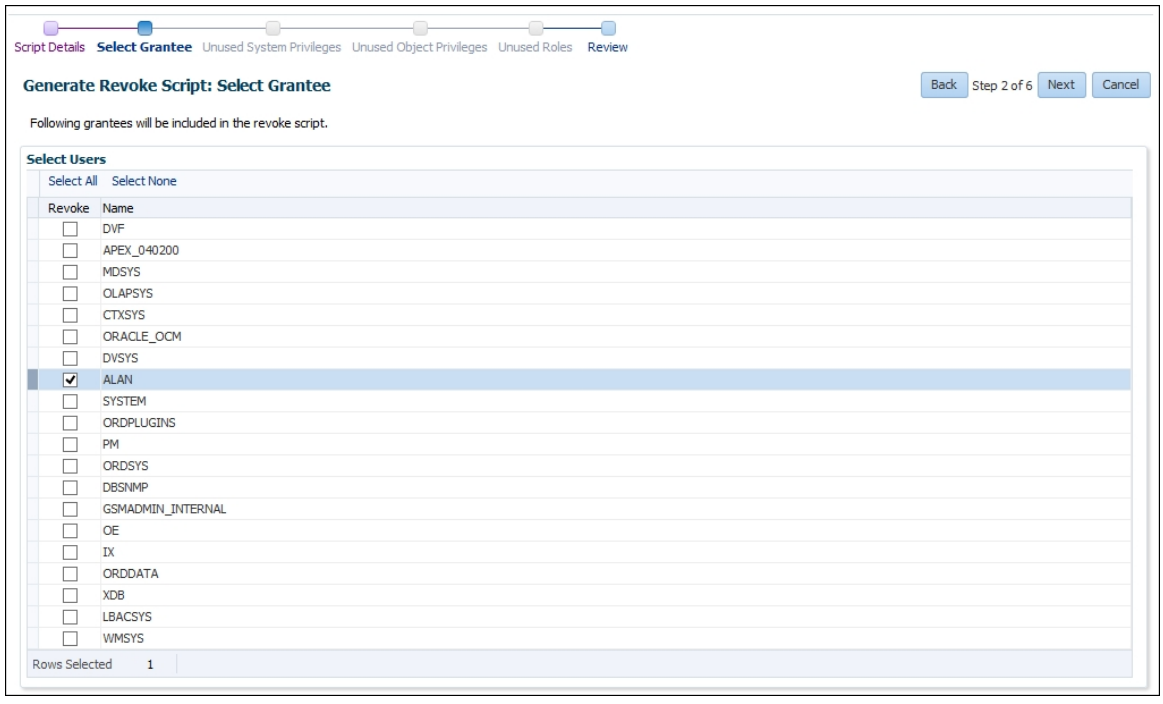
Generating a script

4. Generate script to revoke all the unused object privileges from the user Alan. Fill out form as shown in the figure below and click on the Next button:



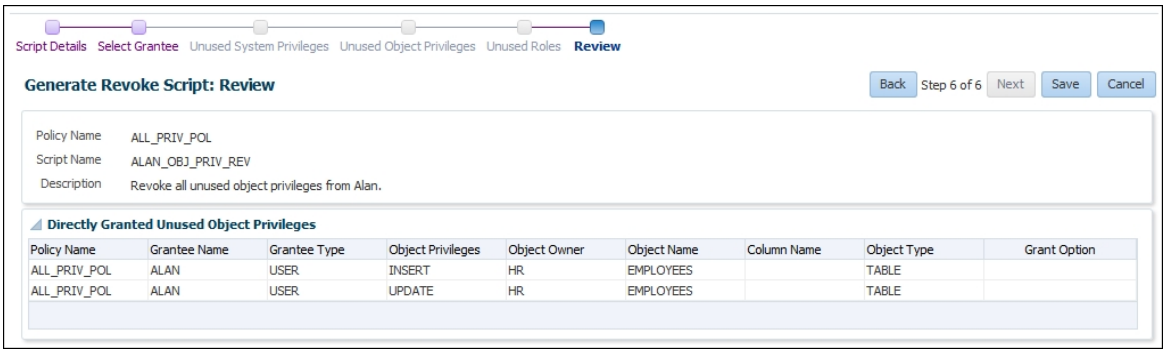
Revoking the script configuration

5. Click on the Select None link and tick revoke checkbox for the user Alan:



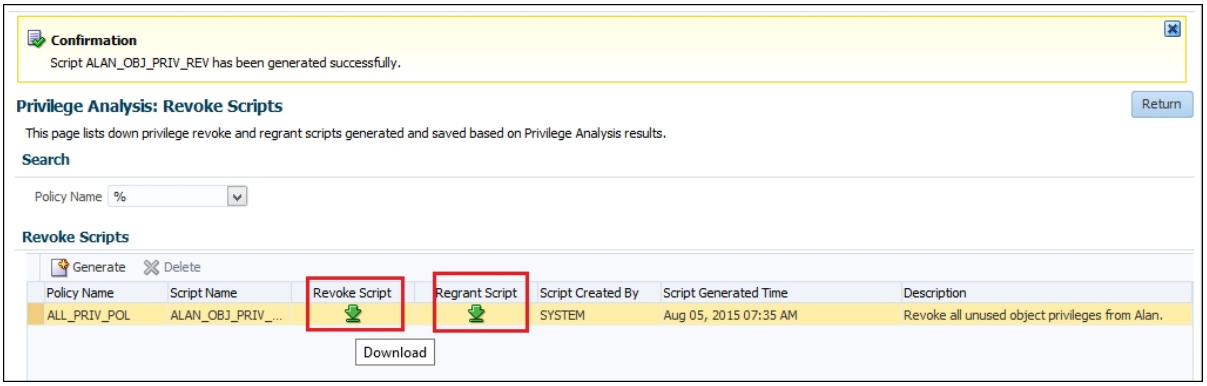
Choose to revoke privilege only from the user Alan

Click on the **Next** button. Review your choices and click on the **Save** button:



Review

You should receive confirmation similar to the one shown:



The confirmation message

6. Click on the green arrow in the Revoke Script column to download the generated revoke script. Note that Regrant Script has also been generated.

7. View the generated revoke script- ALAN_OBJ_PRIV_REV_revokeScript.sql:

```
-- REVOKE SCRIPT GENERATED BY SYSTEM AT Aug 05, 2015 07:35 AM.
-- SCRIPT FOR REVOKING DIRECTLY GRANTED UNUSED OBJECT
PRIVILEGES :

REVOKE INSERT ON HR.EMPLOYEES FROM ALAN;
REVOKE UPDATE ON HR.EMPLOYEES FROM ALAN;
```

The generated revoke script

Dropping the analysis

1. Connect to the database as system or a user who has appropriate privileges:

$ sqlplus system

2. Drop a privilege analysis policy (for example, ALL_PRIV_POL,

SQL> BEGIN SYS.DBMS_PRIVILEGE_CAPTURE.DROP_CAPTURE(name => '<policy_name>'); END; /

```
SQL> BEGIN
  2  SYS.DBMS_PRIVILEGE_CAPTURE.DROP_CAPTURE(
  3  name => 'ALL_PRIV_POL');
  4  END;
  5  /

PL/SQL procedure successfully completed.
```

Drop policy

3. Verify that all the records about the used and unused privileges, which have been gathered according to the policy, are also dropped:

SQL> SELECT username, sys_priv, obj_priv, object_owner, object_name FROM DBA_USED_PRIVS WHERE capture='<policy_name>';

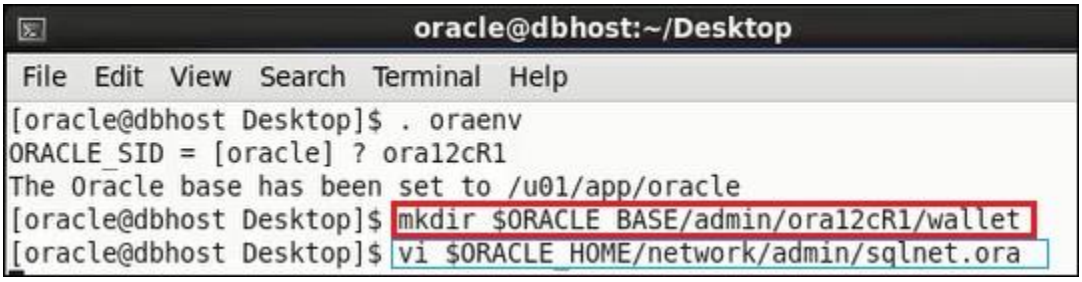
```
SQL> select username, sys_priv, obj_priv, object_owner, object_name
  2  from DBA_USED_PRIVS
  3  where capture='ALL_PRIV_POL';

no rows selected
```

Records doesn't exist anymore

Transparent Data Encryption

Configuring keystore location in sqlnet.ora

1. ***Create a directory, to hold a keystore, that is accessible to the owner of Oracle software (for example, $ORACLE_BASE/admin/ora12cR1/wallet).***



Create a directory and edit sqlnet.ora

2. ***Edit sqlnet.ora and add entry to specify the location of the keystore. This step is optional if you are using default location for the wallet, which is $ORACLE_HOME/admin/<db_name>/wallet.***

Creating and opening the keystore

1. ***Connect to the database as a user who can grant administer key management privilege (for example, SYS) and grant the privilege to an existing user (for example, maja).***

2. ***To create a password-based software keystore, connect to the database as the user in the previous step (for example, maja) and execute the following statement (after you change parameters so that they are appropriate for your environment):***

SQL> ADMINISTER KEY MANAGEMENT CREATE KEYSTORE 'keystore_location' IDENTIFIED BY keystore_password;

```
SQL> grant administer key management to maja;

Grant succeeded.

SQL> connect maja
Enter password:
Connected.
SQL> ADMINISTER KEY MANAGEMENT CREATE KEYSTORE '/u01/app/oracle/admin/ora12cR1/w
allet' identified by welcome1;

keystore altered.
```

Creating a password-based software keystore

3. ***Open the keystore you created in the previous step by executing the following statement:***

SQL> ADMINISTER KEY MANAGEMENT SET KEYSTORE OPEN IDENTIFIED BY keystore_password;

```
SQL> ADMINISTER KEY MANAGEMENT SET KEYSTORE OPEN IDENTIFIED BY welcome1;

keystore altered.
```

Opening the password-based keystore

<u>Setting master encryption key in software keystore</u>

1. ***Connect to the database as a user who has the SYSKM administrative or administer key management privilege (for example, maja):***

$ sqlplus maja

2. ***Create a master key for the password-based keystore:***

SQL> ADMINISTER KEY MANAGEMENT SET KEY IDENTIFIED BY keystore_password WITH BACKUP USING 'desc_purpose';

```
SQL> ADMINISTER KEY MANAGEMENT SET KEY IDENTIFIED BY welcome1 WITH BACKUP USING
'transparent';

keystore altered.
```

Column encryption - adding new encrypted column to table

1. ***Connect to the database as a user who has administer key privilege or SYSKM privilege (for example, maja) and verify that the keystore is in the OPEN status. You should get the result similar to the next figure:***

$ sqlplus maja

```
SQL> SELECT WRL_PARAMETER, STATUS, WALLET_TYPE FROM V$ENCRYPTION_WALLET;

WRL_PARAMETER                                    STATUS     WALLET_TYPE
------------------------------------------------ ---------- --------------------
/u01/app/oracle/admin/ora12cR1/wallet/           OPEN       PASSWORD
```

2. ***Add a column (for example, bonus) to a table (for example, hr.employees), encrypted using the AES 256 algorithm.***

```
SQL> ALTER TABLE HR.EMPLOYEES ADD (BONUS NUMBER(10) ENCRYPT USING 'AES256');

Table altered.
```

Adding the new encrypted column to the table

Column encryption - creating new table that has encrypted column(s)

1. ***Connect to the database as a user who has administer key privilege or SYSKM privilege (for example, maja):***

$ sqlplus maja

2. ***Create a new table (for example, table enc_cols in schema hr) that has, for example, the following structure:***

Column name	Column type	Encrypted
NAME	VARCHAR2 (50)	No
CREDIT_LIMIT	NUMBER (10)	Yes, AES192
SALARY	NUMBER (10)	Yes, AES192

```
SQL> CREATE TABLE HR.ENC_COLS (
  2  NAME VARCHAR2(50),
  3  CREDIT_LIMIT NUMBER(10) ENCRYPT,
  4  SALARY NUMBER(10) ENCRYPT);

Table created.
```

A syntax to create the table hr.enc_cols

3. ***Connect to the database as a user who can insert and view data in the table (for example, hr user):***

SQL> connect hr

4. ***Insert several arbitrary values into the table HR.ENC_COLS.***

```
SQL> INSERT INTO HR.ENC_COLS VALUES ('Debra',50000,20000);

1 row created.

SQL> INSERT INTO HR.ENC_COLS VALUES ('Sarah',48000,18500);

1 row created.

SQL> INSERT INTO HR.ENC_COLS VALUES ('Tim',45000,14800);

1 row created.

SQL> INSERT INTO HR.ENC_COLS VALUES ('Alex',49000,23000);

1 row created.
```

Test values

5. ***Verify that the user can view unencrypted values in all columns.***

```
SQL> SET LINESIZE 300
SQL> COLUMN NAME FORMAT A10
SQL> select * from hr.enc_cols;

NAME       CREDIT_LIMIT     SALARY
---------- ------------ ----------
Debra             50000      20000
Sarah             48000      18500
Tim               45000      14800
Alex              49000      23000
```

Encryption is transparent

6. ***Connect to the database as a user who can't view data in the table (for example, james) and try to view data in all columns:***

SQL> connect jamesSQL> select * from hr.enc_cols;

```
SQL> connect james
Enter password:
Connected.
SQL> select * from hr.enc_cols;
select * from hr.enc_cols
                 *
ERROR at line 1:
ORA-00942: table or view does not exist
```

User who doesn't have "view" privilege(s) won't see encrypted values

<u>Using salt and MAC</u>

1. ***Connect to the database as a user who has administer key privilege or SYSKM privilege (for example, maja):***

$ connect maja

2. ***Encrypt two columns in an existing table (for example, sh.customers)***

```
SQL> ALTER TABLE SH.CUSTOMERS MODIFY (
  2  CUST_LAST_NAME ENCRYPT USING 'AES256',
  3  CUST_STREET_ADDRESS ENCRYPT USING 'AES256' NO SALT);

Table altered.
```

Using salt and MAC

<u>Column encryption - encrypting existing column</u>

1. ***Connect to the database as a user who can read data from the OE.CUSTOMERS table (for example, the oe user):***

$ sqlplus oe

2. ***Select data from column you want to encrypt (for example, cust_email), just to verify that the user can view it.***

```
SQL> SELECT CUST_EMAIL FROM OE.CUSTOMERS
  2  WHERE CUST_EMAIL LIKE 'Am%';

CUST_EMAIL
----------------------------------------
Amanda.Brown@THRASHER.EXAMPLE.COM
Amanda.Finney@STILT.EXAMPLE.COM
Amanda.Tanner@TEAL.EXAMPLE.COM
Amrish.Palin@EIDER.EXAMPLE.COM
```

A test query

3. ***Connect to the database as a user who has administer key privilege or SYSKM privilege (for example, maja):***

SQL> connect maja

4. ***Encrypt the cust_email column in the oe.customers table using the default encryption algorithm (AES192) and no salt.***

```
SQL> ALTER TABLE OE.CUSTOMERS MODIFY (CUST_EMAIL ENCRYPT NO SALT);

Table altered.
```

Encrypting an existing column, which has an index

5. ***Execute steps 1 and 2 again to verify that there is no change in the way user/application views data after TDE column encryption is applied.***

Auto-login keystore

1. ***Connect to the database as a user who has administer key privilege or SYSKM privilege (for example, maja):***

$ sqlplus maja

2. ***Create (local) an autologin keystore. In our case, keystore_location is /u01/app/oracle/admin/ora12cR1/wallet and keystore_password is welcome1:***

SQL> ADMINISTER KEY MANAGEMENT CREATE LOCAL AUTO_LOGIN KEYSTORE FROM KEYSTORE 'keystore_location' IDENTIFIED BY keystore_password; OR SQL> ADMINISTER KEY MANAGEMENT CREATE AUTO_LOGIN KEYSTORE FROM KEYSTORE 'keystore_location' IDENTIFIED BY keystore_password;

Encrypting tablespace

1. ***Connect to the database as a user who has a create tablespace privilege (for example, ernesto):***

$ sqlplus ernesto

2. ***Create encrypted tablespace (for example, TEST_ENC) using AES192 encryption algorithm:***

SQL> CREATE TABLESPACE TEST_ENC DATAFILE '/u01/app/oracle/oradata/ORA12CR1/datafile/testenc01.dbf' SIZE 20M ENCRYPTION USING 'AES192' DEFAULT STORAGE (ENCRYPT);

```
SQL> CREATE TABLESPACE TEST_ENC
  2  DATAFILE '/u01/app/oracle/oradata/ORA12CR1/datafile/testenc01.dbf'  SIZE 20M
  3  ENCRYPTION USING 'AES192'
  4  DEFAULT STORAGE (ENCRYPT);

Tablespace created.
```

Encrypting tablespace

Rekeying

1. ***Connect to the database as a user who has administer key privilege or SYSKM privilege (for example, maja):***

$ sqlplus maja

2. ***To rekey a table (for example, the oe.customer) using a different encryption algorithm (for example, AES128), execute the following statement:***

```
SQL> ALTER TABLE OE.CUSTOMERS REKEY USING 'AES128';

Table altered.
```

Rekeying a table key

3. ***Change a master key by executing the following statement (in our example, keystore_password is welcome1):***

SQL> ADMINISTER KEY MANAGEMENT SET KEY IDENTIFIED BY keystore_password WITH BACKUP;

```
SQL> ADMINISTER KEY MANAGEMENT SET KEY IDENTIFIED BY welcome1
  2  WITH BACKUP;

keystore altered.
```

Rekeying a master key

Backup and Recovery

1. ***Connect to the RMAN as user who has the sysbackup privilege:***

$ rman target '"ernesto@orcl as sysbackup"'

2. ***Configure encryption on a database level:***

RMAN> CONFIGURE ENCRYPTION FOR DATABASE ON;

3. ***Backup a tablespace example in transparent mode:***

RMAN> BACKUP TABLESPACE EXAMPLE tag 'tran_mode';

4. ***Enable dual mode encryption and backup tablespace example in dual mode:***

RMAN> SET ENCRYPTION ON IDENTIFIED BY "password_1";RMAN> BACKUP TABLESPACE EXAMPLE tag 'dual_mode';

5. ***Enable password mode and backup tablespace example in password mode:***

RMAN> SET ENCRYPTION ON IDENTIFIED BY "password_2" ONLY; RMAN> BACKUP TABLESPACE EXAMPLE tag 'pass_mode';

Database Vault

Registering Database Vault

To register Database Vault with Oracle Database 12c when the database is already installed, perform the following steps:

1. ***Connect to the root container as a user who has privileges to create users and grant create sessionand set container privileges (for example, c##maja):***

$ sqlplus c##maja

2. ***Create two users (for example, c##dbv_owner and c##dbv_acctmgr) and grant them create session and set container privileges:***

SQL> create user c##dbv_owner identified by oraDVO123 CONTAINER = ALL; SQL> grant create session, set container to c##dbv_owner CONTAINER = ALL; SQL> create user c##dbv_acctmgr identified by oraDVA123 CONTAINER = ALL; SQL> grant create session, set container to c##dbv_acctmgr CONTAINER = ALL;

3. ***Connect to the root as a SYS user:***

SQL> connect sys as sysdba

4. ***Configure the Database Vault users:***

SQL> begin DVSYS.CONFIGURE_DV (dvowner_uname => 'c##dbv_owner', dvacctmgr_uname => 'c##dbv_acctmgr'); end; /

5. ***Execute the utlrp.sql script:***

SQL> @?/rdbms/admin/utlrp.sql

6. ***Connect to the root as the Database Vault Owner user that you just configured (for example, the c##dbv_owner):***

SQL> connect c##dbv_owner/oraDVO123

7. ***Enable Oracle Database Vault:***

SQL> exec DBMS_MACADM.ENABLE_DV

8. ***Connect as a SYS user:***

SQL> CONNECT / AS SYSDBA

9. ***Restart the database.***

For each PDB, perform step 3 through step 8 and then close and reopen the pluggable database (for example, FENAGODB1).

SQL> alter pluggable database fenagodb1 close immediate;
SQL> alter pluggable database fenagodb1 open;

Preventing users from exercising system privileges on schema objects

1. ***Connect to a pluggable database (for example, fenagodb1) as a Database Vault account manager (for example, c##dbv_acctmgr):***

SQL> connect c##dbv_acctmgr@fenagodb1

2. ***Create a new local user in the pluggable database (for example, usr1):***

SQL> create user usr1 identified by oracle;

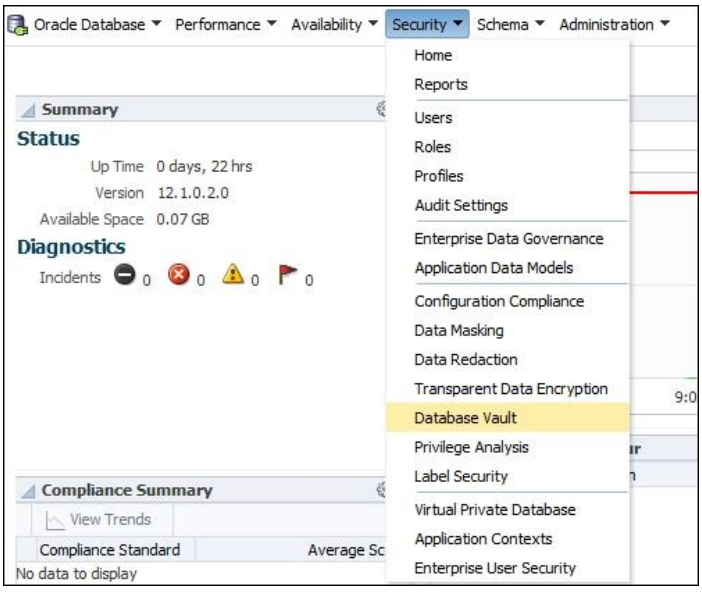
3. ***Connect to the pluggable database as a common user who has a DBA role in fenagodb1 (for example, c##ernesto):***

SQL> connect c##ernesto@fenagodb1

4. ***Grant the select privilege on the table HR.EMPLOYEES and the create session privilege to the user usr1:***

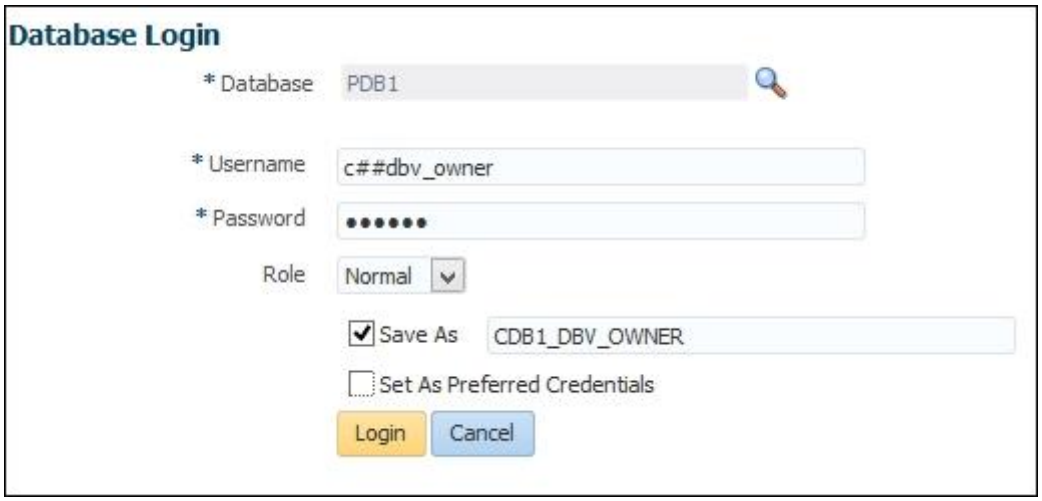
SQL> grant select on hr.employees to usr1;
SQL> grant create session to usr1;

5. ***Connect to the Enterprise Manager Cloud Control 12c (EM) as a privileged user (SYSMAN or some other privileged user, for example, ernesto). From Security drop-down menu, choose Database Vault***



Selecting Database Vault

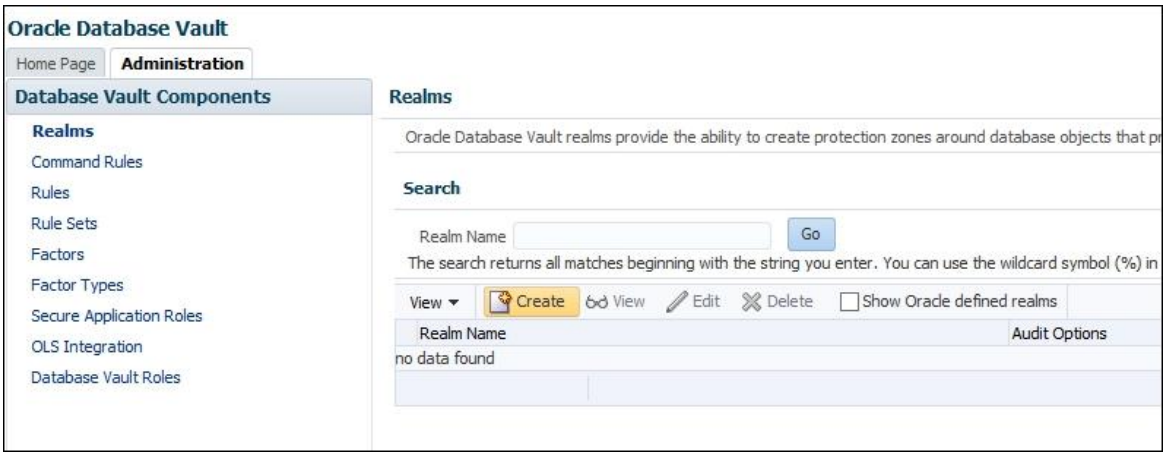
6. ***Log in to the pluggable database FENAGODB1 as a user who is the Database Vault Owner***



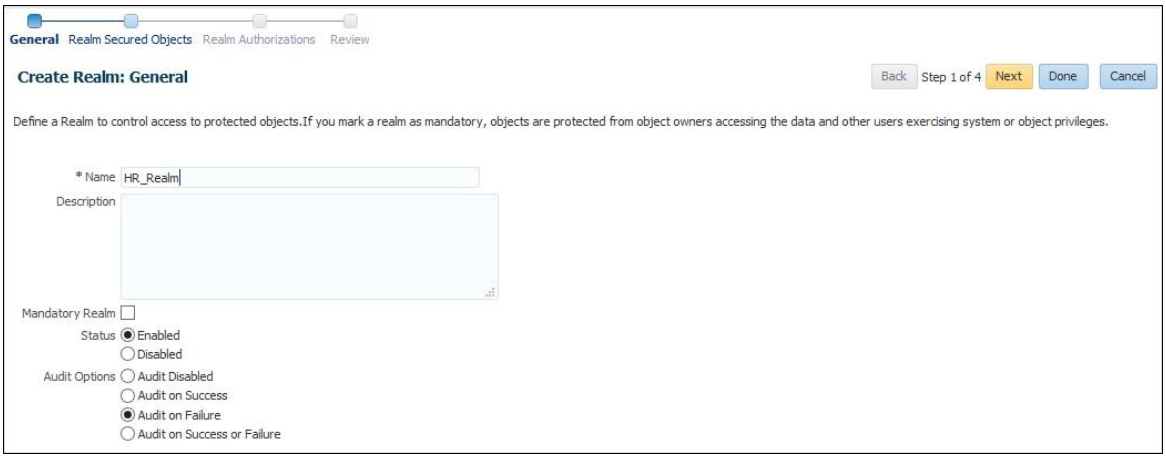
7. ***On the next page, click on the Administration tab***

Switching to the Administration tab

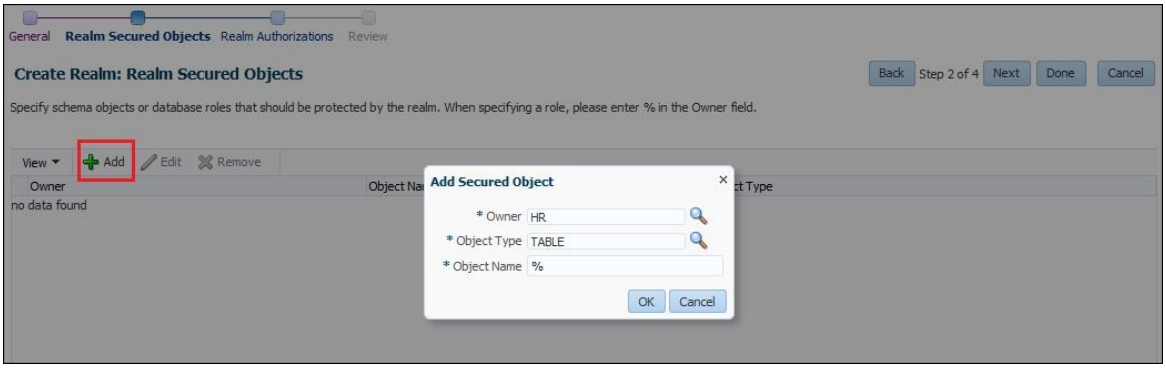
8. ***Create HR_Realm, as shown in the following figures. First, click on the Create button.***



9. ***Name the realm (for example, HR_Realm) and leave default values for other parts of the form.***

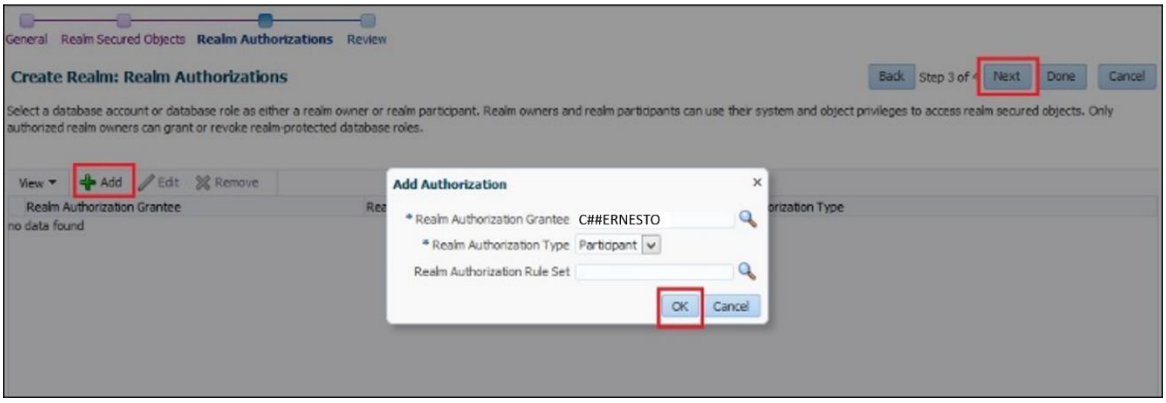


10.***Securing all tables in HR schema.***



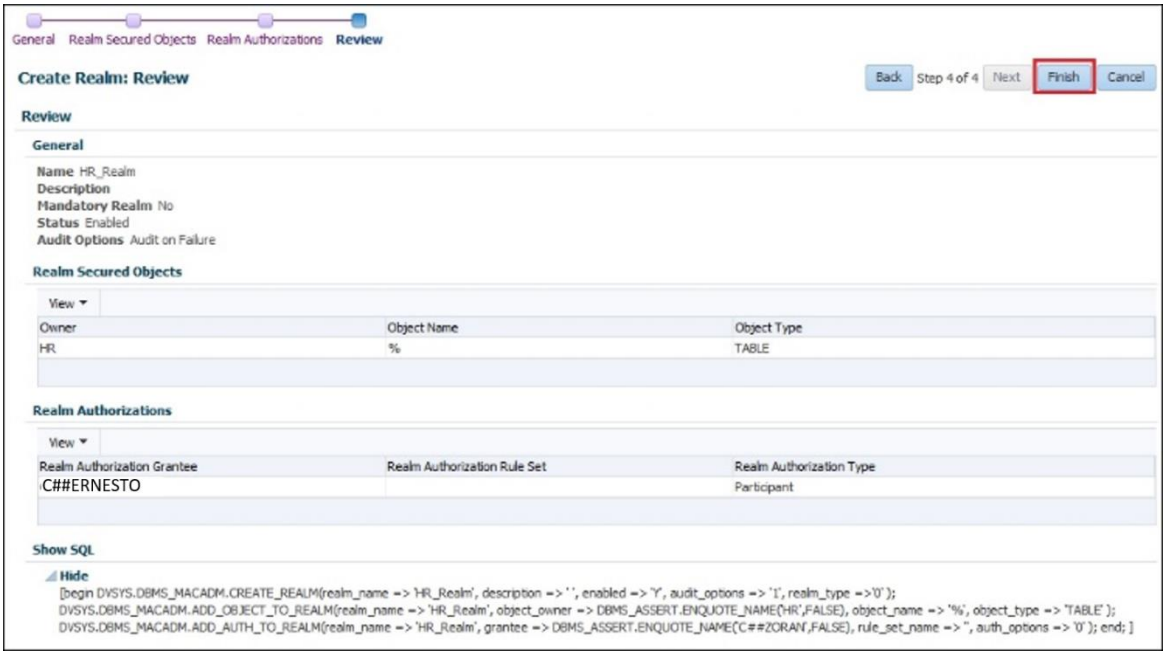
Adding secured objects

11.***Add realm participant (for example, C##ERNESTO).***



Adding authorized user(s)

12. ***After you make sure that you chose the options you wanted, click on the Finish button.***

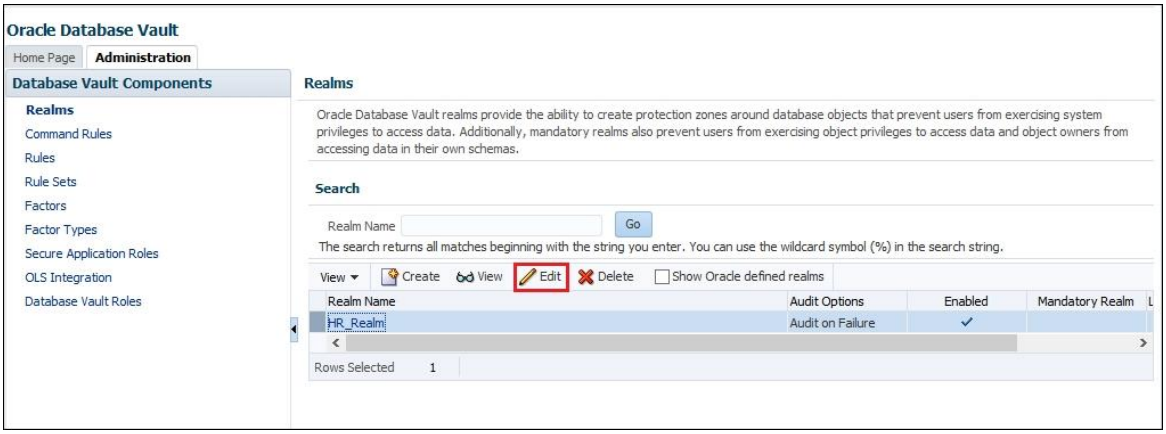


Reviewing and clicking on the Finish button

13. ***Verify that the usr1 and hr users can view data in the HR.EMPLOYEES table:***

SQL> connect usr1@fenagodb1
SQL> select count(*) from hr.employees; COUNT(*) ---------- 107
SQL> connect hr@fenagodb1
SQL> select count(*) from hr.employees; COUNT(*) ---------- 107

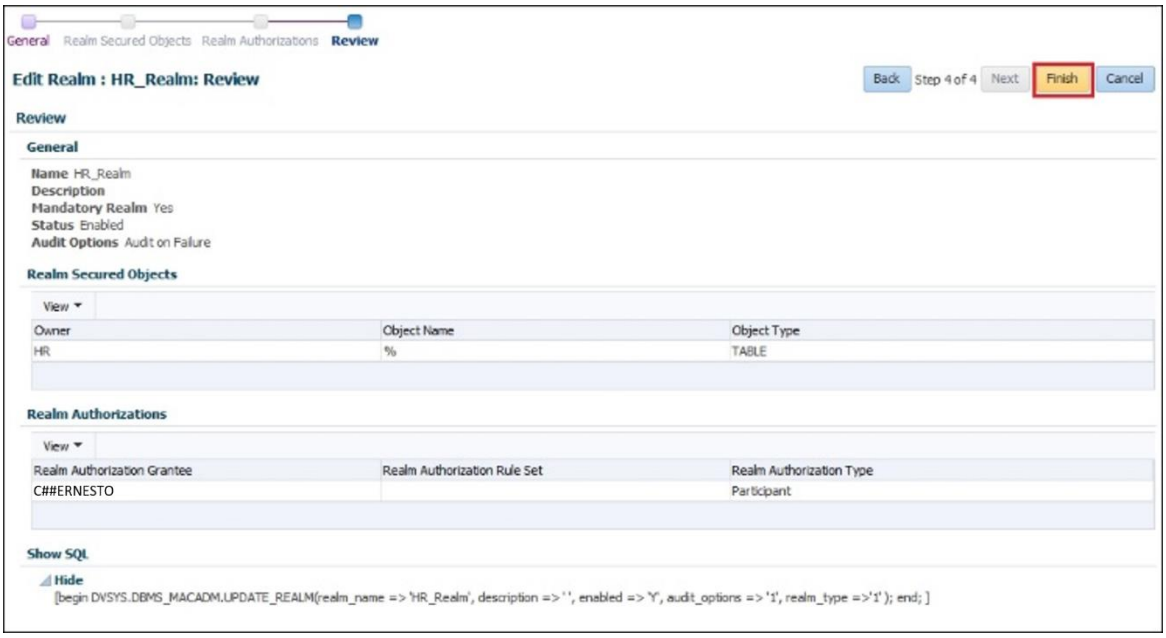
14. ***To provide better security, edit the realm HR_Realm and select the checkbox Mandatory Realm.***



Editing HR_Realm

Mandatory Realm checkbox

15. ***Clicking on the Finish button.***



Leaving other settings as they were and clicking on the Finish button

Securing roles

1. ***Connect to the pluggable database FENAGODB1 as a SYS user:***

SQL> connect sys@fenagodb1 as sysdba

2. ***Create the role role1:***

SQL> create role role1;

3. ***Grant the create session and select any table privileges to the role:***

SQL> grant create session, select any table to role1;

4. ***Create realm ROLE1_Realm in Enterprise Manager Cloud Control 12c.***

Creating ROLE1_Realm

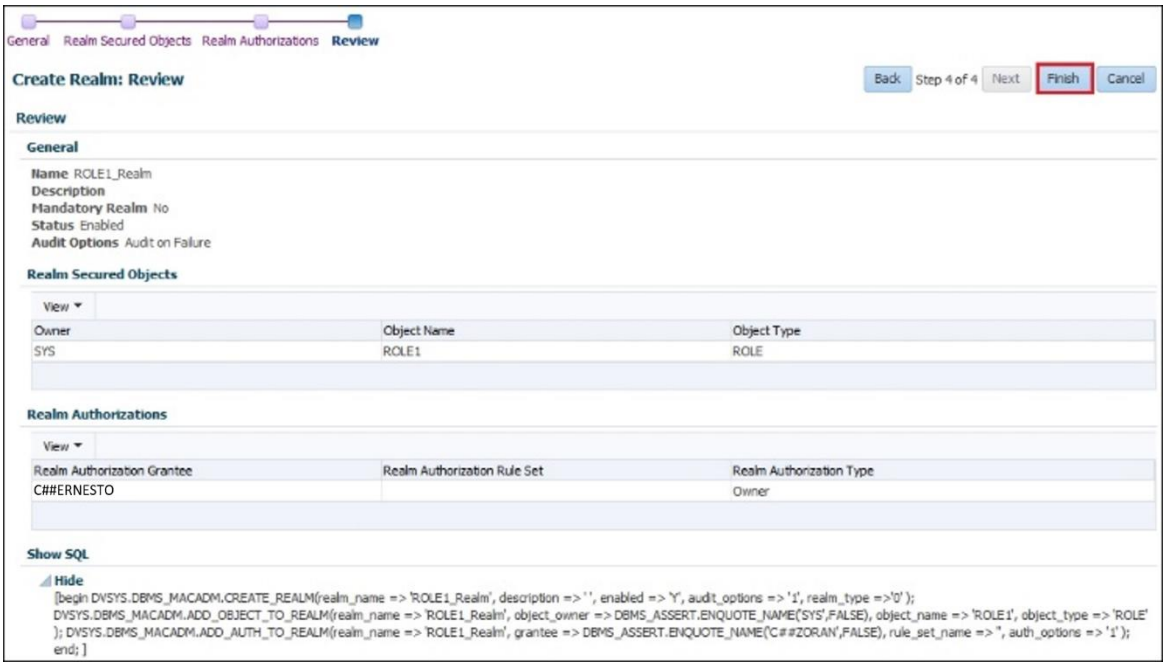
5. ***Add realm-secured objects***.

Adding secured objects

6. ***Add realm authorizations and click on the Next button.***

Realm authorizations

7. ***Review and click on the Finish button***



8. ***Connect to the pluggable database FENAGODB1 as a SYS user:***

SQL> connect sys@fenagodb1 as sysdba

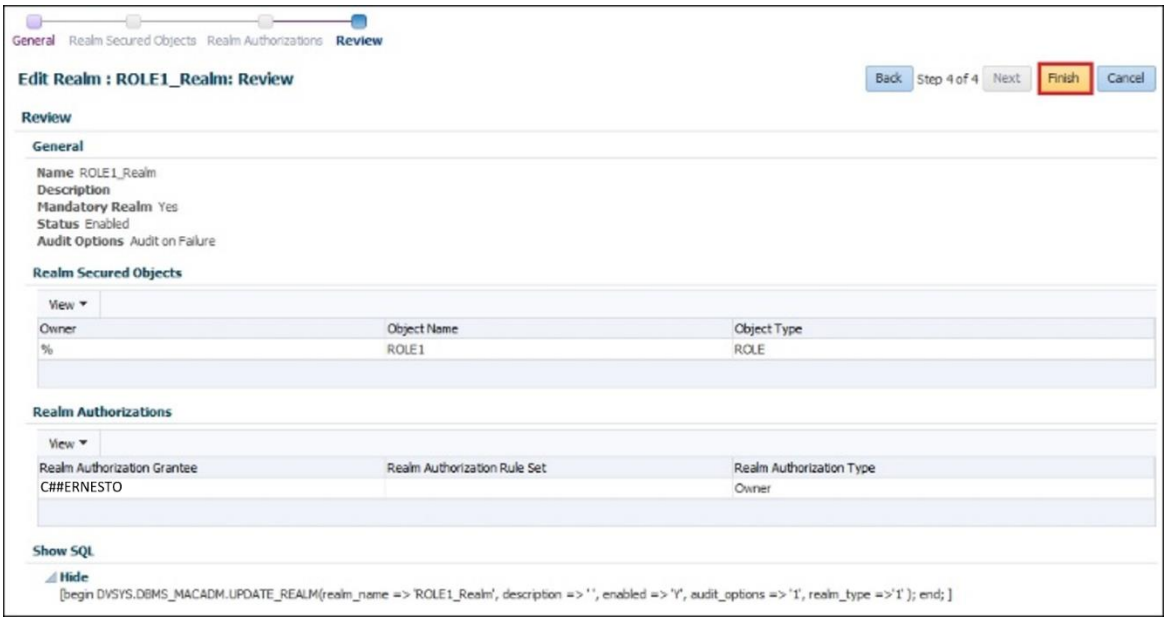
9. ***Verify that SYS still can revoke/grant privileges from/to role role1, even though role1 is protected by the realm:***

SQL> revoke select any table from role1;
SQL> grant drop any synonym to role1;

10. ***Edit the realm ROLE1_Realm and make it mandatory (select the Mandatory Realm checkbox).***

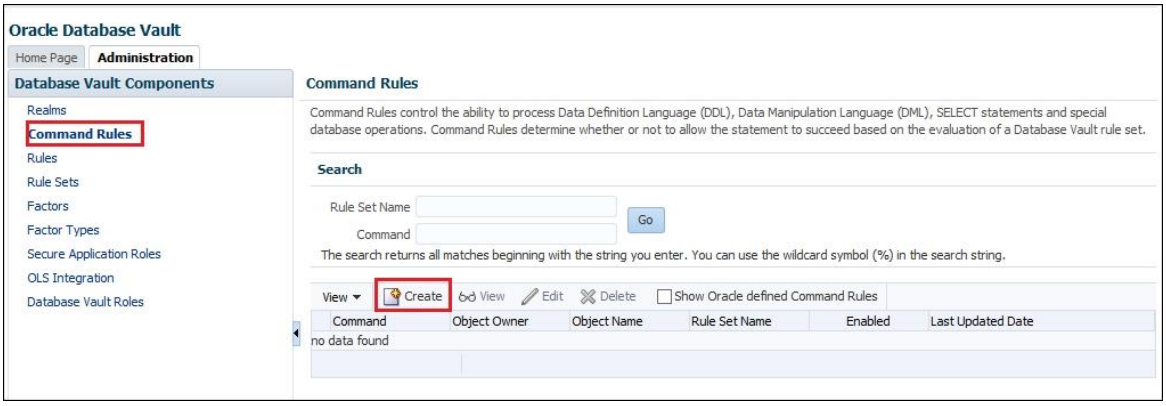
Editing realm

11.***Review and confirm the change of ROLE1_Realm.***



Preventing users from executing specific command on specific object

Create a command rule by following these steps:



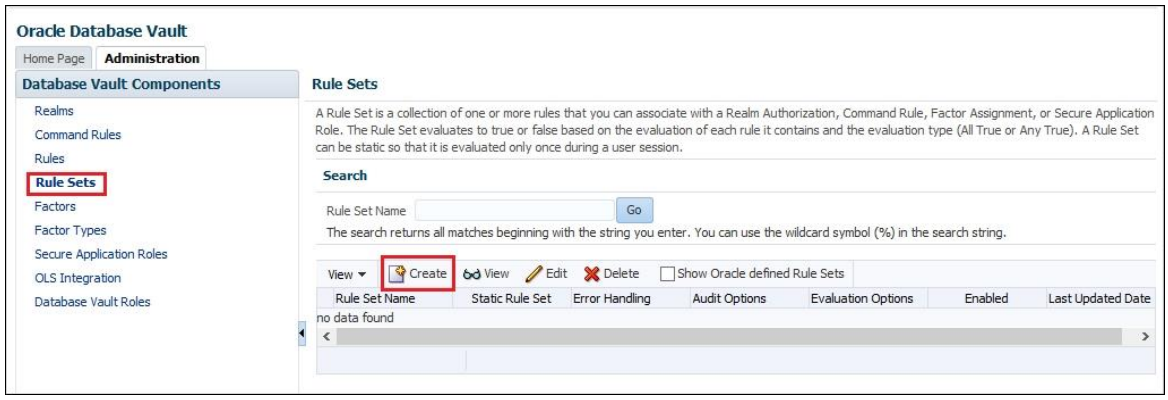
Creating a command rule

In the **Command** field, write UPDATE; in the **Applicable Object Owner** field, write OE; in the **Applicable Object Name** field, write ORDERS; and select **Disabled** for **Rule Set**.

A Command rule to secure the UPDATE operation on OE.Orders

Creating a rule set

1. ***Go to Rule Sets component and then click on Create***



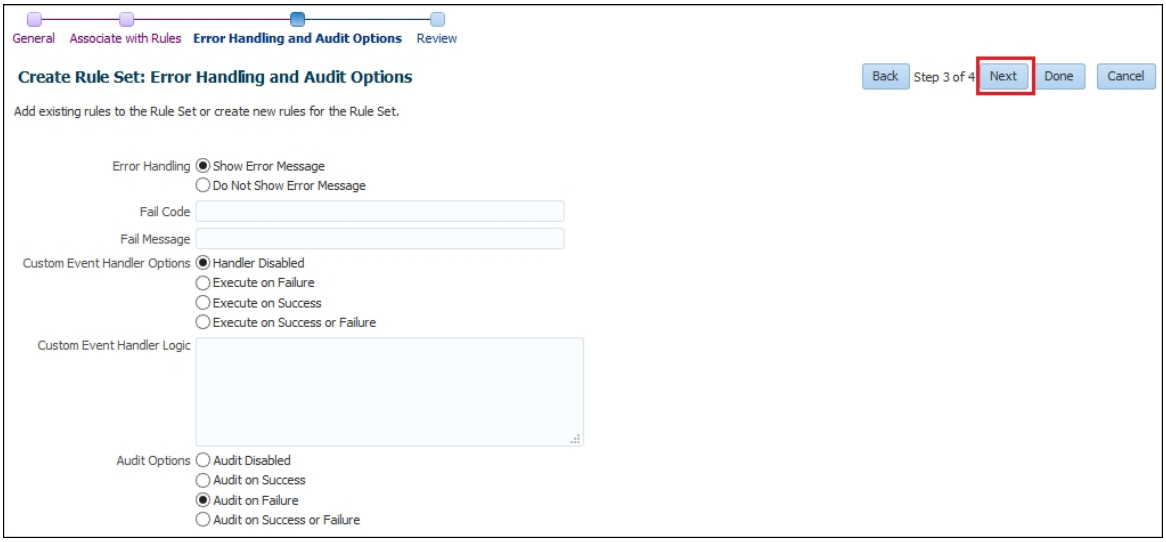
2. ***As a name, enter Working Hours and click on Next. For Evaluation Options, choose All True.***

Our rule set "Working Hours"

3. ***Add two rules (Is Working Day and Is Working Hour) by clicking on Create Rule before adding each of them. Enter the details in Rule Name and Rule Expression as shown in the next figure. After you added both rules, click on Next.***

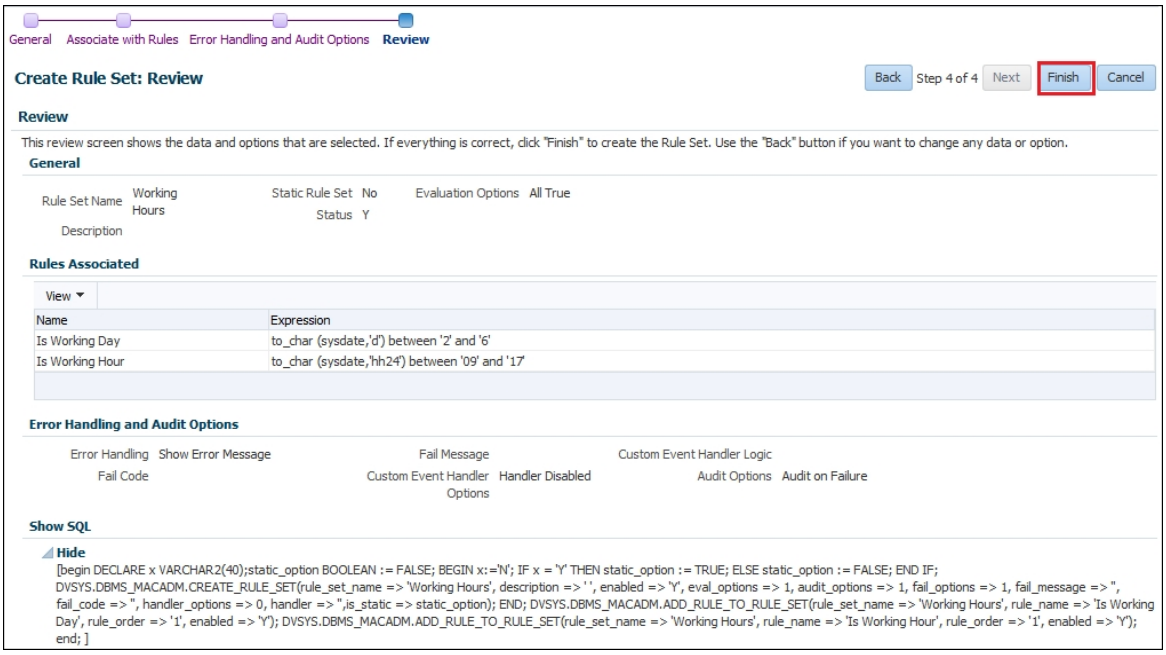
Create two rules

4. ***Leave all options on defaults and click on Next.***



Error handling and audit options

5. ***Click on Finish.***



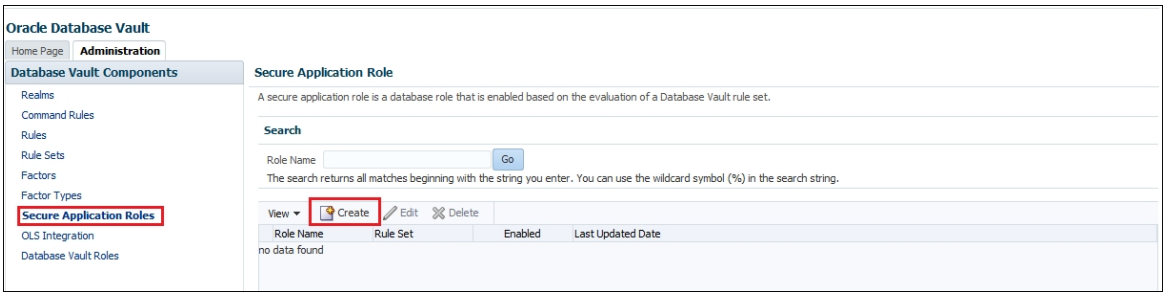
Finish

Creating a secure application role

1. ***Create rule set with name Can Access Customer Data and with rule DVF.F$MACHINE = <your host name> (for example, name it: Is Local Machine). In our case, hostname is host01.challengeernesto.com.***

Is a Local Machine rule

2. ***In the Database Vault Components panel, click on the Secure Application Roles link and then click on the Create button.***



Create a secure application role

3. ***Define secure application role settings. In our case, we secure the role cust_role and condition for enablement is defined by the Can Access Customer Data rule set.***

Define secure application role

Using Database Vault to implement that administrators cannot view data

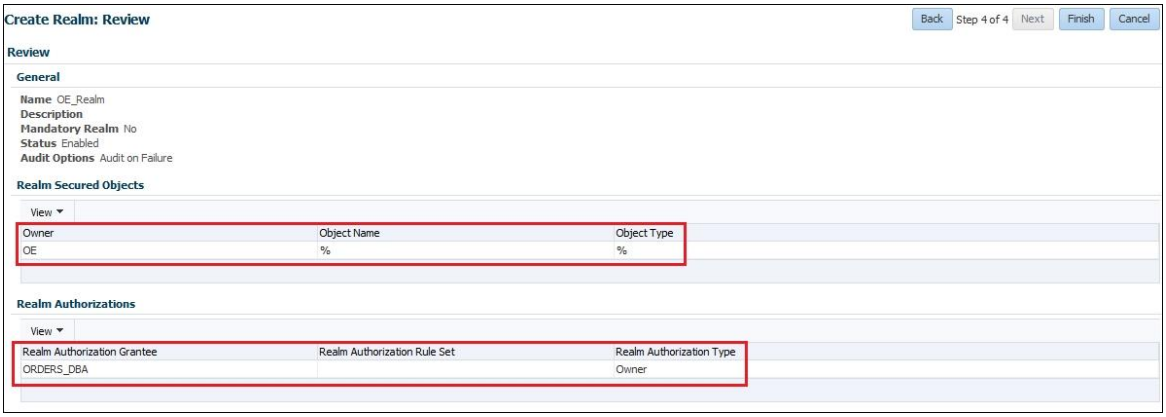
1. ***Connect to the pluggable database FENAGODB1 as the user c##dbv_acctmgr:***

SQL> connect c##dbv_acctmgr@fenagodb1 SQL> create user orders_dba identified by oracle1; SQL> create user orders_user identified by oracle2;

2. ***Connect to the pluggable database FENAGODB1 as a SYS user and execute the following statements:***

SQL> connect sys@fenagodb1 as sysdba SQL> grant dba to orders_dba; SQL> grant create session to orders_user; SQL> grant select on oe.orders to orders_user; SQL> grant update on oe.orders to orders_user; SQL> create role ord_usr_role; SQL> grant ord_usr_role to orders_user;

3. ***Create a realm that protects all objects in OE schema and authorize user orders_dba as owner .***



Create realm OE_Realm

4. ***Create realm that protects the ORD_USR_ROLE role and authorize the user c##ernesto as owner***

Create realm Orders_Role_Realm

5. ***Create rule set (exp. role check) that has one rule with name Has ORD_USR_ROLE and expression DBMS_MACUTL.USER_HAS_ROLE_VARCHAR('ORD_USER_ROLE') = 'Y'***

Create Rule Set Role check

6. ***Create a command rule for Select on all objects in OE schema, and as rule set, select one that you created in previous step (exp role check)***

Create a command rule

Running Oracle Database Vault reports

Let's connect as user system and violate some restrictions. First, we are going to select from hr schema, which is going to violate HR realm, and second, we are going to update sal in the scott.emp table, which is going to violate the command rule (we are updating it outside of working hours).

1.

SQL> connect system@fenagodb1

2.

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

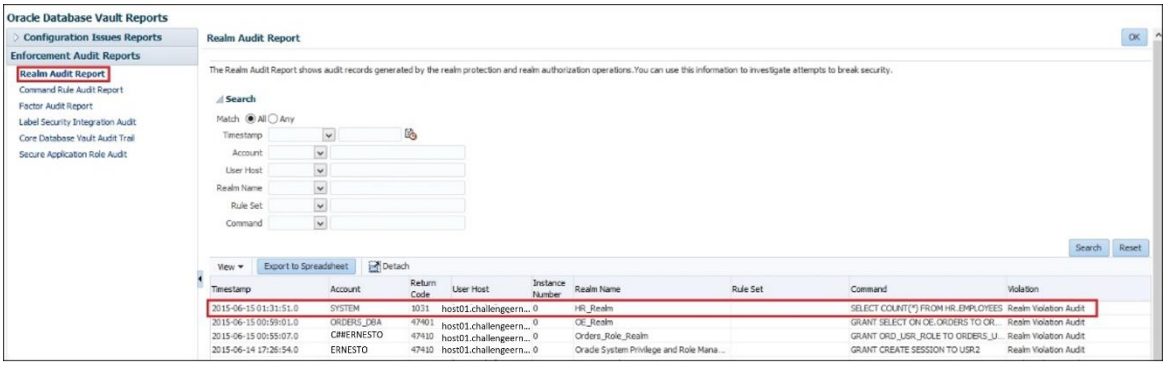
3.

SQL> update scott.emp set sal = sal*1.20 where empno = 7839;

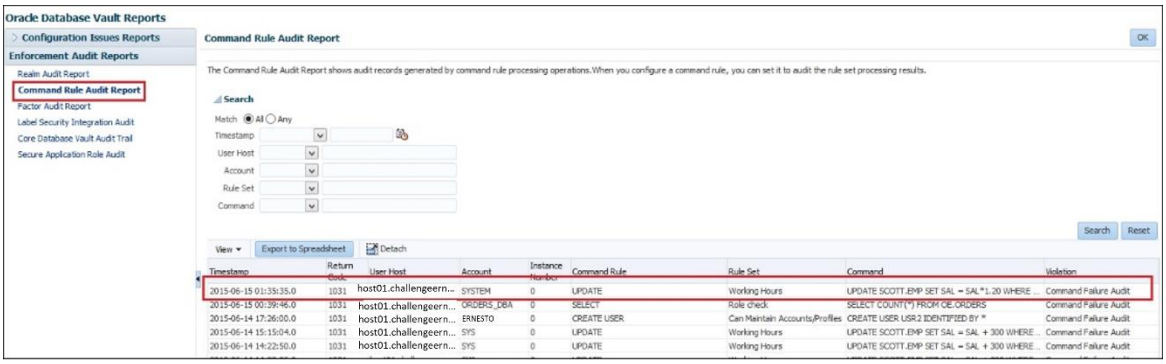
Let's see reports for these violations:

1. ***Go to Database Vault home page***
2. ***Click on Enforcement Audit Reports***

3. ***Click on Realm Audit Report. Observe the line marked in red (violation from step 2 is audited).***

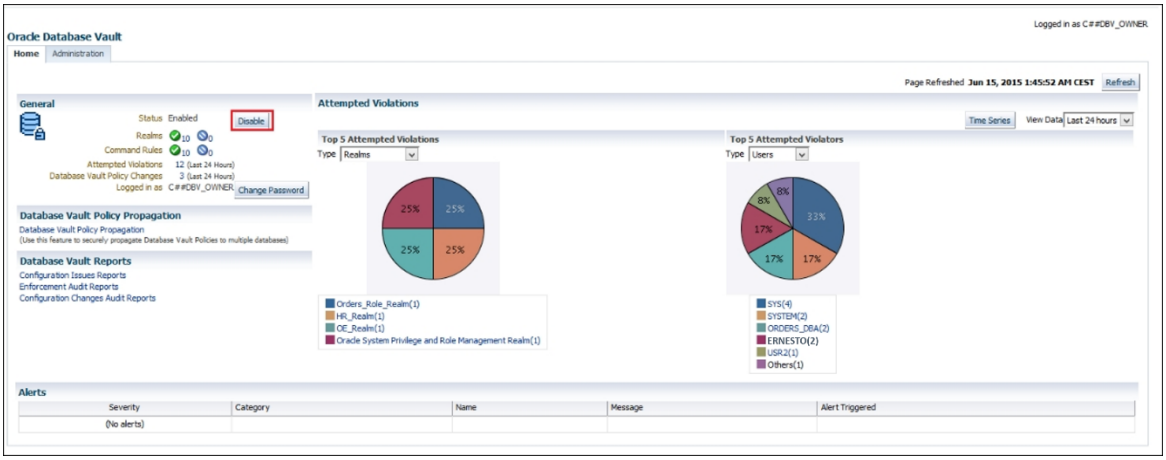


4. ***Next, click on Command Rule Audit Report. Observe the line marked in red (violation from step 3 is audited).***

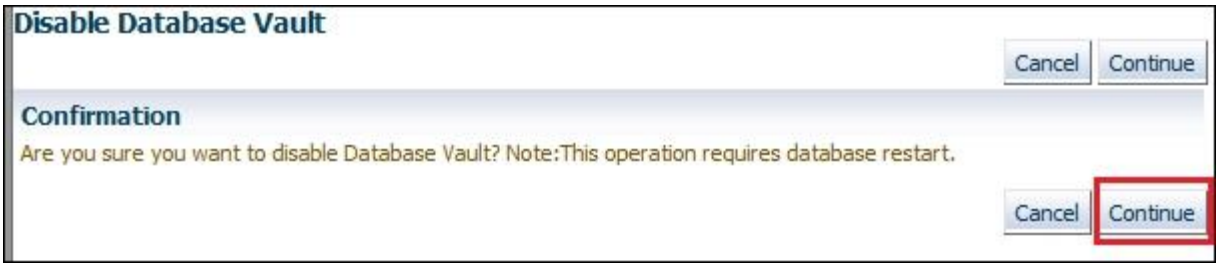


Disabling Database Vault

1. ***Go to Database Vault home page of your database or pluggable database and click on Disable:***



2. ***Click on continue in a small pop-up window***



Or

Connect to the database as Database Vault owner and disable it through command line:

SQL> EXEC DBMS_MACADM.DISABLE_DV;

3. ***Connect to your database or pluggable database and restart it:***

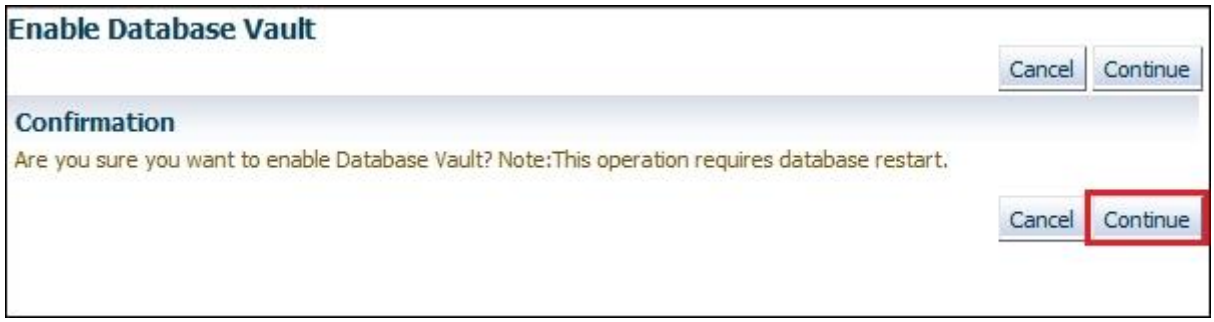
SQL> connect / as sysdba SQL> alter pluggable database fenagodb1 close immediate; SQL> alter pluggable database fenagodb1 open;

4. ***Confirm that Database Vault is disabled:***

SQL> connect c##dbv_owner@fenagodb1
SQL> SELECT PARAMETER, VALUE FROM V$OPTION WHERE PARAMETER = 'Oracle Database Vault'; PARAMETER VALUE ---------- ---------- Oracle Database Vault FALSE

Re-enabling Database Vault

1. ***Go to Database Vault home page of your database or pluggable database and click on Enable, then click on continue in a small pop-up window.***



Or

Connect to the database as Database Vault owner and enable it through command line:

SQL> EXEC DBMS_MACADM.ENABLE_DV;

2. ***Connect to your database or pluggable database and restart it:***

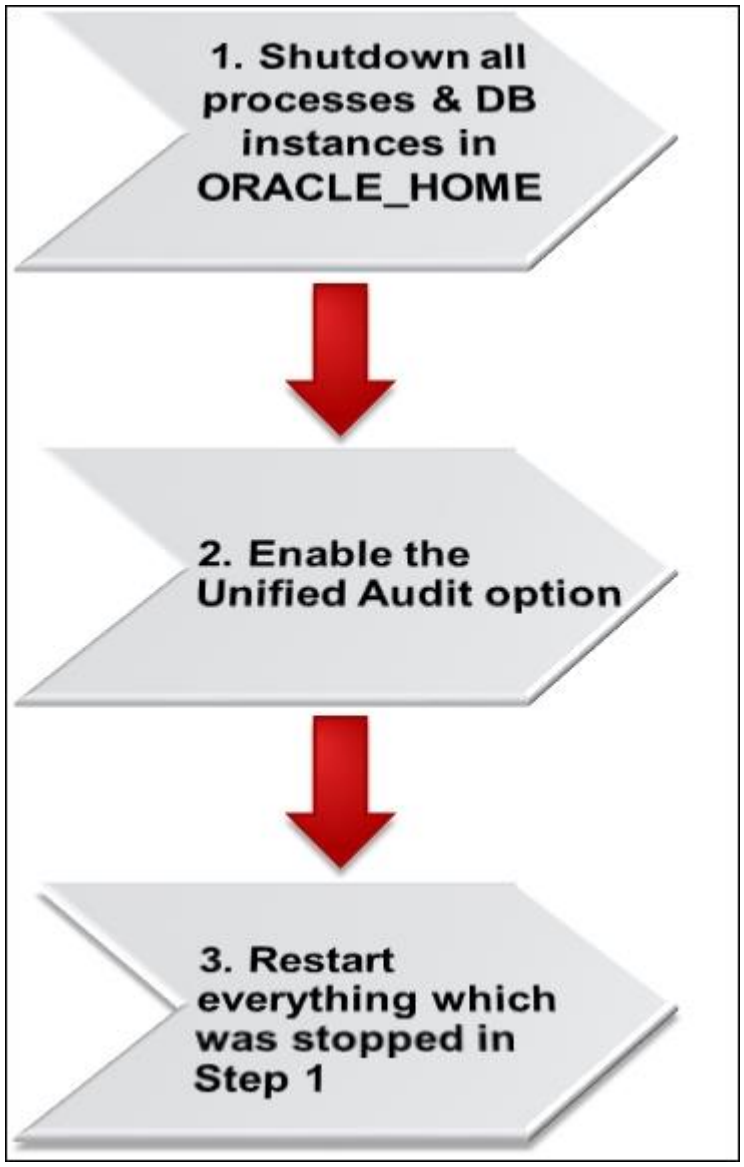
SQL> connect / as sysdba
SQL> alter pluggable database fenagodb1 close immediate;
SQL> alter pluggable database fenagodb1 open;

3. ***Confirm that Database Vault is enabled:***

SQL> connect c##dbv_owner@fenagodb1
SQL> SELECT PARAMETER, VALUE FROM V$OPTION WHERE PARAMETER = 'Oracle Database Vault'; PARAMETER VALUE ---------- ---------- Oracle Database Vault TRUE

Enabling Unified Auditing mode

The process of enabling unified auditing is depicted in the next figure:



1. ***In our case, there is only one database instance. Connect to the instance as sysoper and shut it down. Also, stop the listener:***

$ sqlplus / as sysoper
SQL> shutdown immediate SQL> exit $ lsnrctl stop

2. ***Relink Oracle binaries with the uniaud_on option:***

$ cd $ORACLE_HOME/rdbms/lib
$ make -f ins_rdbms.mk uniaud_on ioracle

3. ***Start the listener and the database instance:***

$ lsnrctl start $ sqlplus / as sysoper SQL> startup

To verify that unified auditing is enabled, issue the following SQL statement:

```
SQL> SELECT PARAMETER, VALUE
  2  from v$option
  3  where PARAMETER = 'Unified Auditing';
```

You should see that value for Unified Auditing parameter is true:

```
PARAMETER          VALUE
-----------------  --------
Unified Auditing   TRUE
```

Configuring whether loss of audit data is acceptable

1. ***Connect to the database as user who has the audit_admin role (for example, jack):***

```
SQL> connect jack
```

2. ***If you want audit records to be immediately written to the unified audit trail set immediate-write mode:***

```
SQL> EXEC DBMS_AUDIT_MGMT.SET_AUDIT_TRAIL_PROPERTY
(DBMS_AUDIT_MGMT.AUDIT_TRAIL_UNIFIED,DBMS_AUDIT_MGM
T. AUDIT_TRAIL_WRITE_MODE,
DBMS_AUDIT_MGMT.AUDIT_TRAIL_IMMEDIATE_WRITE);
```

3. ***Check that the mode is set to immediate-write:***

```
SQL> select * from dba_audit_mgmt_config_params
where parameter_name='AUDIT WRITE MODE';
```

You should see that the value for the AUDIT WRITE MODE parameter is IMMEDIATE WRITE MODE:

```
PARAMETER_NAME      PARAMETER_VALUE      AUDIT_TRAIL
-----------------  --------------------  ------------------
AUDIT WRITE MODE   IMMEDIATE WRITE MODE  UNIFIED
AUDIT TRAIL
```

If you want audit records to be queued in memory and at later time persisted, then set the **queued-write mode**. Instead of step 2, execute:

SQL> EXEC
DBMS_AUDIT_MGMT.SET_AUDIT_TRAIL_PROPERTY
(DBMS_AUDIT_MGMT.AUDIT_TRAIL_UNIFIED,DBMS_AUDIT_MGMT.AUDIT_TRAIL_WRITE_MODE,
DBMS_AUDIT_MGMT.AUDIT_TRAIL_QUEUED_WRITE);

Which roles do you need to have to be able to create audit policies and to view audit data?

1. ***Connect to the database as a user who has the dba role (for example, maja):***

$ sqlplus maja

2. ***Create the user jack and grant him the create session privilege and the audit_admin role.***

SQL> create user jack identified by pQ3s7a4w2;
SQL> grant create session, audit_admin to jack;

3. ***Create the user jill and grant her the create session privilege and the audit_viewer role.***

SQL> create user jill identified by t1m5_R2f3;
SQL> grant create session, audit_viewer to jill;

Auditing RMAN operations

1. ***Connect to the target database as a user who has the SYSBACKUP privilege (for example, tom).***

$ rman target '"tom@ora12cR1 AS SYSBACKUP"'

2. ***Backup the EXAMPLE tablespace and view information about backups:***

RMAN> backup tablespace EXAMPLE;
RMAN> list backup;
RMAN> exit

3. ***Connect to the database as a user who has the DBA role (for example, maja):***

$ sqlplus maja

4. ***Find the location of datafile for EXAMPLE tablespace:***

SQL> select file_name from dba_data_files where tablespace_name='EXAMPLE';
F**ILE_NAME**

/u01/app/oracle/oradata/ORA12CR1/datafile/
o1_mf_example_9z79vpcj_.dbf

5. ***Remove the EXAMPLE tablespace datafile:***

SQL> !rm /u01/app/oracle/oradata/ORA12CR1/datafile/ o1_mf_example_9z79vpcj_.dbf

6. ***Put the EXAMPLE tablespace offline:***

SQL> alter tablespace example offline immediate;
SQL> exit

7. ***Restore the EXAMPLE tablespace datafile:***

$ rman target '"tom@ora12cR1 AS SYSBACKUP"'
RMAN> restore tablespace EXAMPLE;

8. ***Recover the EXAMPLE tablespace datafile:***

RMAN> recover tablespace EXAMPLE;
RMAN> exit

9. ***Put tablespace back online:***

$ sqlplus maja
SQL> alter tablespace EXAMPLE online;

10. ***To verify that RMAN operations were successfully audited, execute the following statements:***

SQL> connect jack

SQL> EXEC SYS.DBMS_AUDIT_MGMT.FLUSH_UNIFIED_AUDIT_TRAIL;

SQL> select dbusername, rman_operation from unified_audit_trail where rman_operation is not null;

Auditing Data Pump operations

1. ***Connect to the database as a user who has the audit_admin role (for example, jack):***

$ sqlplus jack

2. ***Create an audit policy to audit Data Pump export operations:***

SQL> CREATE AUDIT POLICY DP_POLICY ACTIONS COMPONENT=datapump export;

3. ***Enable the audit policy:***

SQL> AUDIT POLICY DP_POLICY;

4. ***Export the table hr.departments:***

$ expdp maja@ora12cR1 dumpfile=test tables=hr.departments DIRECTORY=my_dir

5. ***Verify that the export operation was successfully audited:***

SQL> connect jack
SQL> select DP_TEXT_PARAMETERS1,DP_BOOLEAN_PARAMETERS1 from unified_audit_trail where audit_type='Datapump' and dbusername='MAJA';

Auditing Database Vault operations

1. ***Connect to the database as a user who has the audit_admin role (for example, jack):***

$ connect jack

2. ***Create the audit policy dbv_policy:***

SQL> CREATE AUDIT POLICY dbv_policy
ACTIONS COMPONENT = DV Rule Set Failure on "Working Hours",realm
violation on "HR Realm";

3. ***Enable the audit policy dbv_policy:***

SQL> audit policy dbv_policy;

4. ***Execute several statements that will cause generation of audit records:***

SQL> select * from oe.orders;

SQL> update hr.employees set salary=30000 where salary=24000;

Creating audit policies to audit privileges, actions and roles under specified conditions

1. ***Connect to the database as a user who has the audit_admin role (for example, jack):***

$ sqlplus jack

2. ***Create audit policy my_policy1:***

SQL> CREATE AUDIT POLICY MY_POLICY1
PRIVILEGES SELECT ANY TABLE
ACTIONS CREATE TABLE, DROP TABLE;

3. ***Create the audit policy role_con_policy:***

SQL> CREATE AUDIT POLICY ROLE_CON_POLICY
ROLES HR_ROLE
WHEN
'SYS_CONTEXT(''USERENV'',''HOST'')=''dbhost.orapassion.com'''
EVALUATE PER SESSION;

4. ***Create the audit policy hr_policy:***

SQL> CREATE AUDIT POLICY HR_POLICY
ACTIONS SELECT,INSERT,UPDATE,DELETE ON
HR.DEPARTMENTS;

5. ***Create the audit policy oe_policy:***

SQL> CREATE AUDIT POLICY OE_POLICY
ACTIONS ALL ON OE.ORDERS;

Enabling audit policy

1. ***Connect to the database as a user who has audit_admin role (for example, jack)***

SQL> connect jack

2. ***Enable audit policy oe_policy in such way that it applies only to user JOHN***

SQL> audit policy OE_POLICY BY JOHN;

3. ***Enable audit policy hr_policy to capture only successful events.***

SQL> AUDIT POLICY HR_POLICY WHENEVER SUCCESSFUL;

4. ***Enable policy my_policy1 to audit unsuccessful events for all users except maja and ernesto.***

SQL> audit policy my_policy1 EXCEPT MAJA,
ERNESTO WHENEVER NOT SUCCESSFUL;

5. ***Enable audit policy role_con_policy using default options.***

SQL> audit policy role_con_policy;

Finding information about audit policies and audited data

1. ***Connect to the database as a user who has the audit_admin role (for example, jack):***

$ connect jack

2. ***Find which unified audit policies are defined (exist in the database):***

SQL> select distinct policy_name
from audit_unified_policies;
SQL> desc audit_unified_policies

3. ***View which unified audit policies are enabled:***

SQL> select * from audit_unified_enabled_policies;

4. ***Connect to the database as the user john:***

SQL> connect john

5. ***Execute several statements on the tables HR.EMPLOYEES, HR.DEPARTMENTS, and OE.ORDERS:***

SQL> create table t(a number(10));
SQL> select count(*) from oe.orders;
SQL> select first_name from hr.employees;
SQL> drop table t;
SQL> connect sys / as sysdba
SQL> create table hr.my_table(b varchar2(10));
SQL> connect john
SQL> drop table hr.my_table;

6. ***Connect to the database as a user who has the audit_viewer role (for example, jill):***

SQL> connect jill

7. ***View audit records:***

SQL> set linesize 250
SQL> col event_timestamp format a30
SQL> col action_name format a20
SQL> col unified_audit_policies format a20
SQL> col sql_text format a80

SQL> select event_timestamp, action_name,unified_audit_policies, sql_text from unified_audit_trail where DBUSERNAME = 'SYS'and ACTION_NAME NOT IN ('LOGON','LOGOFF') ORDER BY EVENT_TIMESTAMP DESC; SQL> select event_timestamp, action_name, unified_audit_policies, sql_text from unified_audit_trail where DBUSERNAME = 'JONH'and ACTION_NAME NOT IN ('LOGON','LOGOFF') ORDER BY EVENT_TIMESTAMP DESC;

Auditing application contexts

1. ***Connect to the database as a user who has the audit_admin role (for example, jack):***

$ sqlplus jack

2. ***Configure application context auditing:***

SQL> AUDIT CONTEXT NAMESPACE USERENV ATTRIBUTES SESSION_USER, SERVICE_NAME;

Audit succeeded.

SQL> **AUDIT CONTEXT NAMESPACE USERENV ATTRIBUTES HOST BY jill; Aud**it succeeded.

3. ***View for which application contexts audit data is going to be captured:***

SQL> set linesize 180 SQL> column namespace format A30 SQL> column attribute format A30 SQL> column user_name format A30 SQL> select * from audit_unified_contexts;

4. ***Connect user jill as follows:***

SQL> connect jill

5. ***View audit records:***

SQL> SELECT APPLICATION_CONTEXTS FROM UNIFIED_AUDIT_TRAIL
WHERE APPLICATION_CONTEXTS IS NOT NULL;

Purging audit trail

1. ***Connect to the database as a user who has the audit_admin role (for example, jack):***

$ sqlplus jack

2. ***View number of audit records in the unified audit trail before the cleanup:***

SQL> select count (*) from unified_audit_trail;
To perform the manual cleanup, execute:
SQL> exec DBMS_AUDIT_MGMT.CLEAN_AUDIT_TRAIL(
AUDIT_TRAIL_TYPE =>
DBMS_AUDIT_MGMT.AUDIT_TRAIL_UNIFIED)

To create a purge job:
SQL> exec DBMS_AUDIT_MGMT.CREATE_PURGE_JOB
(AUDIT_TRAIL_TYPE =>
DBMS_AUDIT_MGMT.AUDIT_TRAIL_UNIFIED,
AUDIT_TRAIL_PURGE_INTERVAL => 24,
AUDIT_TRAIL_PURGE_NAME => 'My_Job',
USE_LAST_ARCH_TIMESTAMP => TRUE)

3. ***View number of audit records in the unified audit trail after the cleanup:***

SQL> select count (*) from unified_audit_trail;

Disabling and dropping audit policies

1. ***Connect to the database as a user who has the audit_admin role (for example, jack):***

$ sqlplus jack

2. ***Verify that the policy is enabled:***

SQL> SELECT POLICY_NAME, ENABLED_OPT, USER_NAME, SUCCESS, FAILURE
FROM AUDIT_UNIFIED_ENABLED_POLICIES;

3. ***Disable the policy oe_policy:***

SQL> NOAUDIT policy oe_policy BY JOHN;

4. ***Verify that oe_policy is disabled:***

SQL> select * from AUDIT_UNIFIED_ENABLED_POLICIES;

5. ***Drop the policy oe_policy:***

SQL> drop audit policy oe_policy;

Additional Topics

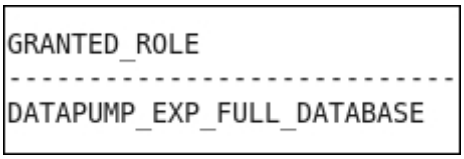
Exporting data using Oracle Data Pump in Oracle Database Vault environment

1. ***Connect to the database as a user who has the DV_OWNER or DV_ADMIN role (for example, dbv_owner):***

$ sqlplus dbv_owner

2. ***Verify that the user piter has the DATAPUMP_EXP_FULL_DATABASE role:***

SQL> SELECT GRANTED_ROLE FROM DBA_ROLE_PRIVS WHERE
GRANTED_ROLE LIKE '%FULL%' AND GRANTEE='PITER';



```
GRANTED_ROLE
------------------------------
DATAPUMP_EXP_FULL_DATABASE
```

Prerequisite role

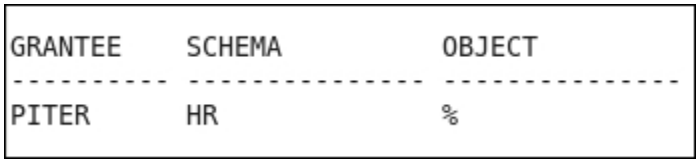
3. ***Authorize the user piter to perform Data Pump operations on HR schema (execute the DBMS_MACADM.AUTHORIZE_DATAPUMP_USER procedure):***

SQL> EXEC DBMS_MACADM.AUTHORIZE_DATAPUMP_USER ('PITER', 'HR');

PL/SQL procedure successfully completed.

4. ***Query the DVSYS.DBA_DV_DATAPUMP_AUTH view to confirm that the user piter is authorized to perform export and import operations only on HR schema:***

SQL> column grantee format A10
SQL> column schema format A15
SQL> column object format A15
SQL> SELECT * FROM DVSYS.DBA_DV_DATAPUMP_AUTH WHERE GRANTEE = 'PITER';



```
GRANTEE    SCHEMA          OBJECT
---------- --------------- ---------------
PITER      HR              %
```

Authorized for all database object in schema HR

5. ***Export the HR.EMPLOYEES and HR.DEPARTMENTS tables:***

$ expdp piter DIRECTORY=dp_dir DUMPFILE= exptables.dmp TABLES= hr.employees, hr.departments

```
Connected to: Oracle Database 12c Enterprise Edition Release 12.1.0.2.0 - 64bit Producti
on
With the Partitioning, Oracle Label Security, OLAP, Advanced Analytics,
Oracle Database Vault, Real Application Testing and Unified Auditing options
Starting "PITER"."SYS_EXPORT_TABLE_01":  piter/******** DIRECTORY=dp_dir DUMPFILE=exptab
les.dmp TABLES=hr.employees, hr.departments
ORA-39327: Oracle Database Vault data is being stored unencrypted in dump file set.
Estimate in progress using BLOCKS method...
Processing object type TABLE_EXPORT/TABLE/TABLE_DATA
Total estimation using BLOCKS method: 128 KB
Processing object type TABLE_EXPORT/TABLE/TABLE
Processing object type TABLE_EXPORT/TABLE/GRANT/OWNER_GRANT/OBJECT_GRANT
Processing object type TABLE_EXPORT/TABLE/COMMENT
Processing object type TABLE_EXPORT/TABLE/INDEX/INDEX
Processing object type TABLE_EXPORT/TABLE/CONSTRAINT/CONSTRAINT
Processing object type TABLE_EXPORT/TABLE/INDEX/STATISTICS/INDEX_STATISTICS
Processing object type TABLE_EXPORT/TABLE/CONSTRAINT/REF_CONSTRAINT
Processing object type TABLE_EXPORT/TABLE/TRIGGER
Processing object type TABLE_EXPORT/TABLE/STATISTICS/TABLE_STATISTICS
Processing object type TABLE_EXPORT/TABLE/STATISTICS/MARKER
. . exported "HR"."DEPARTMENTS"                          7.125 KB      27 rows
. . exported "HR"."EMPLOYEES"                            17.08 KB     107 rows
Master table "PITER"."SYS_EXPORT_TABLE_01" successfully loaded/unloaded
******************************************************************************
```

The warning message

6. ***Export HR schema in an unencrypted format:***

$ expdp piter DIRECTORY=dp_dir DUMPFILE=expsh.dmp SCHEMAS=hr ENCRYPTION=NONE

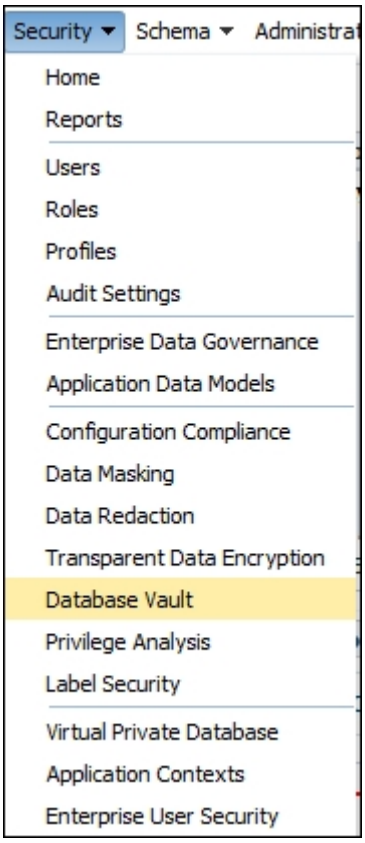
You'll receive the same message as in the previous step (ORA-39327), even though you explicitly stated that you don't want to encrypt export. At the end of the job, you'll see that it completed with one error meaning that one warning:

```
Dump file set for PITER.SYS_EXPORT_SCHEMA_01 is:
  /u01/app/oracle/oradata/dp_exp/expsh.dmp
Job "PITER"."SYS_EXPORT_SCHEMA_01" completed with 1 error(s)
```

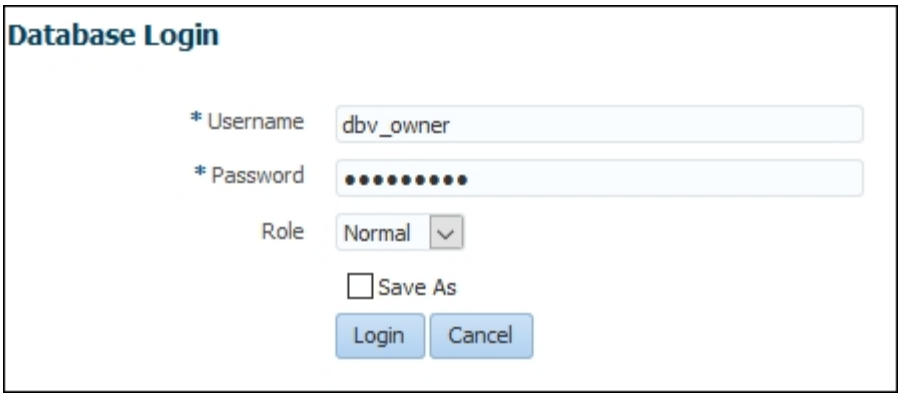
Successful export with warning

Creating factors in Oracle Database Vault

1. ***Log in to EM12c as a SYSMAN or some other privileged user. Select your database. Then, from Security drop-down menu, choose Database Vault.***

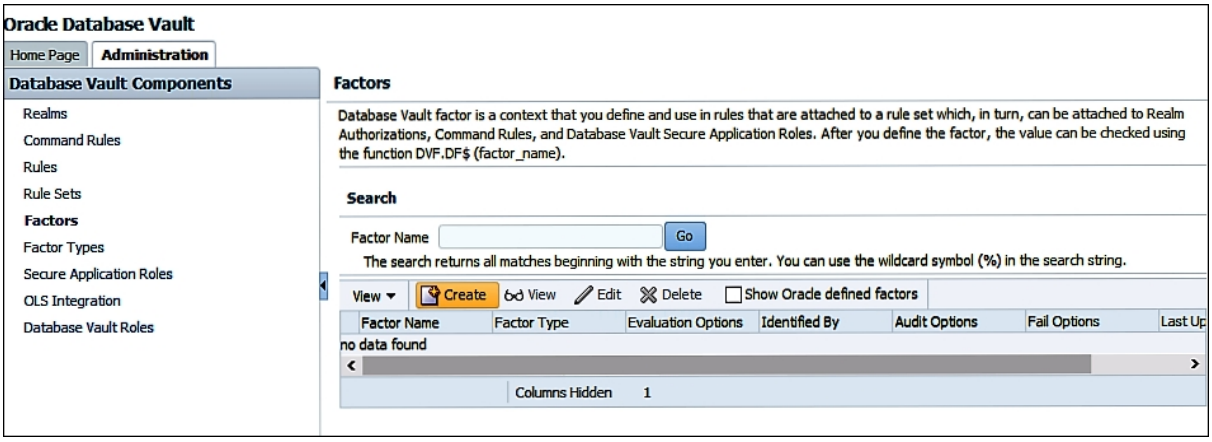


2. ***Log in as the dbv_owner user***

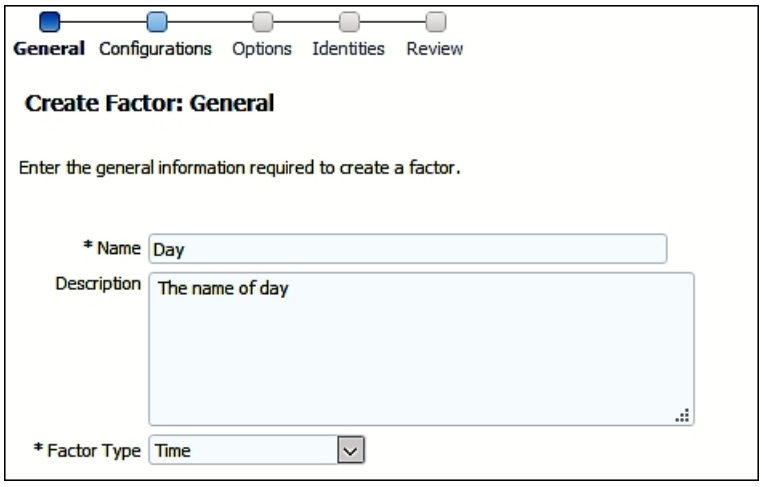


3. ***Choose the Administration tab and click on the Factors link***

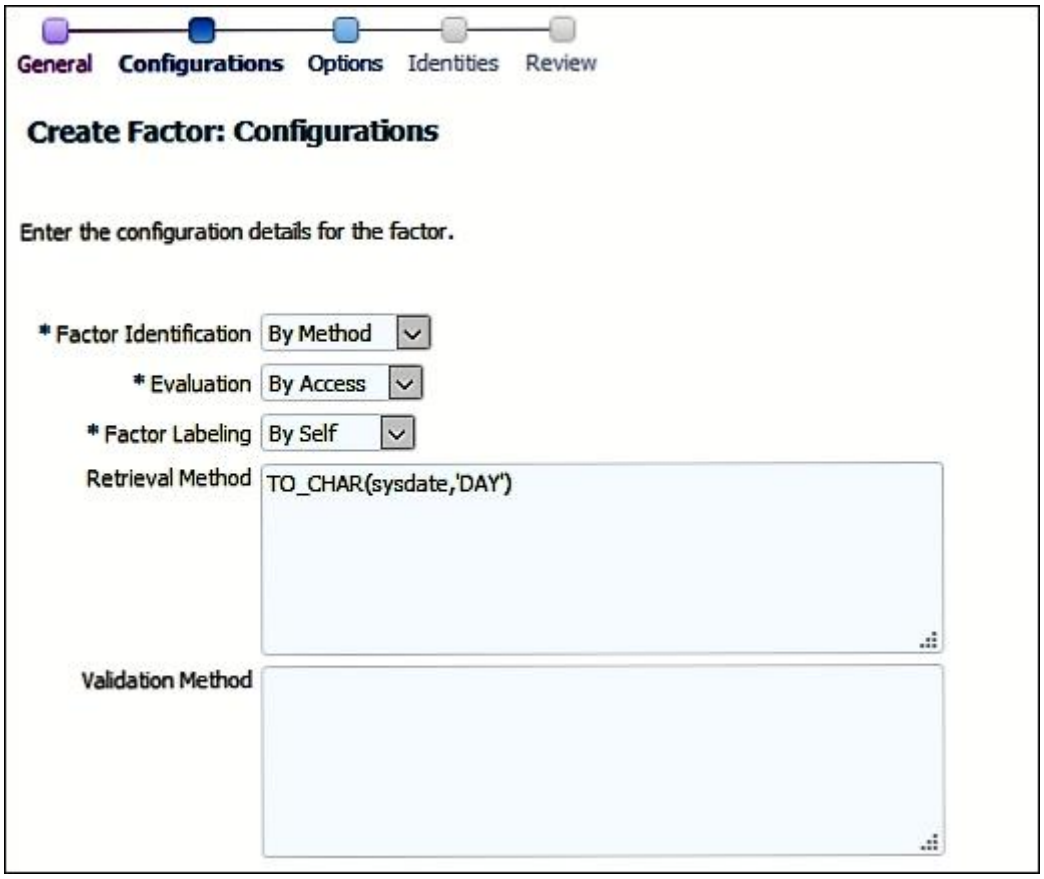
4. ***Click on the Create button to create your first custom factor***



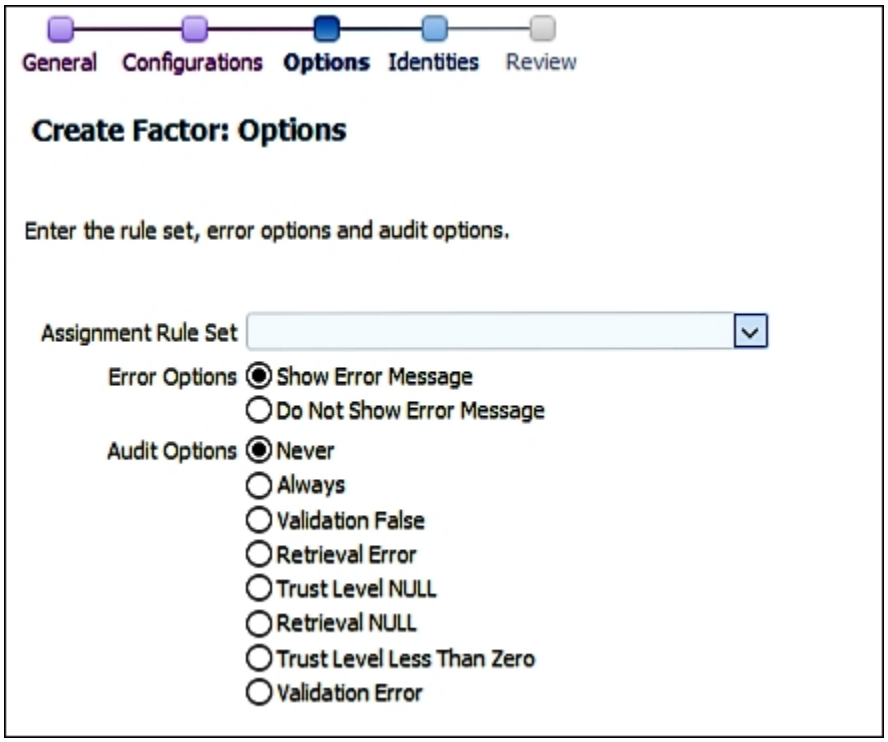
5. ***The name of the factor will be Day, the description will be The name of day, and Factor Type will be Time. After you enter that information, click on the button Next.***



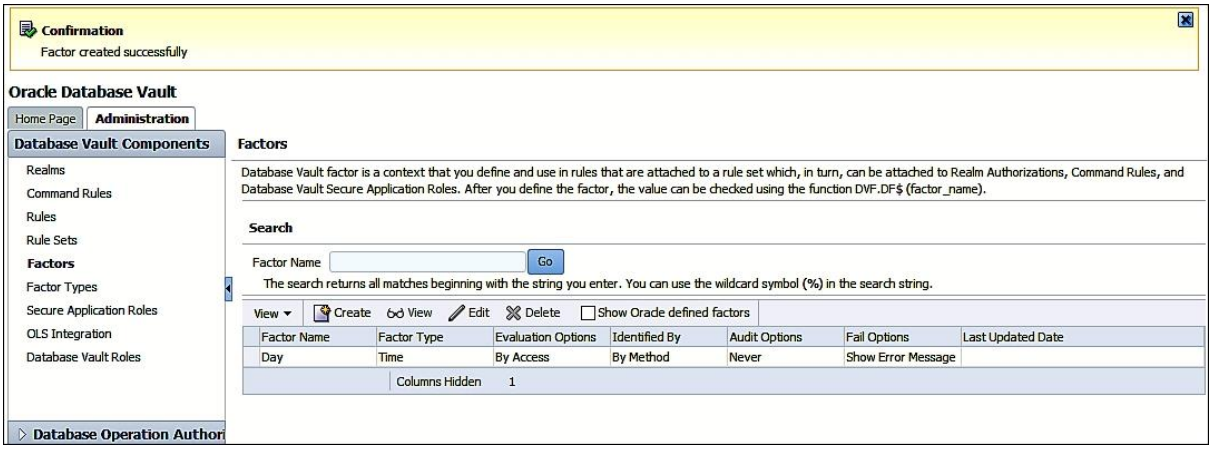
6. ***Enter these configuration details for the factor and click on the button Next. It will appear as shown in this figure :***



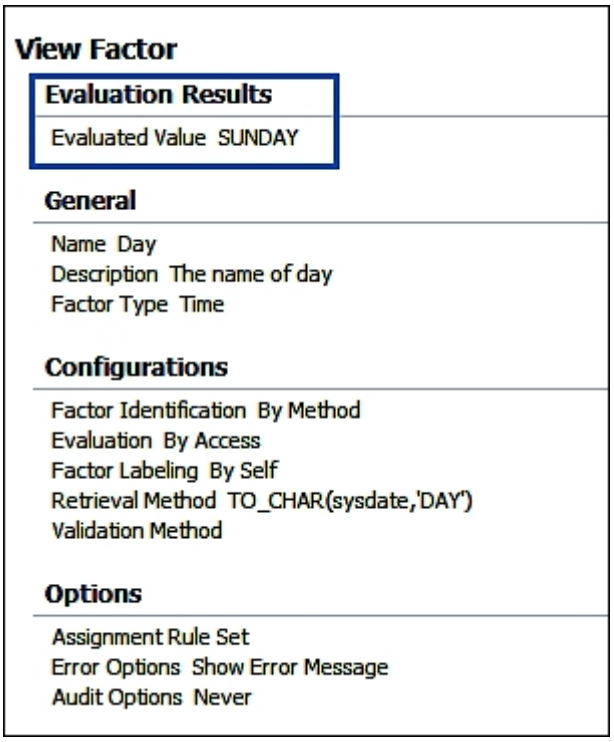
7. ***For Audit Options, choose Never. Leave other default values and click the button Next.***



8. ***You won't create new identities at this moment, so just click on the button Next. After you finish reviewing the configuration, click on the Finish button . You should receive a confirmation message and see the newly created factor Day.***



9. ***Click on Link Day (in the column Factor Name). You will see that factor Day will get value SUNDAY. Click on the OK button.***

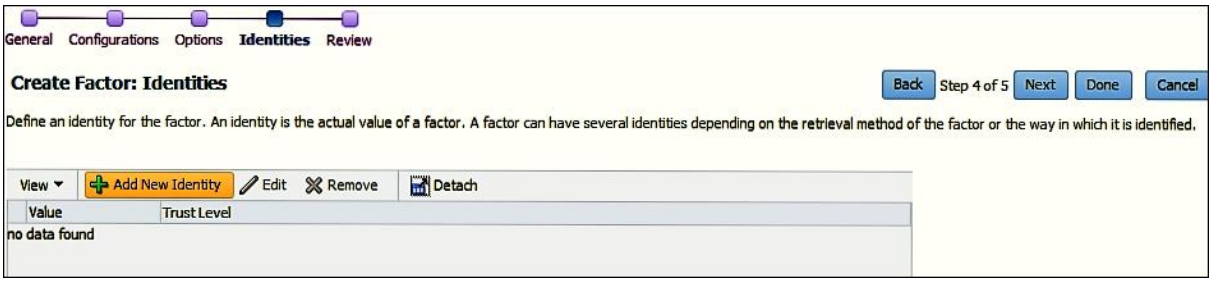


Now create the new factor NonWorkingDay (**Factor Type**: Time) which will, for the beginning, be based only on the factor Day and test it. After you create the factor Holiday, you'll edit the factor NonWorkingDay in such a way that it is based on both factors (Day and Holiday).

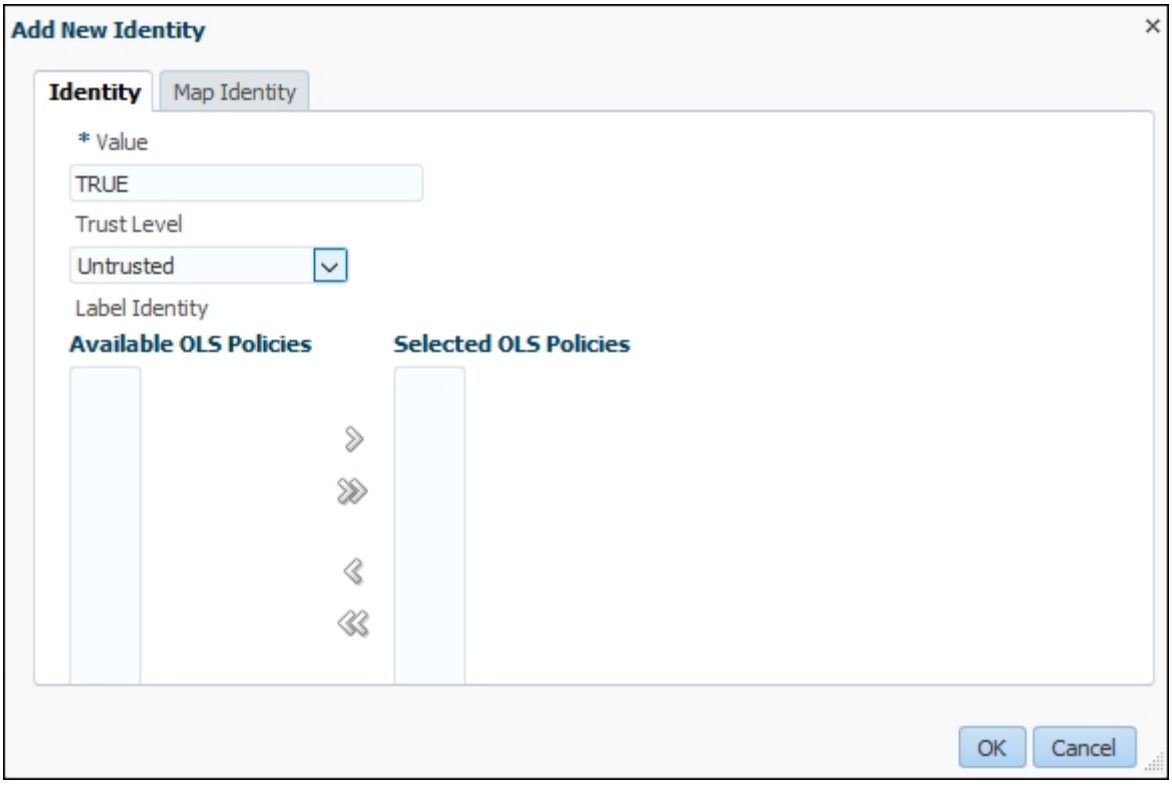
10. ***Repeat steps 4 and 5.***
11. ***Enter these configuration details for the factor and click on the button Next:***

Factor Identification:	**By Factors**
Evaluation:	**By Access**
Factor Labeling:	**By Self**

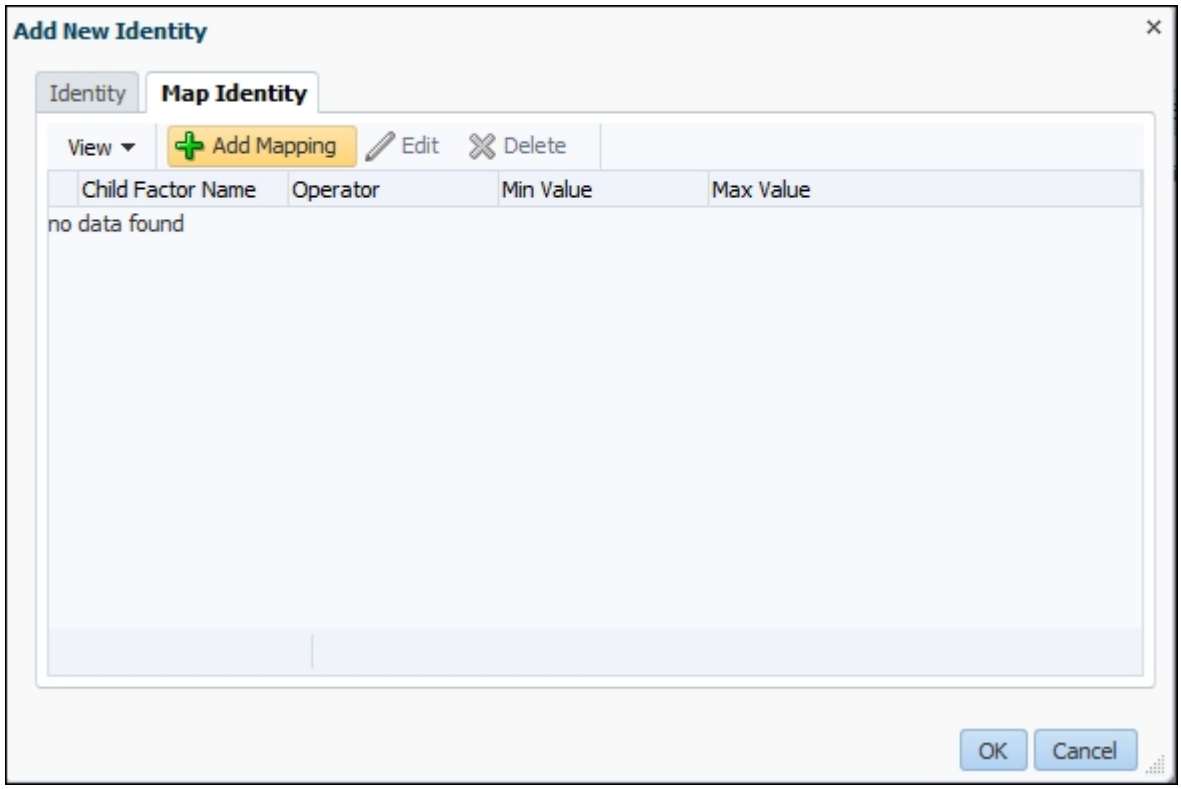
12. ***Leave the default values and click on the Next button.***
13. ***Click on the green plus button - Add New Identity***



14. ***On the tab Identity, enter Value as TRUE and select Untrusted for Trust Level.***



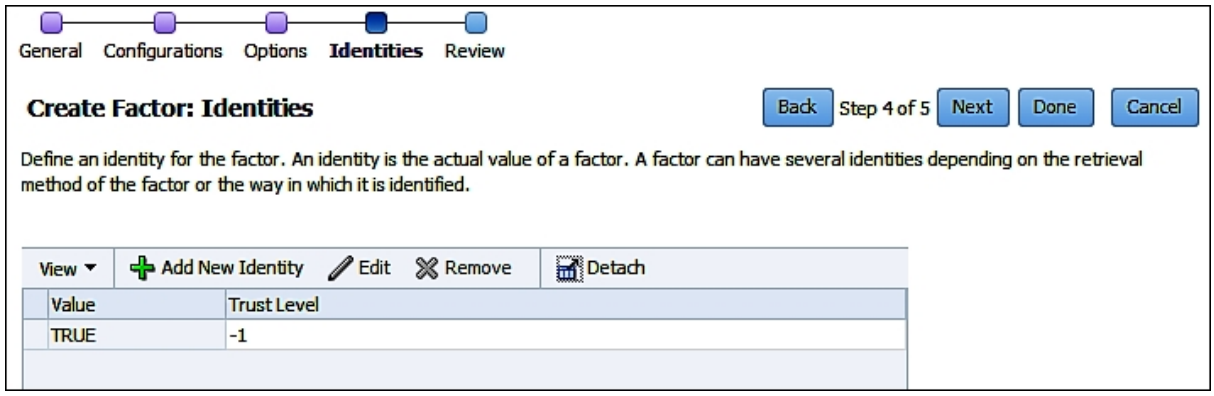
15. ***Click on the Map Identity tab . Click on the green plus button - Add Mapping***



16. ***Select the following values and click on the OK button:***

Child Factor Name	Day
Operator	Like
Min Value	S%

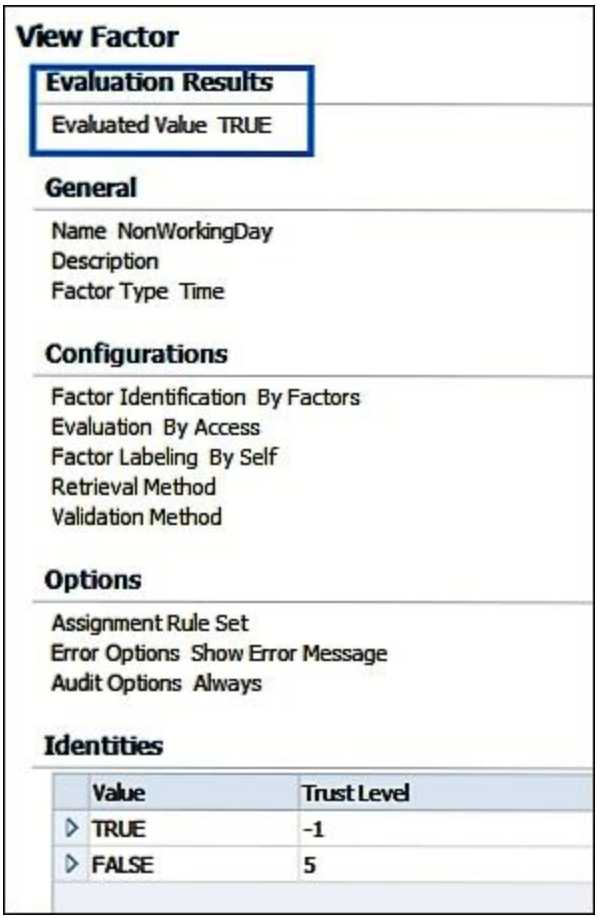
17. ***You should see that identity is added***



18. ***Add the new identity FALSE. Repeat steps from 13 to 16 with appropriate values (for example, the value FALSE, Trust Level as Somewhat trusted; instead of the Like operator, choose Not Like).***

19. ***Click on the Next button. Review the configuration and click on the Finish button. You should see confirmation message.***

20. ***Click on the link NonWorkingDay (in the column Factor Name). You will see that the factor NonWorkingDay will get value TRUE. Click on the OK button.***



21. ***On the Factors page, in the table select row in which Day factor is displayed and click on the Edit button (pencil icon). Click on the Next button.***

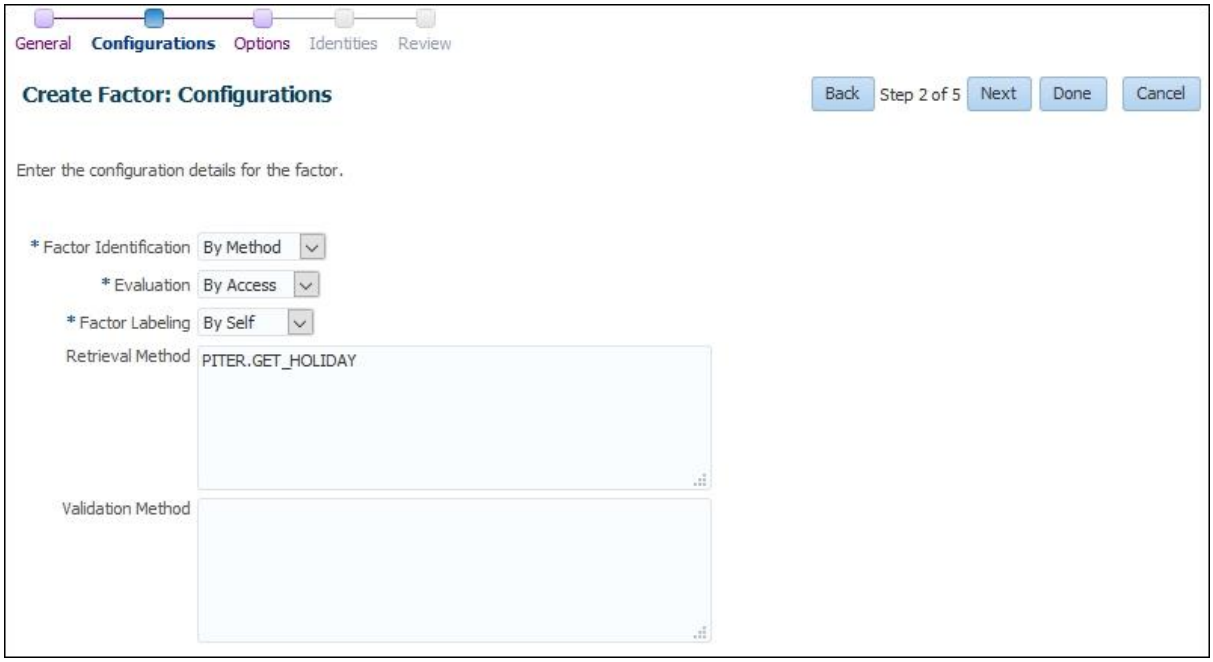
22. ***Change Retrieval Method to RTRIM(TO_CHAR(sysdate, 'DAY')) and click on the Done button.***

23. ***Create the new factor Holiday (Factor Type: Time).***

24. ***Enter these configuration details for the factor and click on the Done button:***

Factor Identification:	**By Method**
Evaluation:	**By Access**
Factor Labeling:	**By Self**
Retrieval Method:	PITER.GET_HOLIDAY

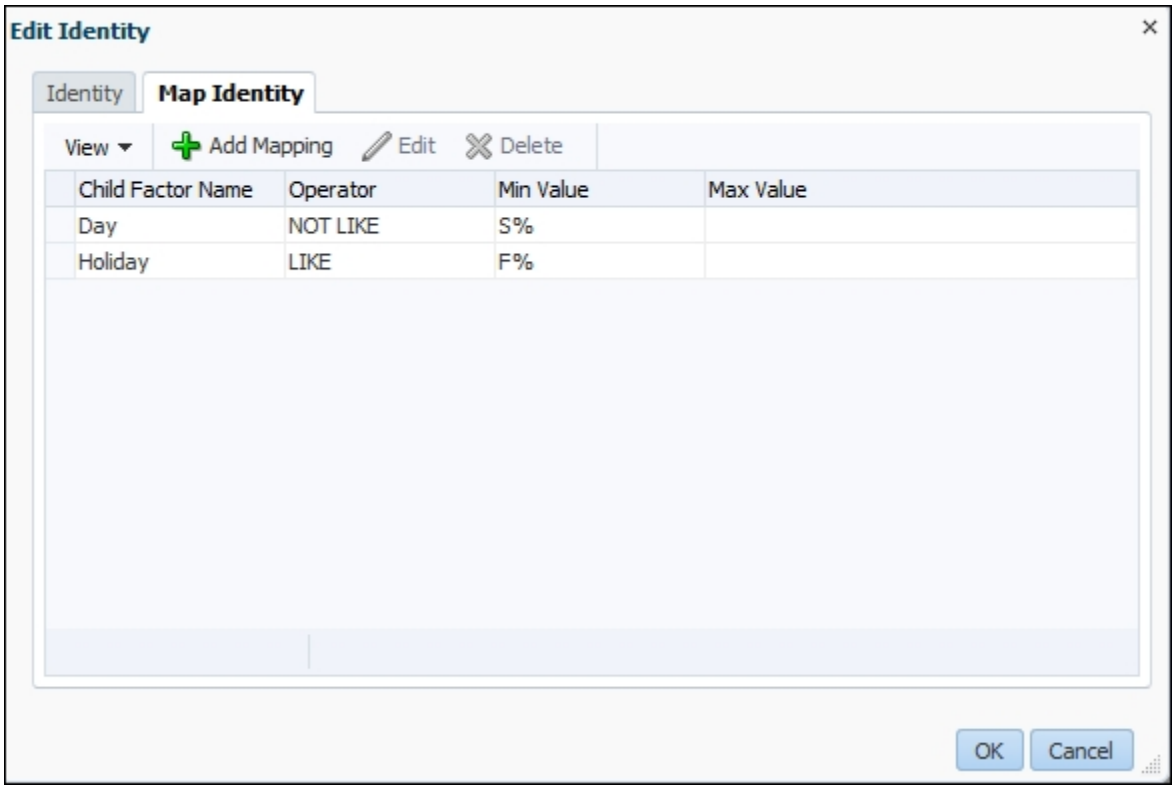
It will appear as shown in this figure :



25. ***Edit the factor NonWorkingDay so that it has three identities (NO, WEEKEND, and COMPANY_HOLIDAY) and click on OK.***

26. ***Perform the following for the three identities:***

26 a. Edit the FALSE identity (change value to **NO**, add mapping in the **Map Identity** - **Child Factor Name**: Holiday, **Operator**: Like, **Min Value**: F%). Click on the **OK** button.



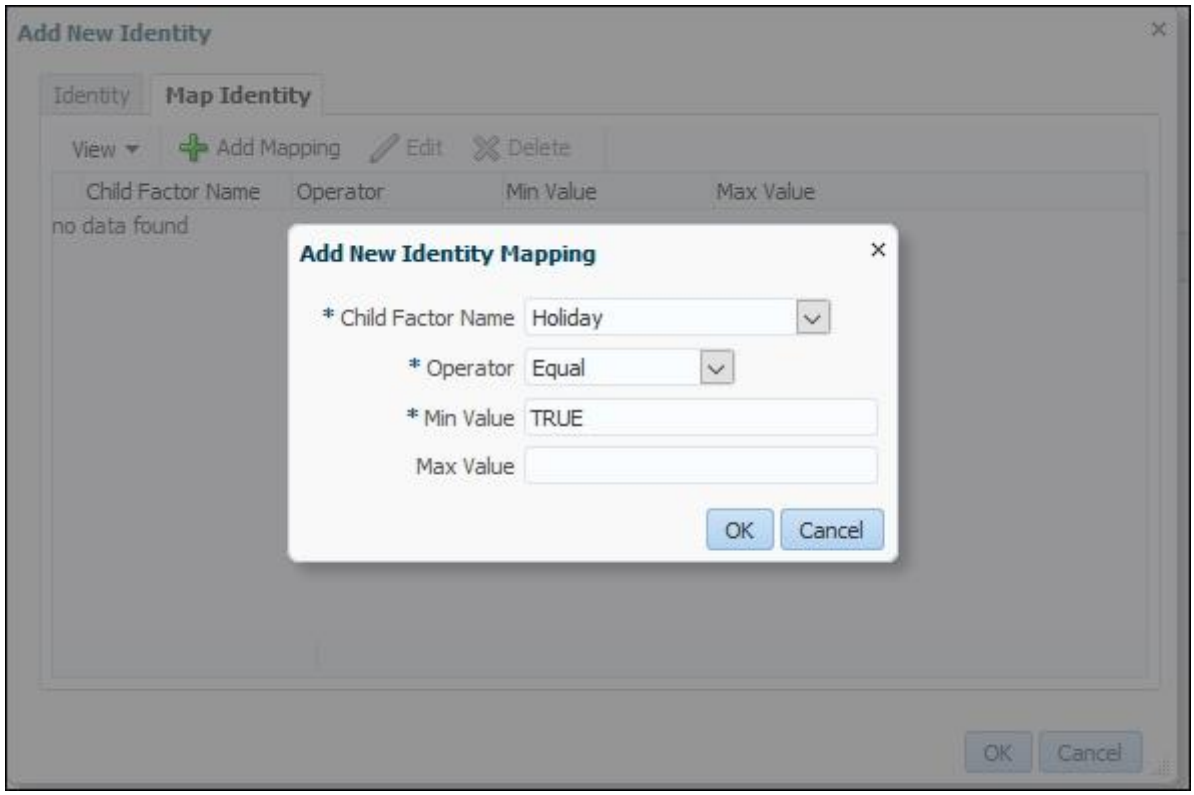
26 b. Edit the TRUE identity and click on the **OK** button (change value to WEEKEND, change mapping to have two rows:

Child Factor Name	Operator	Min Value	Max Value
Day	Equal	SATURDAY	
Day	Equal	SUNDAY	

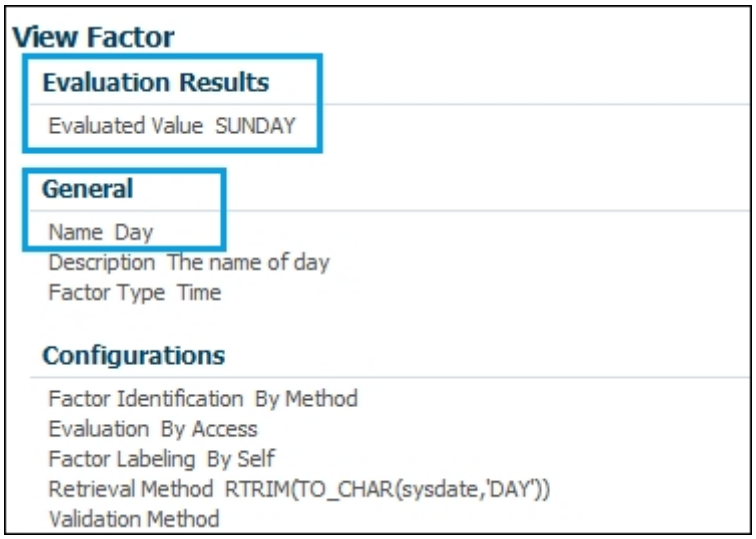
26 c. Add the new COMPANY_HOLIDAY identity (**Trust Level**: **Untrusted**). On the **Map Identity** tab, click on **Add Mapping**. Set the following values and click on **OK**:

Child Factor Name	Operator	Min Value	Max Value
Holiday	Equal	TRUE	

This will appear as shown in this figure:

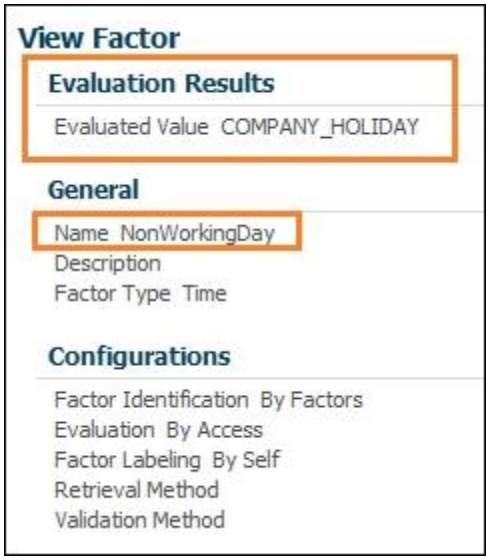


27. ***View evaluated value for factor Day (repeat step 9).***



28. ***View evaluated value for factor Holiday. The result is shown next.***

29. ***View an evaluated value for factor NonWorkingDay. The result is shown next:***



Using TDE in a multitenant environment

1. ***Enter the following text into your sqlnet.ora file located in a network/admin directory of your oracle home (for example, /u01/app/oracle/product/12.1.0/dbhome_1)***

ENCRYPTION_WALLET_LOCATION=
(SOURCE=

(METHOD=FILE)
(METHOD_DATA=
(DIRECTORY=/u01/app/oracle/admin/$ORACLE_SID/wallet)))

2. ***Change your environment to the first container database (for example, fenagodb):***

[oracle@host01 ~]$. oraenv
ORACLE_SID = [oracle] ? fenagodb

3. ***Connect as a user with the DBA role (for example, system), create a new user (for example, c##tdedba) to manage key management administration, and grant him appropriate privileges:***

$ sqlplus system
SQL> create user c##tdedba identified by oracle123 container=all;

SQL> grant administer key management to c##tdedba container=all;

SQL> grant create session to c##tdedba container=all;

SQL> grant select any dictionary to c##tdedba container=all;

SQL> grant set container to c##tdedba container=all;

4. ***Connect as a user c##tdedba and create a keystore:***

SQL> connect c##tdedba/oracle123
SQL> ADMINISTER KEY MANAGEMENT CREATE KEYSTORE '/u01/app/oracle/admin/fenagodb/wallet' identified by oracle1;

5. ***See information about the previously created keystore and open it:***

SQL> select wallet_type,wrl_type,status from v$encryption_wallet;

WALLET_TYPE WRL_TYPE STATUS ---------- ---------- ------ UNKNOWN FILE CLOSED

SQL> ADMINISTER KEY MANAGEMENT SET KEYSTORE OPEN IDENTIFIED BY oracle1; SQL> select wallet_type,wrl_type,status from v$encryption_wallet;

WALLET_TYPE WRL_TYPE STATUS ---------- ---------- ------ ---------- PASSWORD FILE OPEN_NO_MASTER_KEY

SQL> select con_id, tag, key_id from v$encryption_keys;

no rows selected

6. ***Create a new master key for root container:***

SQL> ADMINISTER KEY MANAGEMENT SET KEY USING TAG 'description: root key' IDENTIFIED BY oracle1 WITH BACKUP;

SQL> select con_id, tag, key_id from v$encryption_keys;

```
    CON_ID TAG                  KEY_ID
---------- -------------------- ----------------------------------------------------
         0 description: root key  AQInxR2++E8yv2hvZVrc5aQAAAAAAAAAAAAAAAAAAAAAAAAAAAA
```

SQL> select wallet_type,wrl_type,status from v$encryption_wallet;

WALLET_TYPE **WRL_TYPE STATUS ---------- ---------- -------- ---------- P**ASSWORD FILE OPEN

7. ***Connect to a pluggable database (for example, fenagodb11) inside the first container database and check availability of a keystore:***

SQL> alter session set container=fenagodb11;

SQ**L> select wallet_type,wrl_type,status from v$encryption_wallet;**

WALLET_TYPE WRL_TYPE STATUS ---------- ---------- ------- ------- UNKNOWN FILE CLOSED

8. ***Open a keystore, check availability of a master key, and create one:***

SQL> ADMINISTER KEY MANAGEMENT SET KEYSTORE OPEN IDENTIFIED BY oracle1;
S**QL> select wallet_type,wrl_type,status from v$encryption_wallet;**

WALLET_TYPE WRL_TYPE STATUS ---------- ---------- -------

---------- PASSWORD FILE OPEN_NO_MASTER_KEY

SQL> select con_id, tag, key_id from v$encryption_keys; no rows selected

SQL> ADMINISTER KEY MANAGEMENT SET KEY USING TAG 'description: fenagodb11 key' IDENTIFIED BY oracle1 WITH BACKUP;

SQL> select con_id, tag, key_id from v$encryption_keys;

```
    CON_ID TAG                  KEY_ID
---------- -------------------- ------------------------------------------------------------
         0 description: pdb11 key AeC4mqH5WU+mvxjEMBNk7lcAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
```

SQL> select wallet_type,wrl_type,status from v$encryption_wallet;
WALLET_TYPE WRL_TYPE STATUS ---------- ---------- ---------- PASSWORD FILE OPEN

9. ***Change environment for the second container database (for example, cdb2):***

[oracle@host01 ~]$. oraenv
ORACLE_SID = [fenagodb] ? cdb2

10. ***Connect as a user with the sysdba privileges, create a new user (for example, c##tdedba), and grant him appropriate privileges:***

$ sqlplus / as sysdba
SQL> create user c##tdedba identified by oracle321 container=all;
SQL> grant syskm to c##tdedba container=all;

11. ***Connect as a user c##tdedba (as syskm), create a keystore, and open it for all pluggable databases:***

SQL> ADMINISTER KEY MANAGEMENT CREATE KEYSTORE '/u01/app/oracle/admin/cdb2/wallet' identified by oracle2;

SQL> select wallet_type,wrl_type,status from v$encryption_wallet;

WALLET_TYPE WRL_TYPE STATUS ---------- ---------- ---------- UNKNOWN FILE CLOSED

SQL> ADMINISTER KEY MANAGEMENT SET KEYSTORE OPEN IDENTIFIED BY oracle2 container=all;

SQL> select wallet_type,wrl_type,status from v$encryption_wallet;

WALLET_TYPE WRL_TYPE STATUS ---------- ---------- ---------- PASSWORD FILE OPEN_NO_MASTER_KEY

12. ***Create new master keys for all pdbs:***

SQL> ADMINISTER KEY MANAGEMENT SET KEY USING TAG 'description: all pdbs' IDENTIFIED BY oracle2 WITH BACKUP container=all;

SQL> select con_id, tag, key_id from v$encryption_keys;

```
    CON_ID TAG                  KEY_ID
---------- -------------------- ------------------------------------------------------------
         0 description: all pdbs  AZ07ljUOQU8cv/wRuUgzoBEAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
         0 description: all pdbs  AbwHF8tkj0+ov9/HG43OYiUAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
```

13. ***Connect to a pluggable database as a SYS user and check keystore and masterkey:***

SQL> connect / as sysdba

SQL> alter session set container=pdb21;

SQL> select wallet_type,wrl_type,status from v$encryption_wallet;

WALLET_TYPE WRL_TYPE STATUS ---------- ---------- ---------- PASSWORD FILE OPEN

SQL> select con_id, tag, key_id from v$encryption_keys;

```
    CON_ID TAG                  KEY_ID
---------- -------------------- ------------------------------------------------------------
         0 description: all pdbs  AZ07ljUOQU8cv/wRuUgzoBEAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
```

14. ***Change your environment to the first container database (for example, fenagodb):***

[oracle@host01 ~]$. oraenv ORACLE_SID = [cdb2] ? fenagodb

15. ***Connect to the pluggable database as a user who has the DBA role (for example, c##ernesto), create a test table with one encrypted column, and insert some data:***

```
$ sqlplus c##erneesto@fenagodb11
SQL> create table hr.enc_tbl(a int, b varchar2(20) encrypt);
SQL> insert into hr.enc_tbl values (1, 'value1');
SQL> insert into hr.enc_tbl values (2, 'value2');
SQL> commit;
SQL> select * from hr.enc_tbl;

A         B ---------- ------------      1         value1         2         value2
```

16. ***Export a master key:***

```
SQL> ADMINISTER KEY MANAGEMENT EXPORT KEYS WITH
SECRET "secret1"        to '/home/oracle/keys.exp' IDENTIFIED BY
oracle1;
```

17. ***Close the pluggable database fenagodb11 and unplug it:***

```
SQL> alter pluggable database fenagodb11 close immediate;
SQL> alter pluggable database fenagodb11 unplug into
'/home/oracle/fenagodb11.xml';
SQL> drop pluggable database fenagodb11 keep datafiles;
```

18. ***Change your environment to the second container database (for example, cdb2):***

[oracle@host01 ~]$. oraenv ORACLE_SID = [fenagodb] ? cdb2

19. ***Connect to the second container database (for example, cdb2) as a sys user and plug the previously unplugged database (fenagodb11):***

```
$ sqlplus / as sysdba
SQL> create pluggable database fenagodb11 using
'/home/oracle/fenagodb11.xml';
```

20. ***Open the pluggable database:***

SQL> alter pluggable database fenagodb11 open;

Warning: PDB altered with errors.

SQL> **show pdbs**
CON_ID CON_NAME OPEN MODE RESTRICTED ---------- ---------- ---------- ---------- 2 PDB$SEED READ ONLY NO 3 PDB21 READ WRITE NO 4 FENAGODB11 READ WRITE YES

21. ***Connect to fenagodb11, as a SYS user, open the keystore, and try to select from table with encrypted column:***

SQL> alter session set container=fenagodb11;
SQL> ADMINISTER KEY MANAGEMENT SET KEYSTORE OPEN IDENTIFIED BY oracle2;
SQL> select * from hr.enc_tbl;
select * from hr.enc_tbl
*****
ERROR at line 1:
ORA-28362: master key not found

22. ***Import the master key for this pluggable database and restart it:***

SQL> ADMINISTER KEY MANAGEMENT IMPORT ENCRYPTION KEYS WITH SECRET "secret1" FROM '/home/oracle/keys.exp' IDENTIFIED BY oracle2 WITH BACKUP; SQL> alter pluggable database fenagodb11 close immediate;

SQL> **alter pluggable database fenagodb11 open;**

SQL> show pdbs
CON_ID CON_NAME OPEN MODE RESTRICTED ---------- ---------- ---------- ---------- 2 PDB$SEED READ ONLY NO 3 PDB21 READ WRITE NO 4 FENAGODB11 READ WRITE NO

23. ***Connect to the pluggable database (fenagodb11), open the keystore, and select from table with encrypted column:***

SQL> alter session set container=fenagodb11;

SQL> ADMINISTER KEY MANAGEMENT SET KEYSTORE OPEN IDENTIFIED BY oracle2;

SQL> select * from hr.enc_tbl;
A B ---------- ---------- 1 value1 2 value2

Appendix – Application Contexts

Exploring and using built-in contexts

1. ***Connect to the database as a user who has appropriate privileges (for example, user maja):***

$ sqlplus maja

2. ***Find the name of host machine from which the client has connected to the database.***

```
SQL> select sys_context('USERENV','HOST') from dual;

SYS_CONTEXT('USERENV','HOST')
--------------------------------------------------------------------------------
dbhost.orapassion.com
```

The name of the client host machine

3. ***Find the name of the user who logged on to the database.***

```
SQL> select sys_context('USERENV','SESSION_USER') from dual;

SYS_CONTEXT('USERENV','SESSION_USER')
--------------------------------------------------------------------------------
MAJA
```

The name of the session user

4. ***Find the name of the program used for the database session.***

```
SQL> SELECT sys_context('USERENV', 'CLIENT_PROGRAM_NAME') FROM dual;

SYS_CONTEXT('USERENV','CLIENT_PROGRAM_NAME')
--------------------------------------------------------------------------------
sqlplus@dbhost.orapassion.com (TNS V1-V3)
```

The name of the client program

5. ***Find unified audit session ID.***

```
SQL> select sys_context ('USERENV','UNIFIED_AUDIT_SESSIONID') from dual;

SYS_CONTEXT('USERENV','UNIFIED_AUDIT_SESSIONID')
--------------------------------------------------------------------------------
2303811715
```

A unified audit session ID

Creating an application context

1. ***Connect to the database as a user who has appropriate privileges (for example, user maja).***

$ sqlplus maja

2. ***Create a local application context (for example, sh_client).***

Note

The PL/SQL package that will be used to set application context attributes doesn't have to exist at this time, but you have to specify its name.

SQL> CREATE CONTEXT <context_name> USING <PL/SQL_package_name>;

```
SQL> CREATE CONTEXT sh_client USING sh_ctx_pkg;

Context created.
```

Creating an application context

Setting application context attributes

1. ***Connect to the database as a user who has appropriate privileges (for example, user maja):***

$ sqlplus maja

2. ***Create the PL/SQL package that will set the cust_id attribute with the value, which is equal to the value of the cust_id column when the following statement is evaluated: UPPER(cust_email) = (SYS_CONTEXT('USERENV', 'SESSION_USER') || '@COMPANY.EXAMPLE.COM'). In case session user is not a customer, set the value for cust_id attribute in the application context to 0.***

```
SQL> CREATE OR REPLACE PACKAGE sh_ctx_pkg IS
  2    PROCEDURE set_cust_id;
  3  END;
  4  /

Package created.

SQL> CREATE OR REPLACE PACKAGE BODY sh_ctx_pkg IS
  2    PROCEDURE set_cust_id
  3    IS
  4      v_cust_id NUMBER;
  5    BEGIN
  6      SELECT cust_id INTO v_cust_id FROM sh.customers
  7        WHERE UPPER(cust_email) = (SYS_CONTEXT('USERENV','SESSION_USER') || '@COMPANY.EXAMPLE.COM');
  8      DBMS_SESSION.SET_CONTEXT('sh_client','cust_id',v_cust_id);
  9    EXCEPTION
 10      WHEN no_data_found THEN
 11        DBMS_SESSION.SET_CONTEXT('sh_client','cust_id',0);
 12    END;
 13  END;
 14  /

Package body created.
```

Creating a PL/SQL package

3. ***Create a logon trigger that calls the sh_ctx_pkg.set_cust_id procedure.***

```
SQL> CREATE OR REPLACE TRIGGER sh_ctx_logon
  2  AFTER LOGON ON DATABASE
  3  BEGIN
  4    sh_ctx_pkg.set_cust_id();
  5  END;
  6  /

Trigger created.
```

A logon trigger

Using an application context

1. ***Connect to the database as a newly created user (for example, user sofia):***

$ sqlplus sofia

2. ***Verify that the user (for example, sofia) can access all data in the sh.customers table.***

```
SQL> SELECT COUNT(*) FROM SH.CUSTOMERS;

  COUNT(*)
----------
     55501
```

The entire data in sh.customers

3. ***Verify that when executing the following statement, he or she (for example, sofia) can view only his or her data.***

```
SQL> SELECT COUNT(*) FROM SH.CUSTOMERS
  2  WHERE cust_id = sys_context('sh_client','cust_id');

  COUNT(*)
----------
         1
```

Only data about newly created user