Oracle® Streams
Extended Examples

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Oracle Streams Extended Examples, 12*c* Release 2 (12.2)

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Primary Author: Roopesh Ashok Kumar

Contributors: Randy Urbano, Nimar Arora, Alan Downing, Thuvan Hoang, Tianshu Li, Jing Liu, Edwina Lu, Pat McElroy, Valarie Moore, Neeraj Shodhan, Jim Stamos, Byron Wang, Katherine Weill, Lik Wong, Jingwei Wu

Contents

Preface

Oracle Streams Extended Examples includes detailed examples that use Oracle Streams features.

This Preface contains these topics:

Audience

Oracle Streams Extended Examples is intended for database administrators who create and maintain Oracle Streams environments. These administrators perform one or more of the following tasks

- Plan for an Oracle Streams environment
- Configure an Oracle Streams environment
- Administer an Oracle Streams environment
- Monitor an Oracle Streams environment

To use this document, you must be familiar with relational database concepts, SQL, distributed database administration, general Oracle Streams concepts, Advanced Queuing concepts, PL/SQL, and the operating systems under which you run an Oracle Streams environment.

Documentation Accessibility

For information about Oracle's commitment to accessibility, visit the Oracle Accessibility Program website at http://www.oracle.com/pls/topic/lookup?ctx=acc&id=docacc.

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Oracle customers that have purchased support have access to electronic support through My Oracle Support. For information, visit http://www.oracle.com/pls/topic/lookup?ctx=acc&id=info or visit http://www.oracle.com/pls/topic/lookup?ctx=acc&id=trs if you are hearing impaired.

Related Documents

For more information, see these Oracle resources:

- *Oracle Streams Concepts and Administration*
- *Oracle Streams Replication Administrator's Guide*
- *Oracle Database Concepts*
- *Oracle Database Administrator's Guide*
- *Oracle Database SQL Language Reference*
- *Oracle Database PL/SQL Packages and Types Reference*
- *Oracle Database PL/SQL Language Reference*
- *Oracle Database Utilities*
- *Oracle Database Heterogeneous Connectivity User's Guide*
- Oracle Streams online Help for the Oracle Streams tool in Oracle Enterprise Manager Cloud Control

Many of the examples in this book use the sample schemas. See *Oracle Database Sample Schemas* for information about these schemas.

Conventions

The following text conventions are used in this document:

Convention	Meaning
boldface	Boldface type indicates graphical user interface elements associated with an action, or terms defined in text or the glossary.
italic	Italic type indicates book titles, emphasis, or placeholder variables for which you supply particular values.
`monospace`	Monospace type indicates commands within a paragraph, URLs, code in examples, text that appears on the screen, or text that you enter.

Changes in This Release for Oracle Streams Extended Examples

This preface contains:

Changes in Oracle Database 12*c* Release 1 (12.1)

The following are changes in *Oracle Streams Extended Examples* for Oracle Database 12*c* Release 1 (12.1).

Deprecated Features

- Oracle Streams is deprecated in Oracle Database 12*c* Release 1 (12.1). Use Oracle GoldenGate to replace all replication features of Oracle Streams.

  Oracle Streams does not support any Oracle Database features added in Oracle Database 12*c* Release 1 (12.1) or later releases.

> **Note:**
>
> Oracle Database Advanced Queuing is independent of Oracle Streams and continues to be enhanced.

> **See Also:**
>
> The Oracle GoldenGate documentation

1
Simple Single-Source Replication Example

This chapter illustrates an example of a simple single-source replication environment that can be constructed using Oracle Streams.

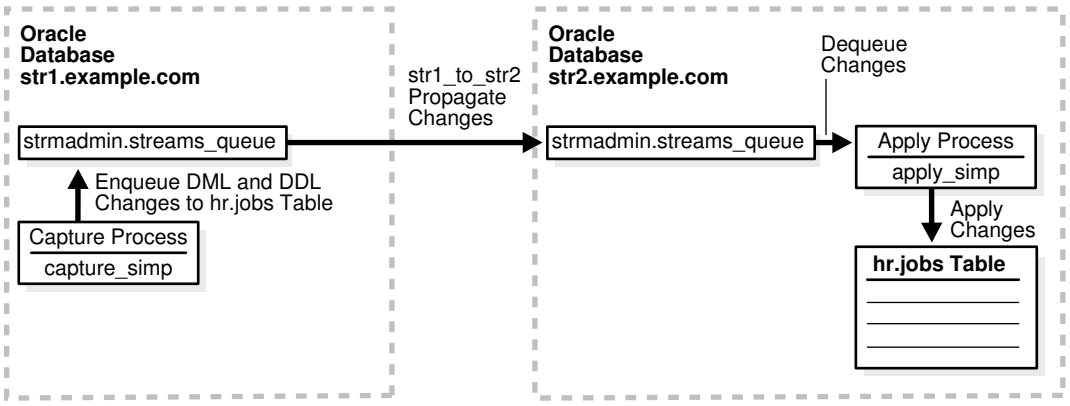
This chapter contains these topics:

1.1 Overview of the Simple Single-Source Replication Example

The example in this chapter illustrates using Oracle Streams to replicate data in one table between two databases. A capture process captures data manipulation language (DML) and data definition language (DDL) changes made to the `jobs` table in the `hr` schema at the `str1.example.com` Oracle database, and a propagation propagates these changes to the `str2.example.com` Oracle database. Next, an apply process applies these changes at the `str2.example.com` database. This example assumes that the `hr.jobs` table is read-only at the `str2.example.com` database.

Figure 1-1 provides an overview of the environment.

Figure 1-1 Simple Example that Shares Data from a Single Source Database



1.2 Prerequisites

The following prerequisites must be completed before you begin the example in this chapter.

- Set the following initialization parameters to the values indicated:
  - `GLOBAL_NAMES`: This parameter must be set to `TRUE` at each database that is participating in your Oracle Streams environment.
  - `COMPATIBLE`: This parameter must be set to `10.2.0` or higher at each database that is participating in your Oracle Streams environment.
  - `STREAMS_POOL_SIZE`: Optionally set this parameter to an appropriate value for each database in the environment. This parameter specifies the size of the Oracle Streams pool. The Oracle Streams pool stores messages in a buffered queue and is used for internal communications during parallel capture and apply. When the `MEMORY_TARGET`, `MEMORY_MAX_TARGET`, or `SGA_TARGET` initialization parameter is set to a nonzero value, the Oracle Streams pool size is managed automatically.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide* for information about other initialization parameters that are important in an Oracle Streams environment

- Any database producing changes that will be captured must be running in `ARCHIVELOG` mode. In this example, changes are produced at `str1.example.com`, and so `str1.example.com` must be running in `ARCHIVELOG` mode.

> **See Also:**
>
> *Oracle Database Administrator's Guide* for information about running a database in `ARCHIVELOG` mode

- Configure your network and Oracle Net so that the `str1.example.com` database can communicate with the `str2.example.com` database.

> **See Also:**
>
> *Oracle Database Net Services Administrator's Guide*

- Create an Oracle Streams administrator at each database in the replication environment. In this example, the databases are `str1.example.com` and `str2.example.com`. This example assumes that the user name of the Oracle Streams administrator is `strmadmin`.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide* for instructions about creating an Oracle Streams administrator

1.3 Create Queues and Database Links

Complete the following steps to create queues and database links for an Oracle Streams replication environment that includes two Oracle databases.

1. Show Output and Spool Results
2. Create the ANYDATA Queue at str1.example.com
3. Create the Database Link at str1.example.com
4. Set Up the ANYDATA Queue at str2.example.com
5. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect to all of the databases in the environment.

```
/************************ BEGINNING OF SCRIPT ******************************
```

Show Output and Spool Results
Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/

SET ECHO ON
SPOOL streams_setup_simple.out

/*
```

Create the ANYDATA Queue at str1.example.com
Connect as the Oracle Streams administrator at the database where you want to capture changes. In this example, that database is `str1.example.com`.

```
*/

CONNECT strmadmin@str1.example.com

/*
```

Run the SET_UP_QUEUE procedure to create a queue named streams_queue at str1.example.com. This queue will function as the ANYDATA queue by holding the captured changes that will be propagated to other databases.
Running the SET_UP_QUEUE procedure performs the following actions:

- Creates a queue table named streams_queue_table. This queue table is owned by the Oracle Streams administrator (strmadmin) and uses the default storage of this user.
- Creates a queue named streams_queue owned by the Oracle Streams administrator (strmadmin).
- Starts the queue.

```
*/

EXEC DBMS_STREAMS_ADM.SET_UP_QUEUE();

/*
```

Create the Database Link at str1.example.com
Create the database link from the database where changes are captured to the database where changes are propagated. In this example, the database where changes are captured is str1.example.com, and these changes are propagated to str2.example.com.

```
*/

ACCEPT password PROMPT 'Enter password for user: ' HIDE

CREATE DATABASE LINK str2.example.com CONNECT TO strmadmin
   IDENTIFIED BY &password USING 'str2.example.com';

/*
```

Set Up the ANYDATA Queue at str2.example.com
Connect as the Oracle Streams administrator at str2.example.com.

```
*/

CONNECT strmadmin@str2.example.com

/*
```

Run the SET_UP_QUEUE procedure to create a queue named streams_queue at str2.example.com. This queue will function as the ANYDATA queue by holding the changes that will be applied at this database.
Running the SET_UP_QUEUE procedure performs the following actions:

- Creates a queue table named streams_queue_table. This queue table is owned by the Oracle Streams administrator (strmadmin) and uses the default storage of this user.
- Creates a queue named streams_queue owned by the Oracle Streams administrator (strmadmin).
- Starts the queue.

```
*/

EXEC  DBMS_STREAMS_ADM.SET_UP_QUEUE();

/*
```

Check the Spool Results
Check the `streams_setup_simple.out` spool file to ensure that all actions finished successfully after this script is completed.

```
*/

SET ECHO OFF
SPOOL OFF

/************************** END OF SCRIPT ******************************/
```

1.4 Configure Capture, Propagation, and Apply for Changes to One Table

Complete the following steps to specify the capture, propagation, and apply definitions for the `hr.jobs` table using the `DBMS_STEAMS_ADM` package.

1. Show Output and Spool Results
2. Configure Propagation at str1.example.com
3. Configure the Capture Process at str1.example.com
4. Set the Instantiation SCN for the hr.jobs Table at str2.example.com
5. Configure the Apply Process at str2.example.com
6. Start the Apply Process at str2.example.com
7. Start the Capture Process at str1.example.com
8. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect to all of the databases in the environment.

```
/************************ BEGINNING OF SCRIPT ******************************
```

Show Output and Spool Results
Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/
```

```
SET ECHO ON
SPOOL streams_share_jobs.out

/*
```

Configure Propagation at str1.example.com
Connect to `str1.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@str1.example.com

/*
```

Configure and schedule propagation of DML and DDL changes to the `hr.jobs` table from the queue at `str1.example.com` to the queue at `str2.example.com`.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_PROPAGATION_RULES(
    table_name              => 'hr.jobs',
    streams_name            => 'str1_to_str2',
    source_queue_name       => 'strmadmin.streams_queue',
    destination_queue_name  => 'strmadmin.streams_queue@str2.example.com',
    include_dml             => TRUE,
    include_ddl             => TRUE,
    source_database         => 'str1.example.com',
    inclusion_rule          => TRUE,
    queue_to_queue          => TRUE);
END;
/

/*
```

Configure the Capture Process at str1.example.com
Configure the capture process to capture changes to the `hr.jobs` table at `str1.example.com`. This step specifies that changes to this table are captured by the capture process and enqueued into the specified queue.
This step also prepares the `hr.jobs` table for instantiation and enables supplemental logging for any primary key, unique key, bitmap index, and foreign key columns in this table. Supplemental logging places additional information in the redo log for changes made to tables. The apply process needs this extra information to perform certain operations, such as unique row identification and conflict resolution. Because `str1.example.com` is the only database where changes are captured in this environment, it is the only database where supplemental logging must be enabled for the `hr.jobs` table.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide*

```
*/

BEGIN
```

```
  DBMS_STREAMS_ADM.ADD_TABLE_RULES(
    table_name     => 'hr.jobs',
    streams_type   => 'capture',
    streams_name   => 'capture_simp',
    queue_name     => 'strmadmin.streams_queue',
    include_dml    => TRUE,
    include_ddl    => TRUE,
    inclusion_rule => TRUE);
END;
/

/*
```

Set the Instantiation SCN for the hr.jobs Table at str2.example.com

This example assumes that the `hr.jobs` table exists at both the `str1.example.com` database and the `str2.example.com` database, and that this table is synchronized at these databases. Because the `hr.jobs` table already exists at `str2.example.com`, this example uses the `GET_SYSTEM_CHANGE_NUMBER` function in the `DBMS_FLASHBACK` package at `str1.example.com` to obtain the current SCN for the source database. This SCN is used at `str2.example.com` to run the `SET_TABLE_INSTANTIATION_SCN` procedure in the `DBMS_APPLY_ADM` package. Running this procedure sets the instantiation SCN for the `hr.jobs` table at `str2.example.com`.

The `SET_TABLE_INSTANTIATION_SCN` procedure controls which LCRs for a table are ignored by an apply process and which LCRs for a table are applied by an apply process. If the commit SCN of an LCR for a table from a source database is less than or equal to the instantiation SCN for that table at a destination database, then the apply process at the destination database discards the LCR. Otherwise, the apply process applies the LCR.

In this example, both of the apply process at `str2.example.com` will apply transactions to the `hr.jobs` table with SCNs that were committed after SCN obtained in this step.

> **Note:**
>
> This example assumes that the contents of the `hr.jobs` table at `str1.example.com` and `str2.example.com` are consistent when you complete this step. Ensure that there is no activity on this table while the instantiation SCN is being set. You might want to lock the table at each database while you complete this step to ensure consistency. If the table does not exist at the destination database, then you can use export/import for instantiation.

```
*/

DECLARE
  iscn  NUMBER;         -- Variable to hold instantiation SCN value
BEGIN
  iscn := DBMS_FLASHBACK.GET_SYSTEM_CHANGE_NUMBER();
  DBMS_APPLY_ADM.SET_TABLE_INSTANTIATION_SCN@STR2.EXAMPLE.COM(
    source_object_name    => 'hr.jobs',
    source_database_name  => 'str1.example.com',
    instantiation_scn     => iscn);
END;
/

/*
```

Configure the Apply Process at str2.example.com
Connect to `str2.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@str2.example.com

/*
```

Configure `str2.example.com` to apply changes to the `hr.jobs` table.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_RULES(
    table_name      => 'hr.jobs',
    streams_type    => 'apply',
    streams_name    => 'apply_simp',
    queue_name      => 'strmadmin.streams_queue',
    include_dml     => TRUE,
    include_ddl     => TRUE,
    source_database => 'str1.example.com',
    inclusion_rule  => TRUE);
END;
/

/*
```

Start the Apply Process at str2.example.com
Set the `disable_on_error` parameter to `n` so that the apply process will not be disabled if it encounters an error, and start the apply process at `str2.example.com`.

```
*/

BEGIN
  DBMS_APPLY_ADM.SET_PARAMETER(
    apply_name  => 'apply_simp',
    parameter   => 'disable_on_error',
    value       => 'N');
END;
/

BEGIN
  DBMS_APPLY_ADM.START_APPLY(
    apply_name  => 'apply_simp');
END;
/

/*
```

Start the Capture Process at str1.example.com
Connect to `str1.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@str1.example.com

/*
```

Start the capture process at `str1.example.com`.

```
*/

BEGIN
  DBMS_CAPTURE_ADM.START_CAPTURE(
    capture_name  => 'capture_simp');
END;
/

/*
```

Check the Spool Results
Check the `streams_share_jobs.out` spool file to ensure that all actions finished successfully after this script is completed.

```
*/

SET ECHO OFF
SPOOL OFF

/************************** END OF SCRIPT ******************************/
```

1.5 Make Changes to the hr.jobs Table and View Results

Complete the following steps to make DML and DDL changes to the `hr.jobs` table at `str1.example.com` and then confirm that the changes were captured at `str1.example.com`, propagated from `str1.example.com` to `str2.example.com`, and applied to the `hr.jobs` table at `str2.example.com`.

Make Changes to hr.jobs at str1.example.com
Make the following changes to the `hr.jobs` table.

```
CONNECT hr@str1.example.com
Enter password: password

UPDATE hr.jobs SET max_salary=9545 WHERE job_id='PR_REP';
COMMIT;

ALTER TABLE hr.jobs ADD(duties VARCHAR2(4000));
```

Query and Describe the hr.jobs Table at str2.example.com
After some time passes to allow for capture, propagation, and apply of the changes performed in the previous step, run the following query to confirm that the `UPDATE` change was propagated and applied at `str2.example.com`:

```
CONNECT hr@str2.example.com
Enter password: password

SELECT * FROM hr.jobs WHERE job_id='PR_REP';
```

The value in the `max_salary` column should be `9545`.
Next, describe the `hr.jobs` table to confirm that the `ALTER TABLE` change was propagated and applied at `str2.example.com`:

```
DESC hr.jobs
```

The `duties` column should be the last column.

2 Single-Source Heterogeneous Replication Example

This chapter illustrates an example of a single-source heterogeneous replication environment that can be constructed using Oracle Streams, as well as the tasks required to add new objects and databases to such an environment.

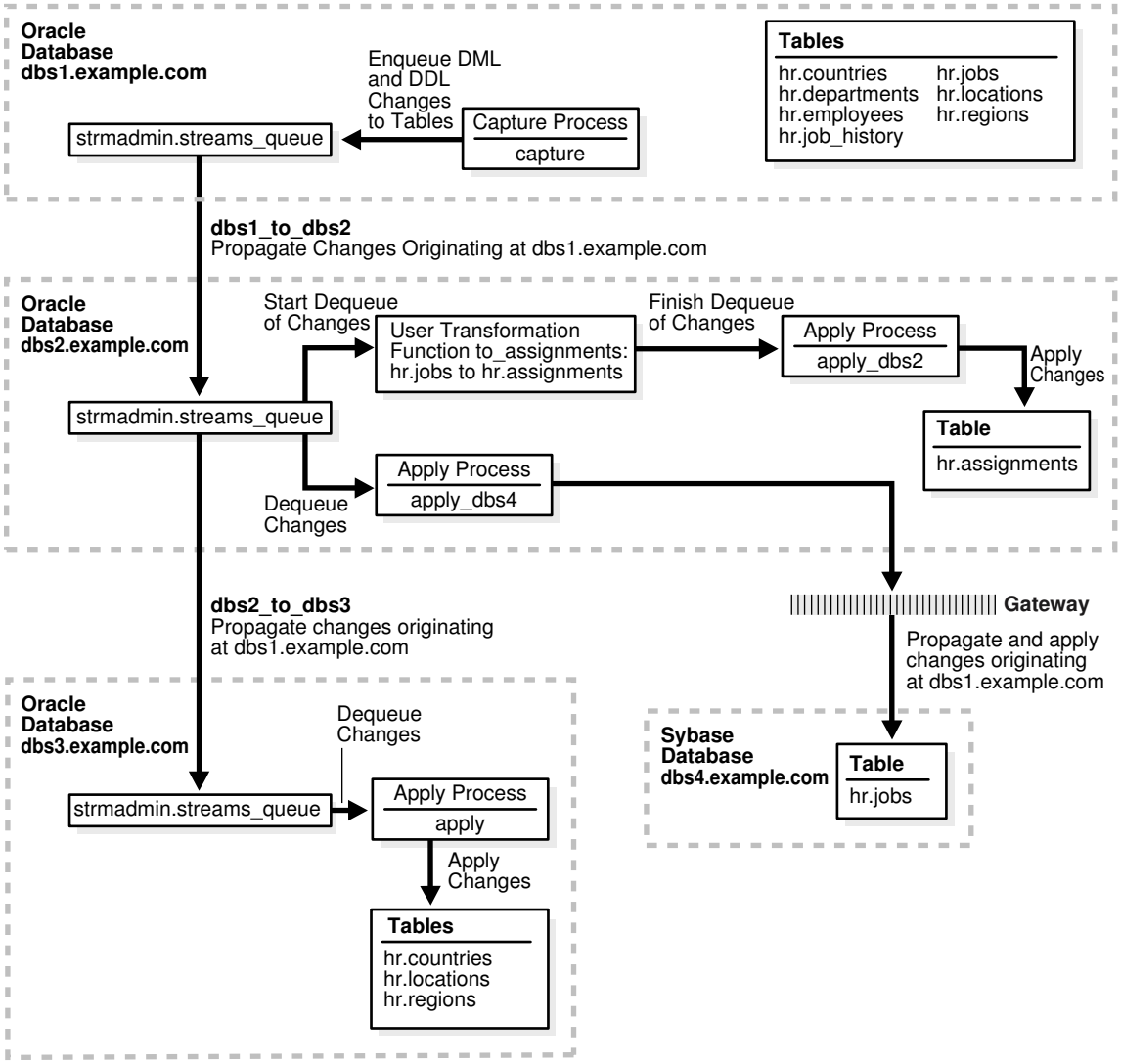
This chapter contains these topics:

2.1 Overview of the Single-Source Heterogeneous Replication Example

This example illustrates using Oracle Streams to replicate data between four databases. The environment is heterogeneous because three of the databases are Oracle databases and one is a Sybase database. DML and DDL changes made to tables in the `hr` schema at the `dbs1.example.com` Oracle database are captured and propagated to the other two Oracle databases. Only DML changes are captured and propagated to the `dbs4.example.com` database, because an apply process cannot apply DDL changes to a non-Oracle database. Changes to the `hr` schema occur only at `dbs1.example.com`. The `hr` schema is read-only at the other databases in the environment.

Figure 2-1 provides an overview of the environment.

Figure 2-1 Sample Environment that Shares Data from a Single Source Database



As illustrated in Figure 2-1, `dbs1.example.com` contains the following tables in the `hr` schema:

- `countries`
- `departments`
- `employees`
- `job_history`
- `jobs`
- `locations`
- `regions`

This example uses directed networks, which means that captured changes at a source database are propagated to another database through one or more intermediate databases. Here, the `dbs1.example.com` database propagates changes to the `dbs3.example.com` database through the intermediate database `dbs2.example.com`. This

configuration is an example of queue forwarding in a directed network. Also, the dbs1.example.com database propagates changes to the dbs2.example.com database, which applies the changes directly to the dbs4.example.com database through an Oracle Database Gateway.

Some of the databases in the environment do not have certain tables. If the database is not an intermediate database for a table and the database does not contain the table, then changes to the table do not need to be propagated to that database. For example, the departments, employees, job_history, and jobs tables do not exist at dbs3.example.com. Therefore, dbs2.example.com does not propagate changes to these tables to dbs3.example.com.

In this example, Oracle Streams is used to perform the following series of actions:

1. The capture process captures DML and DDL changes for all of the tables in the hr schema and enqueues them at the dbs1.example.com database. In this example, changes to only four of the seven tables are propagated to destination databases, but in the example that illustrates "Add Objects to an Existing Oracle Streams Replication Environment", the remaining tables in the hr schema are added to a destination database.
2. The dbs1.example.com database propagates these changes in the form of messages to a queue at dbs2.example.com.
3. At dbs2.example.com, DML changes to the jobs table are transformed into DML changes for the assignments table (which is a direct mapping of jobs) and then applied. Changes to other tables in the hr schema are not applied at dbs2.example.com.
4. Because the queue at dbs3.example.com receives changes from the queue at dbs2.example.com that originated in countries, locations, and regions tables at dbs1.example.com, these changes are propagated from dbs2.example.com to dbs3.example.com. This configuration is an example of directed networks.
5. The apply process at dbs3.example.com applies changes to the countries, locations, and regions tables.
6. Because dbs4.example.com, a Sybase database, receives changes from the queue at dbs2.example.com to the jobs table that originated at dbs1.example.com, these changes are applied remotely from dbs2.example.com using the dbs4.example.com database link through an Oracle Database Gateway. This configuration is an example of heterogeneous support.

2.2 Prerequisites

The following prerequisites must be completed before you begin the example in this chapter.

- Set the following initialization parameters to the values indicated for all databases in the environment:
  - GLOBAL_NAMES: This parameter must be set to TRUE at each database that is participating in your Oracle Streams environment.
  - COMPATIBLE: This parameter must be set to 10.2.0 or higher.
  - STREAMS_POOL_SIZE: Optionally set this parameter to an appropriate value for each database in the environment. This parameter specifies the size of the Oracle Streams pool. The Oracle Streams pool stores messages in a buffered

queue and is used for internal communications during parallel capture and apply. When the `MEMORY_TARGET`, `MEMORY_MAX_TARGET`, or `SGA_TARGET` initialization parameter is set to a nonzero value, the Oracle Streams pool size is managed automatically.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide* for information about other initialization parameters that are important in an Oracle Streams environment

- Any database producing changes that will be captured must be running in `ARCHIVELOG` mode. In this example, changes are produced at `dbs1.example.com`, and so `dbs1.example.com` must be running in `ARCHIVELOG` mode.

> **See Also:**
>
> *Oracle Database Administrator's Guide* for information about running a database in `ARCHIVELOG` mode

- Configure an Oracle Database Gateway on `dbs2.example.com` to communicate with the Sybase database `dbs4.example.com`.

> **See Also:**
>
> *Oracle Database Heterogeneous Connectivity User's Guide*

- At the Sybase database `dbs4.example.com`, set up the `hr` user.

> **See Also:**
>
> Your Sybase documentation for information about creating users and tables in your Sybase database

- Instantiate the `hr.jobs` table from the `dbs1.example.com` Oracle database at the `dbs4.example.com` Sybase database.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide*

- Configure your network and Oracle Net so that the following databases can communicate with each other:
  - `dbs1.example.com` and `dbs2.example.com`
  - `dbs2.example.com` and `dbs3.example.com`

  - `dbs2.example.com` and `dbs4.example.com`
  - `dbs3.example.com` and `dbs1.example.com` (for optional Data Pump network instantiation)

> **See Also:**
>
> *Oracle Database Net Services Administrator's Guide*

- Create an Oracle Streams administrator at each Oracle database in the replication environment. In this example, the databases are `dbs1.example.com`, `dbs2.example.com`, and `dbs3.example.com`. This example assumes that the user name of the Oracle Streams administrator is `strmadmin`.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide* for instructions about creating an Oracle Streams administrator

2.3 Create Queues and Database Links

Complete the following steps to create queues and database links for an Oracle Streams replication environment that includes three Oracle databases and one Sybase database:

1. Show Output and Spool Results
2. Create the ANYDATA Queue at dbs1.example.com
3. Create the Database Link at dbs1.example.com
4. Create the ANYDATA Queue at dbs2.example.com
5. Create the Database Links at dbs2.example.com
6. Create the hr.assignments Table at dbs2.example.com
7. Create the ANYDATA Queue at dbs3.example.com
8. Create the Database Links at dbs2.example.com
9. Drop All of the Tables in the hr Schema at dbs3.example.com
10. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect to all of the databases in the environment.

```
/************************ BEGINNING OF SCRIPT ****************************
```

Show Output and Spool Results
Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/

SET ECHO ON
SPOOL streams_setup_single.out

/*
```

Create the ANYDATA Queue at dbs1.example.com
Connect as the Oracle Streams administrator at the database where you want to capture changes. In this example, that database is `dbs1.example.com`.

```
*/

CONNECT strmadmin@dbs1.example.com

/*
```

Run the `SET_UP_QUEUE` procedure to create a queue named `streams_queue` at `dbs1.example.com`. This queue will function as the `ANYDATA` queue by holding the captured changes that will be propagated to other databases.
Running the `SET_UP_QUEUE` procedure performs the following actions:

- Creates a queue table named `streams_queue_table`. This queue table is owned by the Oracle Streams administrator (`strmadmin`) and uses the default storage of this user.
- Creates a queue named `streams_queue` owned by the Oracle Streams administrator (`strmadmin`).
- Starts the queue.

```
*/

EXEC DBMS_STREAMS_ADM.SET_UP_QUEUE();

/*
```

Create the Database Link at dbs1.example.com
Create the database link from the database where changes are captured to the database where changes are propagated. In this example, the database where changes are captured is `dbs1.example.com`, and these changes are propagated to `dbs2.example.com`.

```
*/

ACCEPT password PROMPT 'Enter password for user: ' HIDE

CREATE DATABASE LINK dbs2.example.com CONNECT TO strmadmin
   IDENTIFIED BY &password USING 'dbs2.example.com';

/*
```

Create the ANYDATA Queue at dbs2.example.com
Connect as the Oracle Streams administrator at `dbs2.example.com`.

```
*/

CONNECT strmadmin@dbs2.example.com

/*
```

Run the `SET_UP_QUEUE` procedure to create a queue named `streams_queue` at `dbs2.example.com`. This queue will function as the `ANYDATA` queue by holding the changes that will be applied at this database and the changes that will be propagated to other databases.
Running the `SET_UP_QUEUE` procedure performs the following actions:

- Creates a queue table named `streams_queue_table`. This queue table is owned by the Oracle Streams administrator (`strmadmin`) and uses the default storage of this user.
- Creates a queue named `streams_queue` owned by the Oracle Streams administrator (`strmadmin`).
- Starts the queue.

```
*/

EXEC  DBMS_STREAMS_ADM.SET_UP_QUEUE();

/*
```

Create the Database Links at dbs2.example.com
Create the database links to the databases where changes are propagated. In this example, database `dbs2.example.com` propagates changes to `dbs3.example.com`, which is another Oracle database, and to `dbs4.example.com`, which is a Sybase database. Notice that the database link to the Sybase database connects to the owner of the tables, not to the Oracle Streams administrator. This database link can connect to any user at `dbs4.example.com` that has privileges to change the `hr.jobs` table at that database.

> **Note:**
>
> On some non-Oracle databases, including Sybase, you must ensure that the characters in the user name and password are in the correct case. Therefore, double quotation marks are specified for the user name and password at the Sybase database.

```
*/

CREATE DATABASE LINK dbs3.example.com CONNECT TO strmadmin
   IDENTIFIED BY &password USING 'dbs3.example.com';

CREATE DATABASE LINK dbs4.example.com CONNECT TO "hr"
   IDENTIFIED BY "&password" USING 'dbs4.example.com';

/*
```

Create the hr.assignments Table at dbs2.example.com
This example illustrates a custom rule-based transformation in which changes to the `hr.jobs` table at `dbs1.example.com` are transformed into changes to the `hr.assignments`

table at dbs2.example.com. You must create the hr.assignments table on dbs2.example.com for the transformation portion of this example to work properly.

> **Note:**
>
> Instead of using a custom rule-based transformation to change the name of the table, you can use a RENAME_TABLE declarative rule-based transformation. See *Oracle Streams Concepts and Administration*.

Connect as hr at dbs2.example.com.

```
*/

CONNECT hr@dbs2.example.com

/*
```

Create the hr.assignments table in the dbs2.example.com database.

```
*/

CREATE TABLE hr.assignments AS SELECT * FROM hr.jobs;

ALTER TABLE hr.assignments ADD PRIMARY KEY (job_id);

/*
```

Create the ANYDATA Queue at dbs3.example.com
Connect as the Oracle Streams administrator at dbs3.example.com.

```
*/

CONNECT strmadmin@dbs3.example.com

/*
```

Run the SET_UP_QUEUE procedure to create a queue named streams_queue at dbs3.example.com. This queue will function as the ANYDATA queue by holding the changes that will be applied at this database.
Running the SET_UP_QUEUE procedure performs the following actions:

- Creates a queue table named streams_queue_table. This queue table is owned by the Oracle Streams administrator (strmadmin) and uses the default storage of this user.
- Creates a queue named streams_queue owned by the Oracle Streams administrator (strmadmin).
- Starts the queue.

```
*/

EXEC  DBMS_STREAMS_ADM.SET_UP_QUEUE();

/*
```

Create a Database Link at dbs3.example.com to dbs1.example.com
Create a database link from `dbs3.example.com` to `dbs1.example.com`. Later in this example, this database link is used for the instantiation of some of the database objects that were dropped in Step Drop All of the Tables in the hr Schema at dbs3.example.com. This example uses the `DBMS_DATAPUMP` package to perform a network import of these database objects directly from the `dbs1.example.com` database. Because this example performs a network import, no dump file is required. Alternatively, you can perform an export at the source database `dbs1.example.com`, transfer the export dump file to the destination database `dbs3.example.com`, and then import the export dump file at the destination database. In this case, the database link created in this step is not required.

```
*/

CREATE DATABASE LINK dbs1.example.com CONNECT TO strmadmin
   IDENTIFIED BY &password USING 'dbs1.example.com';

/*
```

Drop All of the Tables in the hr Schema at dbs3.example.com
This example illustrates instantiating tables in the `hr` schema by importing them from `dbs1.example.com` into `dbs3.example.com` with Data Pump. You must delete these tables at `dbs3.example.com` for the instantiation portion of this example to work properly. Connect as `hr` at `dbs3.example.com`.

```
*/

CONNECT hr@dbs3.example.com

/*
```

Drop all tables in the `hr` schema in the `dbs3.example.com` database.

> **Note:**
>
> If you complete this step and drop all of the tables in the `hr` schema, then you should complete the remaining sections of this example to reinstantiate the `hr` schema at `dbs3.example.com`. If the `hr` schema does not exist in an Oracle database, then some examples in the Oracle documentation set can fail.

```
*/

DROP TABLE hr.countries CASCADE CONSTRAINTS;
DROP TABLE hr.departments CASCADE CONSTRAINTS;
DROP TABLE hr.employees CASCADE CONSTRAINTS;
DROP TABLE hr.job_history CASCADE CONSTRAINTS;
DROP TABLE hr.jobs CASCADE CONSTRAINTS;
DROP TABLE hr.locations CASCADE CONSTRAINTS;
DROP TABLE hr.regions CASCADE CONSTRAINTS;

/*
```

Check the Spool Results
Check the `streams_setup_single.out` spool file to ensure that all actions finished successfully after this script is completed.

```
*/

SET ECHO OFF
SPOOL OFF

/************************** END OF SCRIPT ****************************/
```

2.4 Example Scripts for Sharing Data from One Database

This example illustrates two ways to accomplish the replication of the tables in the `hr` schema using Oracle Streams.

- "Simple Configuration for Sharing Data from a Single Database" demonstrates a simple way to configure the environment. This example uses the `DBMS_STREAMS_ADM` package to create a capture process, propagations, and apply processes, as well as the rule sets associated with them. Using the `DBMS_STREAMS_ADM` package is the simplest way to configure an Oracle Streams environment.
- "Flexible Configuration for Sharing Data from a Single Database" demonstrates a more flexible way to configure this environment. This example uses the `DBMS_CAPTURE_ADM` package to create a capture process, the `DBMS_PROPAGATION_ADM` package to create propagations, and the `DBMS_APPLY_ADM` package to create apply processes. Also, this example uses the `DBMS_RULES_ADM` package to create and populate the rule sets associated with these capture processes, propagations, and apply processes. Using these packages, instead of the `DBMS_STREAMS_ADM` package, provides more configuration options and flexibility.

> **Note:**
>
> These examples illustrate two different ways to configure the same Oracle Streams environment. Therefore, you should run only one of the examples for a particular distributed database system. Otherwise, errors stating that objects already exist will result.

2.4.1 Simple Configuration for Sharing Data from a Single Database

Complete the following steps to specify the capture, propagation, and apply definitions using primarily the `DBMS_STEAMS_ADM` package.

1. Show Output and Spool Results
2. Configure Propagation at dbs1.example.com
3. Configure the Capture Process at dbs1.example.com
4. Set the Instantiation SCN for the Existing Tables at Other Databases
5. Instantiate the dbs1.example.com Tables at dbs3.example.com
6. Configure the Apply Process at dbs3.example.com
7. Specify hr as the Apply User for the Apply Process at dbs3.example.com
8. Grant the hr User Execute Privilege on the Apply Process Rule Set
9. Start the Apply Process at dbs3.example.com
10. Configure Propagation at dbs2.example.com

11. Create the Custom Rule-Based Transformation for Row LCRs at dbs2.example.com
12. Configure the Apply Process for Local Apply at dbs2.example.com
13. Specify hr as the Apply User for the Apply Process at dbs2.example.com
14. Grant the hr User Execute Privilege on the Apply Process Rule Set
15. Start the Apply Process at dbs2.example.com for Local Apply
16. Configure the Apply Process at dbs2.example.com for Apply at dbs4.example.com
17. Start the Apply Process at dbs2.example.com for Apply at dbs4.example.com
18. Start the Capture Process at dbs1.example.com
19. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect to all of the databases in the environment.

```
/************************ BEGINNING OF SCRIPT ******************************
```

Show Output and Spool Results
Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/

SET ECHO ON
SPOOL streams_share_schema1.out

/*
```

Configure Propagation at dbs1.example.com
Connect to `dbs1.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@dbs1.example.com

/*
```

Configure and schedule propagation of DML and DDL changes in the `hr` schema from the queue at `dbs1.example.com` to the queue at `dbs2.example.com`.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_PROPAGATION_RULES(
    schema_name             => 'hr',
```

```
    streams_name            => 'dbs1_to_dbs2',
    source_queue_name       => 'strmadmin.streams_queue',
    destination_queue_name  => 'strmadmin.streams_queue@dbs2.example.com',
    include_dml             => TRUE,
    include_ddl             => TRUE,
    source_database         => 'dbs1.example.com',
    inclusion_rule          => TRUE,
    queue_to_queue          => TRUE);
END;
/

/*
```

Configure the Capture Process at dbs1.example.com

Configure the capture process to capture changes to the entire `hr` schema at `dbs1.example.com`. This step specifies that changes to the tables in the specified schema are captured by the capture process and enqueued into the specified queue. This step also prepares the `hr` schema for instantiation and enables supplemental logging for any primary key, unique key, bitmap index, and foreign key columns in the tables in this schema. Supplemental logging places additional information in the redo log for changes made to tables. The apply process needs this extra information to perform certain operations, such as unique row identification and conflict resolution. Because `dbs1.example.com` is the only database where changes are captured in this environment, it is the only database where you must specify supplemental logging for the tables in the `hr` schema.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide*

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_RULES(
    schema_name    => 'hr',
    streams_type   => 'capture',
    streams_name   => 'capture',
    queue_name     => 'strmadmin.streams_queue',
    include_dml    => TRUE,
    include_ddl    => TRUE,
    inclusion_rule => TRUE);
END;
/

/*
```

Set the Instantiation SCN for the Existing Tables at Other Databases

In this example, the `hr.jobs` table already exists at `dbs2.example.com` and `dbs4.example.com`. At `dbs2.example.com`, this table is named `assignments`, but it has the same shape and data as the `jobs` table at `dbs1.example.com`. Also, in this example, `dbs4.example.com` is a Sybase database. All of the other tables in the Oracle Streams environment are instantiated at the other destination databases using Data Pump import.

Because the `hr.jobs` table already exists at `dbs2.example.com` and `dbs4.example.com`, this example uses the `GET_SYSTEM_CHANGE_NUMBER` function in the `DBMS_FLASHBACK`

package at dbs1.example.com to obtain the current SCN for the database. This SCN is used at dbs2.example.com to run the SET_TABLE_INSTANTIATION_SCN procedure in the DBMS_APPLY_ADM package. Running this procedure twice sets the instantiation SCN for the hr.jobs table at dbs2.example.com and dbs4.example.com.
The SET_TABLE_INSTANTIATION_SCN procedure controls which LCRs for a table are ignored by an apply process and which LCRs for a table are applied by an apply process. If the commit SCN of an LCR for a table from a source database is less than or equal to the instantiation SCN for that table at a destination database, then the apply process at the destination database discards the LCR. Otherwise, the apply process applies the LCR.
In this example, both of the apply processes at dbs2.example.com will apply transactions to the hr.jobs table with SCNs that were committed after SCN obtained in this step.

> **Note:**
>
> This example assumes that the contents of the hr.jobs table at dbs1.example.com, dbs2.example.com (as hr.assignments), and dbs4.example.com are consistent when you complete this step. You might want to lock the table at each database while you complete this step to ensure consistency.

```
*/

DECLARE
  iscn  NUMBER;         -- Variable to hold instantiation SCN value
BEGIN
  iscn := DBMS_FLASHBACK.GET_SYSTEM_CHANGE_NUMBER();
  DBMS_APPLY_ADM.SET_TABLE_INSTANTIATION_SCN@DBS2.EXAMPLE.COM(
    source_object_name    => 'hr.jobs',
    source_database_name  => 'dbs1.example.com',
    instantiation_scn     => iscn);
  DBMS_APPLY_ADM.SET_TABLE_INSTANTIATION_SCN@DBS2.EXAMPLE.COM(
    source_object_name    => 'hr.jobs',
    source_database_name  => 'dbs1.example.com',
    instantiation_scn     => iscn,
    apply_database_link   => 'dbs4.example.com');
END;
/

/*
```

Instantiate the dbs1.example.com Tables at dbs3.example.com
This example performs a network Data Pump import of the following tables:

- hr.countries
- hr.locations
- hr.regions

A network import means that Data Pump imports these tables from dbs1.example.com without using an export dump file.

> **See Also:**
>
> *Oracle Database Utilities* for information about performing an import

Connect to `dbs3.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@dbs3.example.com

/*
```

This example will do a table import using the `DBMS_DATAPUMP` package. For simplicity, exceptions from any of the API calls will not be trapped. However, Oracle recommends that you define exception handlers and call `GET_STATUS` to retrieve more detailed error information if a failure occurs. If you want to monitor the import, then query the `DBA_DATAPUMP_JOBS` data dictionary view at the import database.

```
*/

SET SERVEROUTPUT ON
DECLARE
  h1        NUMBER;         -- Data Pump job handle
  sscn      NUMBER;         -- Variable to hold current source SCN
  job_state VARCHAR2(30);   -- To keep track of job state
  js        ku$_JobStatus;  -- The job status from GET_STATUS
  sts       ku$_Status;     -- The status object returned by GET_STATUS
  job_not_exist    exception;
  pragma exception_init(job_not_exist, -31626);
BEGIN
-- Create a (user-named) Data Pump job to do a table-level import.
  h1 := DBMS_DATAPUMP.OPEN(
          operation   => 'IMPORT',
          job_mode    => 'TABLE',
          remote_link => 'DBS1.EXAMPLE.COM',
          job_name    => 'dp_sing1');
-- A metadata filter is used to specify the schema that owns the tables
-- that will be imported.
  DBMS_DATAPUMP.METADATA_FILTER(
    handle    => h1,
    name      => 'SCHEMA_EXPR',
    value     => '=''HR''');
-- A metadata filter is used to specify the tables that will be imported.
  DBMS_DATAPUMP.METADATA_FILTER(
    handle    => h1,
    name      => 'NAME_EXPR',
    value     => 'IN(''COUNTRIES'', ''REGIONS'', ''LOCATIONS'')');
-- Get the current SCN of the source database, and set the FLASHBACK_SCN
-- parameter to this value to ensure consistency between all of the
-- objects included in the import.
  sscn := DBMS_FLASHBACK.GET_SYSTEM_CHANGE_NUMBER@dbs1.example.com();
  DBMS_DATAPUMP.SET_PARAMETER(
    handle => h1,
    name   => 'FLASHBACK_SCN',
    value  => sscn);
-- Start the job.
  DBMS_DATAPUMP.START_JOB(h1);
```

```
-- The import job should be running. In the following loop, the job
-- is monitored until it completes.
  job_state := 'UNDEFINED';
  BEGIN
    WHILE (job_state != 'COMPLETED') AND (job_state != 'STOPPED') LOOP
      sts:=DBMS_DATAPUMP.GET_STATUS(
             handle  => h1,
             mask    => DBMS_DATAPUMP.KU$_STATUS_JOB_ERROR +
                        DBMS_DATAPUMP.KU$_STATUS_JOB_STATUS +
                        DBMS_DATAPUMP.KU$_STATUS_WIP,
             timeout => -1);
      js := sts.job_status;
      DBMS_LOCK.SLEEP(10);
      job_state := js.state;
    END LOOP;
  -- Gets an exception when job no longer exists
    EXCEPTION WHEN job_not_exist THEN
      DBMS_OUTPUT.PUT_LINE('Data Pump job has completed');
      DBMS_OUTPUT.PUT_LINE('Instantiation SCN: ' ||sscn);
  END;
END;
/

/*
```

Configure the Apply Process at dbs3.example.com

Connect to `dbs3.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@dbs3.example.com

/*
```

Configure `dbs3.example.com` to apply changes to the `countries` table, `locations` table, and `regions` table.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_RULES(
    table_name      => 'hr.countries',
    streams_type    => 'apply',
    streams_name    => 'apply',
    queue_name      => 'strmadmin.streams_queue',
    include_dml     => TRUE,
    include_ddl     => TRUE,
    source_database => 'dbs1.example.com',
    inclusion_rule  => TRUE);
END;
/

BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_RULES(
    table_name      => 'hr.locations',
    streams_type    => 'apply',
    streams_name    => 'apply',
    queue_name      => 'strmadmin.streams_queue',
    include_dml     => TRUE,
```

```
    include_ddl     => TRUE,
    source_database => 'dbs1.example.com',
    inclusion_rule  => TRUE);
END;
/

BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_RULES(
    table_name      => 'hr.regions',
    streams_type    => 'apply',
    streams_name    => 'apply',
    queue_name      => 'strmadmin.streams_queue',
    include_dml     => TRUE,
    include_ddl     => TRUE,
    source_database => 'dbs1.example.com',
    inclusion_rule  => TRUE);
END;
/

/*
```

Specify hr as the Apply User for the Apply Process at dbs3.example.com
In this example, the `hr` user owns all of the database objects for which changes are applied by the apply process at this database. Therefore, `hr` already has the necessary privileges to change these database objects, and it is convenient to make `hr` the apply user.
When the apply process was created in the previous step, the Oracle Streams administrator `strmadmin` was specified as the apply user by default, because `strmadmin` ran the procedure that created the apply process. Instead of specifying hr as the apply user, you could retain `strmadmin` as the apply user, but then you must grant `strmadmin` privileges on all of the database objects for which changes are applied and privileges to execute all user procedures used by the apply process. In an environment where an apply process applies changes to database objects in multiple schemas, it might be more convenient to use the Oracle Streams administrator as the apply user.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide* for more information about configuring an Oracle Streams administrator

```
*/

BEGIN
  DBMS_APPLY_ADM.ALTER_APPLY(
    apply_name => 'apply',
    apply_user => 'hr');
END;
/

/*
```

Grant the hr User Execute Privilege on the Apply Process Rule Set
Because the `hr` user was specified as the apply user in the previous step, the `hr` user requires `EXECUTE` privilege on the positive rule set used by the apply process

```
*/

DECLARE
   rs_name  VARCHAR2(64);   -- Variable to hold rule set name
BEGIN
  SELECT RULE_SET_OWNER||'.'||RULE_SET_NAME
    INTO rs_name
    FROM DBA_APPLY
    WHERE APPLY_NAME='APPLY';
  DBMS_RULE_ADM.GRANT_OBJECT_PRIVILEGE(
    privilege   => SYS.DBMS_RULE_ADM.EXECUTE_ON_RULE_SET,
    object_name => rs_name,
    grantee     => 'hr');
END;
/

/*
```

Start the Apply Process at dbs3.example.com

Set the `disable_on_error` parameter to `n` so that the apply process will not be disabled if it encounters an error, and start the apply process at `dbs3.example.com`.

```
*/

BEGIN
  DBMS_APPLY_ADM.SET_PARAMETER(
    apply_name  => 'apply',
    parameter   => 'disable_on_error',
    value       => 'N');
END;
/

BEGIN
  DBMS_APPLY_ADM.START_APPLY(
    apply_name  => 'apply');
END;
/

/*
```

Configure Propagation at dbs2.example.com

Connect to `dbs2.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@dbs2.example.com

/*
```

Configure and schedule propagation from the queue at `dbs2.example.com` to the queue at `dbs3.example.com`. You must specify this propagation for each table that will apply changes at `dbs3.example.com`. This configuration is an example of directed networks because the changes at `dbs2.example.com` originated at `dbs1.example.com`.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_PROPAGATION_RULES(
    table_name               => 'hr.countries',
```

```
    streams_name             => 'dbs2_to_dbs3',
    source_queue_name        => 'strmadmin.streams_queue',
    destination_queue_name   => 'strmadmin.streams_queue@dbs3.example.com',
    include_dml              => TRUE,
    include_ddl              => TRUE,
    source_database          => 'dbs1.example.com',
    inclusion_rule           => TRUE,
    queue_to_queue           => TRUE);
END;
/

BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_PROPAGATION_RULES(
    table_name               => 'hr.locations',
    streams_name             => 'dbs2_to_dbs3',
    source_queue_name        => 'strmadmin.streams_queue',
    destination_queue_name   => 'strmadmin.streams_queue@dbs3.example.com',
    include_dml              => TRUE,
    include_ddl              => TRUE,
    source_database          => 'dbs1.example.com',
    inclusion_rule           => TRUE);
END;
/

BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_PROPAGATION_RULES(
    table_name               => 'hr.regions',
    streams_name             => 'dbs2_to_dbs3',
    source_queue_name        => 'strmadmin.streams_queue',
    destination_queue_name   => 'strmadmin.streams_queue@dbs3.example.com',
    include_dml              => TRUE,
    include_ddl              => TRUE,
    source_database          => 'dbs1.example.com',
    inclusion_rule           => TRUE);
END;
/

/*
```

Create the Custom Rule-Based Transformation for Row LCRs at dbs2.example.com

Connect to `dbs2.example.com` as the `hr` user.

```
*/

CONNECT hr@dbs2.example.com

/*
```

Create the custom rule-based transformation function that transforms row changes resulting from DML statements to the `jobs` table from `dbs1.example.com` into row changes to the `assignments` table on `dbs2.example.com`.
The following function transforms every row LCR for the `jobs` table into a row LCR for the `assignments` table.

> **Note:**
>
> If DDL changes were also applied to the `assignments` table, then another transformation would be required for the DDL LCRs. This transformation would need to change the object name and the DDL text.

```
*/

CREATE OR REPLACE FUNCTION hr.to_assignments_trans_dml(
  p_in_data in ANYDATA)
  RETURN ANYDATA IS out_data SYS.LCR$_ROW_RECORD;
  tc   pls_integer;
BEGIN
  -- Typecast AnyData to LCR$_ROW_RECORD
     tc := p_in_data.GetObject(out_data);
     IF out_data.GET_OBJECT_NAME() = 'JOBS'
     THEN
  -- Transform the in_data into the out_data
     out_data.SET_OBJECT_NAME('ASSIGNMENTS');
     END IF;
  -- Convert to AnyData
     RETURN ANYDATA.ConvertObject(out_data);
END;
/

/*
```

Configure the Apply Process for Local Apply at dbs2.example.com
Connect to `dbs2.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@dbs2.example.com

/*
```

Configure `dbs2.example.com` to apply changes to the `assignments` table. Remember that the `assignments` table receives changes from the `jobs` table at `dbs1.example.com`.

```
*/

DECLARE
  to_assignments_rulename_dml   VARCHAR2(30);
  dummy_rule                    VARCHAR2(30);
BEGIN
--  DML changes to the jobs table from dbs1.example.com are applied
--  to the assignments table. The to_assignments_rulename_dml variable
--  is an out parameter in this call.
  DBMS_STREAMS_ADM.ADD_TABLE_RULES(
    table_name      => 'hr.jobs', -- jobs, not assignments, specified
    streams_type    => 'apply',
    streams_name    => 'apply_dbs2',
    queue_name      => 'strmadmin.streams_queue',
    include_dml     => TRUE,
    include_ddl     => FALSE,
    source_database => 'dbs1.example.com',
    dml_rule_name   => to_assignments_rulename_dml,
```

```
    ddl_rule_name   => dummy_rule,
    inclusion_rule  => TRUE);
--  Modify the rule for the hr.jobs table to use the transformation function.
  DBMS_STREAMS_ADM.SET_RULE_TRANSFORM_FUNCTION(
    rule_name          => to_assignments_rulename_dml,
    transform_function => 'hr.to_assignments_trans_dml');
END;
/

/*
```

Specify hr as the Apply User for the Apply Process at dbs2.example.com
In this example, the `hr` user owns all of the database objects for which changes are applied by the apply process at this database. Therefore, `hr` already has the necessary privileges to change these database objects, and it is convenient to make `hr` the apply user.
When the apply process was created in the previous step, the Oracle Streams administrator `strmadmin` was specified as the apply user by default, because `strmadmin` ran the procedure that created the apply process. Instead of specifying hr as the apply user, you could retain `strmadmin` as the apply user, but then you must grant `strmadmin` privileges on all of the database objects for which changes are applied and privileges to execute all user procedures used by the apply process. In an environment where an apply process applies changes to database objects in multiple schemas, it might be more convenient to use the Oracle Streams administrator as the apply user.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide* for more information about configuring an Oracle Streams administrator

```
*/

BEGIN
  DBMS_APPLY_ADM.ALTER_APPLY(
    apply_name => 'apply_dbs2',
    apply_user => 'hr');
END;
/

/*
```

Grant the hr User Execute Privilege on the Apply Process Rule Set
Because the `hr` user was specified as the apply user in the previous step, the `hr` user requires `EXECUTE` privilege on the positive rule set used by the apply process

```
*/

DECLARE
   rs_name  VARCHAR2(64);   -- Variable to hold rule set name
BEGIN
  SELECT RULE_SET_OWNER||'.'||RULE_SET_NAME
    INTO rs_name
    FROM DBA_APPLY
    WHERE APPLY_NAME='APPLY_DBS2';
  DBMS_RULE_ADM.GRANT_OBJECT_PRIVILEGE(
```

```
    privilege   => SYS.DBMS_RULE_ADM.EXECUTE_ON_RULE_SET,
    object_name => rs_name,
    grantee     => 'hr');
END;
/

/*
```

Start the Apply Process at dbs2.example.com for Local Apply

Set the `disable_on_error` parameter to `n` so that the apply process will not be disabled if it encounters an error, and start the apply process for local apply at `dbs2.example.com`.

```
*/

BEGIN
  DBMS_APPLY_ADM.SET_PARAMETER(
    apply_name  => 'apply_dbs2',
    parameter   => 'disable_on_error',
    value       => 'N');
END;
/

BEGIN
  DBMS_APPLY_ADM.START_APPLY(
    apply_name  => 'apply_dbs2');
END;
/

/*
```

Configure the Apply Process at dbs2.example.com for Apply at dbs4.example.com

Configure the apply process for `dbs4.example.com`, which is a Sybase database. The `dbs2.example.com` database is acting as a gateway to `dbs4.example.com`. Therefore, the apply process for `dbs4.example.com` must be configured at `dbs2.example.com`. The apply process cannot apply DDL changes to non-Oracle databases. Therefore, the `include_ddl` parameter is set to `FALSE` when the `ADD_TABLE_RULES` procedure is run.

```
*/

BEGIN
  DBMS_APPLY_ADM.CREATE_APPLY(
    queue_name          => 'strmadmin.streams_queue',
    apply_name          => 'apply_dbs4',
    apply_database_link => 'dbs4.example.com',
    apply_captured      => TRUE);
END;
/

BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_RULES(
    table_name      => 'hr.jobs',
    streams_type    => 'apply',
    streams_name    => 'apply_dbs4',
    queue_name      => 'strmadmin.streams_queue',
    include_dml     => TRUE,
    include_ddl     => FALSE,
    source_database => 'dbs1.example.com',
```

```
    inclusion_rule  => TRUE);
END;
/

/*
```

Start the Apply Process at dbs2.example.com for Apply at dbs4.example.com
Set the `disable_on_error` parameter to `n` so that the apply process will not be disabled if it encounters an error, and start the remote apply for Sybase using database link `dbs4.example.com`.

```
*/

BEGIN
  DBMS_APPLY_ADM.SET_PARAMETER(
    apply_name  => 'apply_dbs4',
    parameter   => 'disable_on_error',
    value       => 'N');
END;
/

BEGIN
  DBMS_APPLY_ADM.START_APPLY(
    apply_name  => 'apply_dbs4');
END;
/

/*
```

Start the Capture Process at dbs1.example.com
Connect to `dbs1.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@dbs1.example.com

/*
```

Start the capture process at `dbs1.example.com`.

```
*/

BEGIN
  DBMS_CAPTURE_ADM.START_CAPTURE(
    capture_name  => 'capture');
END;
/

/*
```

Check the Spool Results
Check the `streams_share_schema1.out` spool file to ensure that all actions finished successfully after this script is completed.

```
*/

SET ECHO OFF
SPOOL OFF

/*
```

You can now make DML and DDL changes to specific tables at `dbs1.example.com` and see these changes replicated to the other databases in the environment based on the rules you configured for the Oracle Streams processes and propagations in this environment.

> **See Also:**
>
> "Make DML and DDL Changes to Tables in the hr Schema" for examples of changes that are replicated in this environment

```
/************************* END OF SCRIPT ****************************/
```

2.4.2 Flexible Configuration for Sharing Data from a Single Database

Complete the following steps to use a more flexible approach for specifying the capture, propagation, and apply definitions. This approach does not use the `DBMS_STREAMS_ADM` package. Instead, it uses the following packages:

- The `DBMS_CAPTURE_ADM` package to configure capture processes
- The `DBMS_PROPAGATION_ADM` package to configure propagations
- The `DBMS_APPLY_ADM` package to configure apply processes
- The `DBMS_RULES_ADM` package to specify capture process, propagation, and apply process rules and rule sets

> **Note:**
>
> Neither the `ALL_STREAMS_TABLE_RULES` nor the `DBA_STREAMS_TABLE_RULES` data dictionary view is populated by the rules created in this example. To view the rules created in this example, you can query the `ALL_STREAMS_RULES` or `DBA_STREAMS_RULES` data dictionary view.

This example includes the following steps:

1. Show Output and Spool Results
2. Configure Propagation at dbs1.example.com
3. Configure the Capture Process at dbs1.example.com
4. Prepare the hr Schema at dbs1.example.com for Instantiation
5. Set the Instantiation SCN for the Existing Tables at Other Databases
6. Instantiate the dbs1.example.com Tables at dbs3.example.com
7. Configure the Apply Process at dbs3.example.com
8. Grant the hr User Execute Privilege on the Apply Process Rule Set
9. Start the Apply Process at dbs3.example.com
10. Configure Propagation at dbs2.example.com
11. Create the Custom Rule-Based Transformation for Row LCRs at dbs2.example.com

12. Configure the Apply Process for Local Apply at dbs2.example.com
13. Grant the hr User Execute Privilege on the Apply Process Rule Set
14. Start the Apply Process at dbs2.example.com for Local Apply
15. Configure the Apply Process at dbs2.example.com for Apply at dbs4.example.com
16. Start the Apply Process at dbs2.example.com for Apply at dbs4.example.com
17. Start the Capture Process at dbs1.example.com
18. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect to all of the databases in the environment.

```
/************************ BEGINNING OF SCRIPT ******************************
```

Show Output and Spool Results
Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/

SET ECHO ON
SPOOL streams_share_schema2.out

/*
```

Configure Propagation at dbs1.example.com
Connect to `dbs1.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@dbs1.example.com

/*
```

Configure and schedule propagation from the queue at `dbs1.example.com` to the queue at `dbs2.example.com`. This configuration specifies that the propagation propagates all changes to the `hr` schema. You have the option of omitting the rule set specification, but then everything in the queue will be propagated, which might not be desired if, in the future, multiple capture processes will use the `streams_queue`.

```
*/

BEGIN
  -- Create the rule set
  DBMS_RULE_ADM.CREATE_RULE_SET(
    rule_set_name       => 'strmadmin.propagation_dbs1_rules',
    evaluation_context  => 'SYS.STREAMS$_EVALUATION_CONTEXT');
```

```
  -- Create rules for all modifications to the hr schema
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name  => 'strmadmin.all_hr_dml',
    condition  => ' :dml.get_object_owner() = ''HR'' AND ' ||
                  ' :dml.is_null_tag() = ''Y'' AND ' ||
                  ' :dml.get_source_database_name() = ''DBS1.EXAMPLE.COM'' ');
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name  => 'strmadmin.all_hr_ddl',
    condition  => ' (:ddl.get_object_owner() = ''HR'' OR ' ||
                  ' :ddl.get_base_table_owner() =     ''HR'') AND ' ||
                  ' :ddl.is_null_tag() = ''Y'' AND ' ||
                  ' :ddl.get_source_database_name() = ''DBS1.EXAMPLE.COM'' ');
  -- Add rules to rule set
  DBMS_RULE_ADM.ADD_RULE(
    rule_name      => 'strmadmin.all_hr_dml',
    rule_set_name  => 'strmadmin.propagation_dbs1_rules');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name      => 'strmadmin.all_hr_ddl',
    rule_set_name  => 'strmadmin.propagation_dbs1_rules');
  -- Create a propagation that uses the rule set as its positive rule set
  DBMS_PROPAGATION_ADM.CREATE_PROPAGATION(
    propagation_name    => 'dbs1_to_dbs2',
    source_queue        => 'strmadmin.streams_queue',
    destination_queue   => 'strmadmin.streams_queue',
    destination_dblink  => 'dbs2.example.com',
    rule_set_name       => 'strmadmin.propagation_dbs1_rules');
END;
/

/*
```

Configure the Capture Process at dbs1.example.com

Create a capture process and rules to capture the entire `hr` schema at `dbs1.example.com`.

```
*/

BEGIN
  -- Create the rule set
  DBMS_RULE_ADM.CREATE_RULE_SET(
    rule_set_name       => 'strmadmin.demo_rules',
    evaluation_context  => 'SYS.STREAMS$_EVALUATION_CONTEXT');
  --   Create rules that specify the entire hr schema
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name  => 'strmadmin.schema_hr_dml',
    condition  => ' :dml.get_object_owner() = ''HR''  AND ' ||
                  ' :dml.is_null_tag() = ''Y'' AND ' ||
                  ' :dml.get_source_database_name() = ''DBS1.EXAMPLE.COM'' ');
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name  => 'strmadmin.schema_hr_ddl',
    condition  => ' (:ddl.get_object_owner() = ''HR'' OR ' ||
                  ' :ddl.get_base_table_owner() =     ''HR'') AND ' ||
                  ' :ddl.is_null_tag() = ''Y'' AND ' ||
                  ' :ddl.get_source_database_name() = ''DBS1.EXAMPLE.COM'' ');
  --  Add the rules to the rule set
  DBMS_RULE_ADM.ADD_RULE(
    rule_name      => 'strmadmin.schema_hr_dml',
    rule_set_name  => 'strmadmin.demo_rules');
  DBMS_RULE_ADM.ADD_RULE(
```

```
    rule_name      => 'strmadmin.schema_hr_ddl',
    rule_set_name  => 'strmadmin.demo_rules');
  --  Create a capture process that uses the rule set as its positive rule set
  DBMS_CAPTURE_ADM.CREATE_CAPTURE(
    queue_name     => 'strmadmin.streams_queue',
    capture_name   => 'capture',
    rule_set_name => 'strmadmin.demo_rules');
END;
/

/*
```

Prepare the hr Schema at dbs1.example.com for Instantiation
While still connected as the Oracle Streams administrator at `dbs1.example.com`, prepare the `hr` schema at `dbs1.example.com` for instantiation at `dbs3.example.com`. This step marks the lowest SCN of the tables in the schema for instantiation. SCNs subsequent to the lowest SCN can be used for instantiation.
This step also enables supplemental logging for any primary key, unique key, bitmap index, and foreign key columns in the tables in the `hr` schema. Supplemental logging places additional information in the redo log for changes made to tables. The apply process needs this extra information to perform certain operations, such as unique row identification and conflict resolution. Because `dbs1.example.com` is the only database where changes are captured in this environment, it is the only database where you must specify supplemental logging for the tables in the `hr` schema.

> **Note:**
>
> This step is not required in the "Simple Configuration for Sharing Data from a Single Database". In that example, when the `ADD_SCHEMA_RULES` procedure in the `DBMS_STREAMS_ADM` package is run in Step Configure the Capture Process at dbs1.example.comConfigure the Capture Process at dbs1.example.com, the `PREPARE_SCHEMA_INSTANTIATION` procedure in the `DBMS_CAPTURE_ADM` package is run automatically for the `hr` schema.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide*

```
*/

BEGIN
  DBMS_CAPTURE_ADM.PREPARE_SCHEMA_INSTANTIATION(
    schema_name          => 'hr',
    supplemental_logging => 'keys');
END;
/

/*
```

Set the Instantiation SCN for the Existing Tables at Other Databases
In this example, the `hr.jobs` table already exists at `dbs2.example.com` and `dbs4.example.com`. At `dbs2.example.com`, this table is named `assignments`, but it has the same shape and data as the `jobs` table at `dbs1.example.com`. Also, in this example,

dbs4.example.com is a Sybase database. All of the other tables in the Oracle Streams environment are instantiated at the other destination databases using Data Pump import.
Because the hr.jobs table already exists at dbs2.example.com and dbs4.example.com, this example uses the GET_SYSTEM_CHANGE_NUMBER function in the DBMS_FLASHBACK package at dbs1.example.com to obtain the current SCN for the database. This SCN is used at dbs2.example.com to run the SET_TABLE_INSTANTIATION_SCN procedure in the DBMS_APPLY_ADM package. Running this procedure twice sets the instantiation SCN for the hr.jobs table at dbs2.example.com and dbs4.example.com.
The SET_TABLE_INSTANTIATION_SCN procedure controls which LCRs for a table are ignored by an apply process and which LCRs for a table are applied by an apply process. If the commit SCN of an LCR for a table from a source database is less than or equal to the instantiation SCN for that table at a destination database, then the apply process at the destination database discards the LCR. Otherwise, the apply process applies the LCR.
In this example, both of the apply processes at dbs2.example.com will apply transactions to the hr.jobs table with SCNs that were committed after SCN obtained in this step.

> **Note:**
>
> This example assumes that the contents of the hr.jobs table at dbs1.example.com, dbs2.example.com (as hr.assignments), and dbs4.example.com are consistent when you complete this step. You might want to lock the table at each database while you complete this step to ensure consistency.

```
*/

DECLARE
  iscn  NUMBER;         -- Variable to hold instantiation SCN value
BEGIN
  iscn := DBMS_FLASHBACK.GET_SYSTEM_CHANGE_NUMBER();
  DBMS_APPLY_ADM.SET_TABLE_INSTANTIATION_SCN@DBS2.EXAMPLE.COM(
    source_object_name    => 'hr.jobs',
    source_database_name  => 'dbs1.example.com',
    instantiation_scn     => iscn);
  DBMS_APPLY_ADM.SET_TABLE_INSTANTIATION_SCN@DBS2.EXAMPLE.COM(
    source_object_name    => 'hr.jobs',
    source_database_name  => 'dbs1.example.com',
    instantiation_scn     => iscn,
    apply_database_link   =>     'dbs4.example.com');
END;
/

/*
```

Instantiate the dbs1.example.com Tables at dbs3.example.com
This example performs a network Data Pump import of the following tables:

- hr.countries
- hr.locations
- hr.regions

A network import means that Data Pump imports these tables from `dbs1.example.com` without using an export dump file.

> **See Also:**
>
> *Oracle Database Utilities* for information about performing an import

Connect to `dbs3.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@dbs3.example.com

/*
```

This example will do a table import using the `DBMS_DATAPUMP` package. For simplicity, exceptions from any of the API calls will not be trapped. However, Oracle recommends that you define exception handlers and call `GET_STATUS` to retrieve more detailed error information if a failure occurs. If you want to monitor the import, then query the `DBA_DATAPUMP_JOBS` data dictionary view at the import database.

```
*/

SET SERVEROUTPUT ON
DECLARE
  h1        NUMBER;         -- Data Pump job handle
  sscn      NUMBER;         -- Variable to hold current source SCN
  job_state VARCHAR2(30);   -- To keep track of job state
  js        ku$_JobStatus;  -- The job status from GET_STATUS
  sts       ku$_Status;     -- The status object returned by GET_STATUS
  job_not_exist    exception;
  pragma exception_init(job_not_exist, -31626);
BEGIN
-- Create a (user-named) Data Pump job to do a table-level import.
  h1 := DBMS_DATAPUMP.OPEN(
          operation   => 'IMPORT',
          job_mode    => 'TABLE',
          remote_link => 'DBS1.EXAMPLE.COM',
          job_name    => 'dp_sing2');
-- A metadata filter is used to specify the schema that owns the tables
-- that will be imported.
  DBMS_DATAPUMP.METADATA_FILTER(
    handle    => h1,
    name      => 'SCHEMA_EXPR',
    value     => '=''HR''');
-- A metadata filter is used to specify the tables that will be imported.
  DBMS_DATAPUMP.METADATA_FILTER(
    handle    => h1,
    name      => 'NAME_EXPR',
    value     => 'IN(''COUNTRIES'', ''REGIONS'', ''LOCATIONS'')');
-- Get the current SCN of the source database, and set the FLASHBACK_SCN
-- parameter to this value to ensure consistency between all of the
-- objects included in the import.
  sscn := DBMS_FLASHBACK.GET_SYSTEM_CHANGE_NUMBER@dbs1.example.com();
  DBMS_DATAPUMP.SET_PARAMETER(
    handle => h1,
```

```
    name   => 'FLASHBACK_SCN',
    value  => sscn);
-- Start the job.
  DBMS_DATAPUMP.START_JOB(h1);
-- The import job should be running. In the following loop, the job
-- is monitored until it completes.
  job_state := 'UNDEFINED';
  BEGIN
    WHILE (job_state != 'COMPLETED') AND (job_state != 'STOPPED') LOOP
      sts:=DBMS_DATAPUMP.GET_STATUS(
             handle  => h1,
             mask    => DBMS_DATAPUMP.KU$_STATUS_JOB_ERROR +
                        DBMS_DATAPUMP.KU$_STATUS_JOB_STATUS +
                        DBMS_DATAPUMP.KU$_STATUS_WIP,
             timeout => -1);
      js := sts.job_status;
      DBMS_LOCK.SLEEP(10);
      job_state := js.state;
    END LOOP;
  -- Gets an exception when job no longer exists
    EXCEPTION WHEN job_not_exist THEN
      DBMS_OUTPUT.PUT_LINE('Data Pump job has completed');
      DBMS_OUTPUT.PUT_LINE('Instantiation SCN: ' ||sscn);
  END;
END;
/

/*
```

Configure the Apply Process at dbs3.example.com

Connect to `dbs3.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@dbs3.example.com

/*
```

Configure `dbs3.example.com` to apply DML and DDL changes to the `countries` table, `locations` table, and `regions` table.

```
*/

BEGIN
  -- Create the rule set
  DBMS_RULE_ADM.CREATE_RULE_SET(
    rule_set_name       => 'strmadmin.apply_rules',
    evaluation_context  => 'SYS.STREAMS$_EVALUATION_CONTEXT');
  -- Rules for hr.countries
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name    => 'strmadmin.all_countries_dml',
    condition    => ' :dml.get_object_owner() = ''HR'' AND ' ||
                    ' :dml.get_object_name() = ''COUNTRIES''  AND ' ||
                    ' :dml.is_null_tag() = ''Y'' AND ' ||
                    ' :dml.get_source_database_name() = ''DBS1.EXAMPLE.COM'' ');
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name    => 'strmadmin.all_countries_ddl',
    condition    => ' (:ddl.get_object_owner() = ''HR'' OR ' ||
                    ' :ddl.get_base_table_owner() =     ''HR'') AND ' ||
```

```
                    ' :ddl.get_object_name() = ''COUNTRIES'' AND ' ||
                    ' :ddl.is_null_tag() = ''Y'' AND ' ||
                    ' :ddl.get_source_database_name() = ''DBS1.EXAMPLE.COM'' ');
  -- Rules for hr.locations
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name    => 'strmadmin.all_locations_dml',
    condition    => ' :dml.get_object_owner() = ''HR'' AND ' ||
                    ' :dml.get_object_name() = ''LOCATIONS'' AND ' ||
                    ' :dml.is_null_tag() = ''Y'' AND ' ||
                    ' :dml.get_source_database_name() = ''DBS1.EXAMPLE.COM'' ');
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name    => 'strmadmin.all_locations_ddl',
    condition    => ' (:ddl.get_object_owner() = ''HR'' OR ' ||
                    ' :ddl.get_base_table_owner() =     ''HR'') AND ' ||
                    ' :ddl.get_object_name() = ''LOCATIONS'' AND ' ||
                    ' :ddl.is_null_tag() = ''Y'' AND ' ||
                    ' :ddl.get_source_database_name() = ''DBS1.EXAMPLE.COM'' ');
  -- Rules for hr.regions
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name    => 'strmadmin.all_regions_dml',
    condition    => ' :dml.get_object_owner() = ''HR'' AND ' ||
                    ' :dml.get_object_name() = ''REGIONS'' AND ' ||
                    ' :dml.is_null_tag() = ''Y'' AND ' ||
                    ' :dml.get_source_database_name() = ''DBS1.EXAMPLE.COM'' ');
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name    => 'strmadmin.all_regions_ddl',
    condition    => ' (:ddl.get_object_owner() = ''HR'' OR ' ||
                    ' :ddl.get_base_table_owner() =     ''HR'') AND ' ||
                    ' :ddl.get_object_name() = ''REGIONS'' AND ' ||
                    ' :ddl.is_null_tag() = ''Y'' AND ' ||
                    ' :ddl.get_source_database_name() = ''DBS1.EXAMPLE.COM'' ');
  -- Add rules to rule set
  DBMS_RULE_ADM.ADD_RULE(
    rule_name      => 'strmadmin.all_countries_dml',
    rule_set_name  => 'strmadmin.apply_rules');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name      => 'strmadmin.all_countries_ddl',
    rule_set_name  => 'strmadmin.apply_rules');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name      => 'strmadmin.all_locations_dml',
    rule_set_name  => 'strmadmin.apply_rules');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name      => 'strmadmin.all_locations_ddl',
    rule_set_name  => 'strmadmin.apply_rules');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name      => 'strmadmin.all_regions_dml',
    rule_set_name  => 'strmadmin.apply_rules');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name      => 'strmadmin.all_regions_ddl',
    rule_set_name  => 'strmadmin.apply_rules');
  -- Create an apply process that uses the rule set as its positive rule set
  DBMS_APPLY_ADM.CREATE_APPLY(
    queue_name      => 'strmadmin.streams_queue',
    apply_name      => 'apply',
    rule_set_name   => 'strmadmin.apply_rules',
    apply_user      => 'hr',
    apply_captured  => TRUE,
    source_database => 'dbs1.example.com');
END;
```

```
/

/*
```

Grant the hr User Execute Privilege on the Apply Process Rule Set
Because the `hr` user was specified as the apply user in the previous step, the `hr` user requires `EXECUTE` privilege on the positive rule set used by the apply process

```
*/

BEGIN
  DBMS_RULE_ADM.GRANT_OBJECT_PRIVILEGE(
    privilege   => SYS.DBMS_RULE_ADM.EXECUTE_ON_RULE_SET,
    object_name => 'strmadmin.apply_rules',
    grantee     => 'hr');
END;
/

/*
```

Start the Apply Process at dbs3.example.com
Set the `disable_on_error` parameter to `n` so that the apply process will not be disabled if it encounters an error, and start the apply process at `dbs3.example.com`.

```
*/

BEGIN
  DBMS_APPLY_ADM.SET_PARAMETER(
    apply_name  => 'apply',
    parameter   => 'disable_on_error',
    value       => 'N');
END;
/

BEGIN
  DBMS_APPLY_ADM.START_APPLY(
    apply_name  => 'apply');
END;
/

/*
```

Configure Propagation at dbs2.example.com
Connect to `dbs2.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@dbs2.example.com

/*
```

Configure and schedule propagation from the queue at `dbs2.example.com` to the queue at `dbs3.example.com`. This configuration is an example of directed networks because the changes at `dbs2.example.com` originated at `dbs1.example.com`.

```
*/

BEGIN
  -- Create the rule set
```

```
DBMS_RULE_ADM.CREATE_RULE_SET(
  rule_set_name       => 'strmadmin.propagation_dbs3_rules',
  evaluation_context  => 'SYS.STREAMS$_EVALUATION_CONTEXT');
-- Create rules for all modifications to the countries table
DBMS_RULE_ADM.CREATE_RULE(
  rule_name  => 'strmadmin.all_countries_dml',
  condition  => ' :dml.get_object_owner() = ''HR'' AND ' ||
                ' :dml.get_object_name() = ''COUNTRIES'' AND ' ||
                ' :dml.is_null_tag() = ''Y'' AND ' ||
                ' :dml.get_source_database_name() = ''DBS1.EXAMPLE.COM'' ');
DBMS_RULE_ADM.CREATE_RULE(
  rule_name  => 'strmadmin.all_countries_ddl',
  condition  => ' (:ddl.get_object_owner() = ''HR'' OR ' ||
                ' :ddl.get_base_table_owner() =     ''HR'') AND ' ||
                ' :ddl.get_object_name() = ''COUNTRIES'' AND ' ||
                ' :ddl.is_null_tag() = ''Y'' AND ' ||
                ' :ddl.get_source_database_name() = ''DBS1.EXAMPLE.COM'' ');
-- Create rules for all modifications to the locations table
DBMS_RULE_ADM.CREATE_RULE(
  rule_name   => 'strmadmin.all_locations_dml',
  condition  => ' :dml.get_object_owner() = ''HR'' AND ' ||
                ' :dml.get_object_name() = ''LOCATIONS'' AND ' ||
                ' :dml.is_null_tag() = ''Y'' AND ' ||
                ' :dml.get_source_database_name() = ''DBS1.EXAMPLE.COM'' ');
DBMS_RULE_ADM.CREATE_RULE(
  rule_name   => 'strmadmin.all_locations_ddl',
  condition  => ' (:ddl.get_object_owner() = ''HR'' OR ' ||
                ' :ddl.get_base_table_owner() =     ''HR'') AND ' ||
                ' :ddl.get_object_name() = ''LOCATIONS'' AND ' ||
                ' :ddl.is_null_tag() = ''Y'' AND ' ||
                ' :ddl.get_source_database_name() = ''DBS1.EXAMPLE.COM'' ');
-- Create rules for all modifications to the regions table
DBMS_RULE_ADM.CREATE_RULE(
  rule_name   => 'strmadmin.all_regions_dml',
  condition  => ' :dml.get_object_owner() = ''HR'' AND ' ||
                ' :dml.get_object_name() = ''REGIONS'' AND ' ||
                ' :dml.is_null_tag() = ''Y'' AND ' ||
                ' :dml.get_source_database_name() = ''DBS1.EXAMPLE.COM'' ');
DBMS_RULE_ADM.CREATE_RULE(
  rule_name   => 'strmadmin.all_regions_ddl',
  condition  => ' (:ddl.get_object_owner() = ''HR'' OR ' ||
                ' :ddl.get_base_table_owner() =     ''HR'') AND ' ||
                ' :ddl.get_object_name() = ''REGIONS'' AND ' ||
                ' :ddl.is_null_tag() = ''Y'' AND ' ||
                ' :ddl.get_source_database_name() = ''DBS1.EXAMPLE.COM'' ');
-- Add rules to rule set
DBMS_RULE_ADM.ADD_RULE(
  rule_name      => 'strmadmin.all_countries_dml',
  rule_set_name  => 'strmadmin.propagation_dbs3_rules');
DBMS_RULE_ADM.ADD_RULE(
  rule_name      => 'strmadmin.all_countries_ddl',
  rule_set_name  => 'strmadmin.propagation_dbs3_rules');
DBMS_RULE_ADM.ADD_RULE(
  rule_name      => 'strmadmin.all_locations_dml',
  rule_set_name  => 'strmadmin.propagation_dbs3_rules');
DBMS_RULE_ADM.ADD_RULE(
  rule_name      => 'strmadmin.all_locations_ddl',
  rule_set_name  => 'strmadmin.propagation_dbs3_rules');
DBMS_RULE_ADM.ADD_RULE(
```

```
    rule_name      => 'strmadmin.all_regions_dml',
    rule_set_name  => 'strmadmin.propagation_dbs3_rules');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name      => 'strmadmin.all_regions_ddl',
    rule_set_name  => 'strmadmin.propagation_dbs3_rules');
  -- Create a propagation that uses the rule set as its positive rule set
  DBMS_PROPAGATION_ADM.CREATE_PROPAGATION(
    propagation_name    => 'dbs2_to_dbs3',
    source_queue        => 'strmadmin.streams_queue',
    destination_queue   => 'strmadmin.streams_queue',
    destination_dblink  => 'dbs3.example.com',
    rule_set_name       => 'strmadmin.propagation_dbs3_rules');
END;
/

/*
```

Create the Custom Rule-Based Transformation for Row LCRs at dbs2.example.com

Connect to `dbs2.example.com` as the `hr` user.

```
*/

CONNECT hr@dbs2.example.com

/*
```

Create the custom rule-based transformation function that transforms row changes resulting from DML statements to the `jobs` table from `dbs1.example.com` into row changes to the `assignments` table on `dbs2.example.com`.

The following function transforms every row LCR for the `jobs` table into a row LCR for the `assignments` table.

> **Note:**
>
> If DDL changes were also applied to the `assignments` table, then another transformation would be required for the DDL LCRs. This transformation would need to change the object name and the DDL text.

```
*/

CREATE OR REPLACE FUNCTION hr.to_assignments_trans_dml(
  p_in_data in ANYDATA)
  RETURN ANYDATA IS out_data SYS.LCR$_ROW_RECORD;
  tc   pls_integer;
BEGIN
  -- Typecast AnyData to LCR$_ROW_RECORD
     tc := p_in_data.GetObject(out_data);
     IF out_data.GET_OBJECT_NAME() = 'JOBS'
     THEN
  -- Transform the in_data into the out_data
     out_data.SET_OBJECT_NAME('ASSIGNMENTS');
     END IF;
  -- Convert to AnyData
     RETURN ANYDATA.ConvertObject(out_data);
END;
```

```
/

/*
```

Configure the Apply Process for Local Apply at dbs2.example.com
Connect to `dbs2.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@dbs2.example.com

/*
```

Configure `dbs2.example.com` to apply changes to the local `assignments` table. Remember that the `assignments` table receives changes from the `jobs` table at `dbs1.example.com`. This step specifies a custom rule-based transformation without using the `SET_RULE_TRANSFORM_FUNCTION` procedure in the `DBMS_STREAMS_ADM` package. Instead, a name-value pair is added manually to the action context of the rule. The name-value pair specifies `STREAMS$_TRANSFORM_FUNCTION` for the name and `hr.to_assignments_trans_dml` for the value.

```
*/

DECLARE
  action_ctx_dml       SYS.RE$NV_LIST;
  action_ctx_ddl       SYS.RE$NV_LIST;
  ac_name              VARCHAR2(30) := 'STREAMS$_TRANSFORM_FUNCTION';
BEGIN
  -- Specify the name-value pair in the action context
  action_ctx_dml := SYS.RE$NV_LIST(SYS.RE$NV_ARRAY());
  action_ctx_dml.ADD_PAIR(
    ac_name,
    ANYDATA.CONVERTVARCHAR2('hr.to_assignments_trans_dml'));
  --  Create the rule set strmadmin.apply_rules
  DBMS_RULE_ADM.CREATE_RULE_SET(
    rule_set_name       => 'strmadmin.apply_rules',
    evaluation_context  => 'SYS.STREAMS$_EVALUATION_CONTEXT');
  --  Create a rule that transforms all DML changes to the jobs table into
  --  DML changes for assignments table
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name       => 'strmadmin.all_jobs_dml',
    condition       => ' :dml.get_object_owner() = ''HR'' AND ' ||
                       ' :dml.get_object_name() = ''JOBS'' AND ' ||
                       ' :dml.is_null_tag() = ''Y'' AND ' ||
                       ' :dml.get_source_database_name() = ''DBS1.EXAMPLE.COM'' ',
    action_context  => action_ctx_dml);
  --  Add the rule to the rule set
  DBMS_RULE_ADM.ADD_RULE(
    rule_name      => 'strmadmin.all_jobs_dml',
    rule_set_name  => 'strmadmin.apply_rules');
  -- Create an apply process that uses the rule set as its positive rule set
  DBMS_APPLY_ADM.CREATE_APPLY(
    queue_name      => 'strmadmin.streams_queue',
    apply_name      => 'apply_dbs2',
    rule_set_name   => 'strmadmin.apply_rules',
    apply_user      => 'hr',
    apply_captured  => TRUE,
    source_database => 'dbs1.example.com');
END;
```

```
/

/*
```

Grant the hr User Execute Privilege on the Apply Process Rule Set
Because the `hr` user was specified as the apply user in the previous step, the `hr` user requires `EXECUTE` privilege on the positive rule set used by the apply process

```
*/

BEGIN
  DBMS_RULE_ADM.GRANT_OBJECT_PRIVILEGE(
    privilege   => SYS.DBMS_RULE_ADM.EXECUTE_ON_RULE_SET,
    object_name => 'strmadmin.apply_rules',
    grantee     => 'hr');
END;
/

/*
```

Start the Apply Process at dbs2.example.com for Local Apply
Set the `disable_on_error` parameter to `n` so that the apply process will not be disabled if it encounters an error, and start the apply process for local apply at `dbs2.example.com`.

```
*/

BEGIN
  DBMS_APPLY_ADM.SET_PARAMETER(
    apply_name  => 'apply_dbs2',
    parameter   => 'disable_on_error',
    value       => 'N');
END;
/

BEGIN
  DBMS_APPLY_ADM.START_APPLY(
    apply_name  => 'apply_dbs2');
END;
/

/*
```

Configure the Apply Process at dbs2.example.com for Apply at dbs4.example.com
Configure `dbs2.example.com` to apply DML changes to the `jobs` table at `dbs4.example.com`, which is a Sybase database. Remember that these changes originated at `dbs1.example.com`.

```
*/

BEGIN
  -- Create the rule set
  DBMS_RULE_ADM.CREATE_RULE_SET(
    rule_set_name      => 'strmadmin.apply_dbs4_rules',
    evaluation_context => 'SYS.STREAMS$_EVALUATION_CONTEXT');
  -- Create rule strmadmin.all_jobs_remote for all modifications
  -- to the jobs table
  DBMS_RULE_ADM.CREATE_RULE(
```

```
    rule_name    => 'strmadmin.all_jobs_remote',
    condition    => ' :dml.get_object_owner() = ''HR'' AND ' ||
                    ' :dml.get_object_name() = ''JOBS'' AND ' ||
                    ' :dml.is_null_tag() = ''Y'' AND ' ||
                    ' :dml.get_source_database_name() = ''DBS1.EXAMPLE.COM'' ');
  -- Add the rule to the rule set
  DBMS_RULE_ADM.ADD_RULE(
    rule_name      => 'strmadmin.all_jobs_remote',
    rule_set_name  => 'strmadmin.apply_dbs4_rules');
  -- Create an apply process that uses the rule set as its positive rule set
  DBMS_APPLY_ADM.CREATE_APPLY(
    queue_name          => 'strmadmin.streams_queue',
    apply_name          => 'apply_dbs4',
    rule_set_name       => 'strmadmin.apply_dbs4_rules',
    apply_database_link => 'dbs4.example.com',
    apply_captured      => TRUE,
    source_database     => 'dbs1.example.com');
END;
/

/*
```

Start the Apply Process at dbs2.example.com for Apply at dbs4.example.com
Set the `disable_on_error` parameter to `n` so that the apply process will not be disabled if it encounters an error, and start the remote apply for Sybase using database link `dbs4.example.com`.

```
*/

BEGIN
  DBMS_APPLY_ADM.SET_PARAMETER(
    apply_name  => 'apply_dbs4',
    parameter   => 'disable_on_error',
    value       => 'N');
END;
/

BEGIN
  DBMS_APPLY_ADM.START_APPLY(
    apply_name  => 'apply_dbs4');
END;
/

/*
```

Start the Capture Process at dbs1.example.com
Connect to `dbs1.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@dbs1.example.com

/*
```

Start the capture process at `dbs1.example.com`.

```
*/

BEGIN
```

```
  DBMS_CAPTURE_ADM.START_CAPTURE(
    capture_name  => 'capture');
END;
/

/*
```

Check the Spool Results
Check the `streams_share_schema2.out` spool file to ensure that all actions finished successfully after this script is completed.

```
*/

SET ECHO OFF
SPOOL OFF

/*
```

You can now make DML and DDL changes to specific tables at `dbs1.example.com` and see these changes replicated to the other databases in the environment based on the rules you configured for the Oracle Streams processes and propagations in this environment.

> **See Also:**
>
> "Make DML and DDL Changes to Tables in the hr Schema" for examples of changes that are replicated in this environment

```
/************************** END OF SCRIPT ****************************/
```

2.5 Make DML and DDL Changes to Tables in the hr Schema

After completing either of the examples described in "Example Scripts for Sharing Data from One Database", you can make DML and DDL changes to the tables in the `hr` schema at the `dbs1.example.com` database. These changes will be replicated to the other databases in the environment based on the rules you configured for Oracle Streams processes and propagations. You can check the other databases to see that the changes have been replicated.

For example, complete the following steps to make DML changes to the `hr.jobs` and `hr.locations` tables at `dbs1.example.com`. You can also make a DDL change to the `hr.locations` table at `dbs1.example.com`.

After you make these changes, you can query the `hr.assignments` table at `dbs2.example.com` to see that the DML change you made to this table at `dbs1.example.com` has been replicated. Remember that a custom rule-based transformation configured for the apply process at `dbs2.example.com` transforms DML changes to the `hr.jobs` table into DML changes to the `hr.assignments` table. You can also query the `hr.locations` table at `dbs3.example.com` to see that the DML and DDL changes you made to this table at `dbs1.example.com` have been replicated.

Make DML and DDL Changes to Tables in the hr Schema
Make the following changes:

```
CONNECT hr@dbs1.example.com
Enter password: password

UPDATE hr.jobs SET max_salary=10000 WHERE job_id='MK_REP';
COMMIT;

INSERT INTO hr.locations VALUES(
  3300, '521 Ralston Avenue', '94002', 'Belmont', 'CA', 'US');
COMMIT;

ALTER TABLE hr.locations RENAME COLUMN state_province TO state_or_province;
```

Query the hr.assignments Table at dbs2.example.com
After some time passes to allow for capture, propagation, and apply of the changes performed the previous step, run the following query to confirm that the `UPDATE` change made to the `hr.jobs` table at `dbs1.example.com` has been applied to the `hr.assignments` table at `dbs2.example.com`.

```
CONNECT hr@dbs2.example.com
Enter password: password

SELECT max_salary FROM hr.assignments WHERE job_id='MK_REP';
```

You should see `10000` for the value of the `max_salary`.

Query and Describe the hr.locations Table at dbs3.example.com
Run the following query to confirm that the `INSERT` change made to the `hr.locations` table at `dbs1.example.com` has been applied at `dbs3.example.com`.

```
CONNECT hr@dbs3.example.com
Enter password: password

SELECT * FROM hr.locations WHERE location_id=3300;
```

You should see the row inserted into the `hr.locations` table at `dbs1.example.com` in the previous step.
Next, describe the `hr.locations` table at to confirm that the `ALTER TABLE` change was propagated and applied correctly.

```
DESC hr.locations
```

The fifth column in the table should be `state_or_province`.

2.6 Add Objects to an Existing Oracle Streams Replication Environment

This example extends the Oracle Streams environment configured in the previous sections by adding replicated objects to an existing database. To complete this example, you must have completed the tasks in one of the previous examples in this chapter.

This example will add the following tables to the `hr` schema in the `dbs3.example.com` database:

- `departments`

- employees
- job_history
- jobs

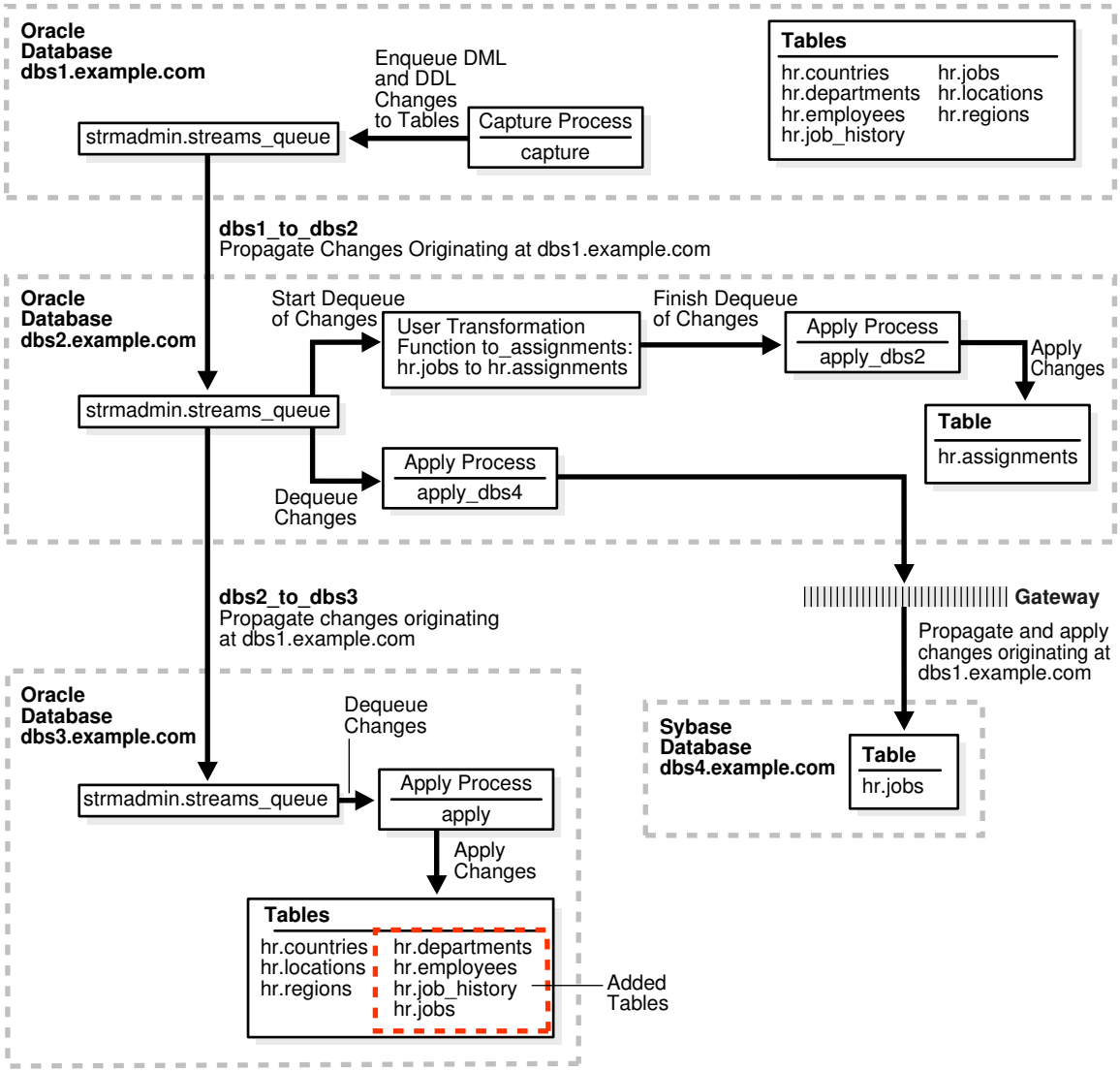
When you complete this example, Oracle Streams processes changes to these tables with the following series of actions:

1. The capture process captures changes at dbs1.example.com and enqueues them at dbs1.example.com.
2. A propagation propagates changes from the queue at dbs1.example.com to the queue at dbs2.example.com.
3. A propagation propagates changes from the queue at dbs2.example.com to the queue at dbs3.example.com.
4. The apply process at dbs3.example.com applies the changes at dbs3.example.com.

When you complete this example, the hr schema at the dbs3.example.com database will have all of its original tables, because the countries, locations, and regions tables were instantiated at dbs3.example.com in the previous section.

Figure 2-2 provides an overview of the environment with the added tables.

Figure 2-2 Adding Objects to dbs3.example.com in the Environment



Complete the following steps to replicate these tables to the `dbs3.example.com` database.

1. Show Output and Spool Results
2. Stop the Apply Process at dbs3.example.com
3. Configure the Apply Process for the Added Tables at dbs3.example.com
4. Specify the Table Propagation Rules for the Added Tables at dbs2.example.com
5. Prepare the Four Added Tables for Instantiation at dbs1.example.com
6. Instantiate the dbs1.example.com Tables at dbs3.example.com
7. Start the Apply Process at dbs3.example.com
8. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect to all of the databases in the environment.

```
/************************ BEGINNING OF SCRIPT ******************************
```

Show Output and Spool Results
Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/

SET ECHO ON
SPOOL streams_addobjs.out

/*
```

Stop the Apply Process at dbs3.example.com
Until you finish adding objects to `dbs3.example.com`, you must ensure that the apply process that will apply changes for the added objects does not try to apply changes for these objects. You can do this by stopping the capture process at the source database. Or, you can do this by stopping propagation of changes from `dbs2.example.com` to `dbs3.example.com`. Yet another alternative is to stop the apply process at `dbs3.example.com`. This example stops the apply process at `dbs3.example.com`.
Connect to `dbs3.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@dbs3.example.com

/*
```

Stop the apply process at `dbs3.example.com`.

```
*/

BEGIN
  DBMS_APPLY_ADM.STOP_APPLY(
    apply_name  => 'apply');
END;
/

/*
```

Configure the Apply Process for the Added Tables at dbs3.example.com
Configure the apply process at `dbs3.example.com` to apply changes to the tables you are adding.

```
*/
```

```
BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_RULES(
    table_name      => 'hr.departments',
    streams_type    => 'apply',
    streams_name    => 'apply',
    queue_name      => 'strmadmin.streams_queue',
    include_dml     => TRUE,
    include_ddl     => TRUE,
    source_database => 'dbs1.example.com',
    inclusion_rule  => TRUE);
END;
/

BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_RULES(
    table_name      => 'hr.employees',
    streams_type    => 'apply',
    streams_name    => 'apply',
    queue_name      => 'strmadmin.streams_queue',
    include_dml     => TRUE,
    include_ddl     => TRUE,
    source_database => 'dbs1.example.com',
    inclusion_rule  => TRUE);
END;
/

BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_RULES(
    table_name      => 'hr.job_history',
    streams_type    => 'apply',
    streams_name    => 'apply',
    queue_name      => 'strmadmin.streams_queue',
    include_dml     => TRUE,
    include_ddl     => TRUE,
    source_database => 'dbs1.example.com',
    inclusion_rule  => TRUE);
END;
/

BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_RULES(
    table_name      => 'hr.jobs',
    streams_type    => 'apply',
    streams_name    => 'apply',
    queue_name      => 'strmadmin.streams_queue',
    include_dml     => TRUE,
    include_ddl     => TRUE,
    source_database => 'dbs1.example.com',
    inclusion_rule  => TRUE);
END;
/

/*
```

Specify the Table Propagation Rules for the Added Tables at dbs2.example.com
Connect to `dbs2.example.com` as the `strmadmin` user.

```
*/
```

```
CONNECT strmadmin@dbs2.example.com

/*
```

Add the tables to the rules for propagation from the queue at `dbs2.example.com` to the queue at `dbs3.example.com`.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_PROPAGATION_RULES(
    table_name               => 'hr.departments',
    streams_name             => 'dbs2_to_dbs3',
    source_queue_name        => 'strmadmin.streams_queue',
    destination_queue_name   => 'strmadmin.streams_queue@dbs3.example.com',
    include_dml              => TRUE,
    include_ddl              => TRUE,
    source_database          => 'dbs1.example.com',
    inclusion_rule           => TRUE);
END;
/

BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_PROPAGATION_RULES(
    table_name              => 'hr.employees',
    streams_name            => 'dbs2_to_dbs3',
    source_queue_name       => 'strmadmin.streams_queue',
    destination_queue_name  => 'strmadmin.streams_queue@dbs3.example.com',
    include_dml             => TRUE,
    include_ddl             => TRUE,
    source_database         => 'dbs1.example.com',
    inclusion_rule          => TRUE);
END;
/

BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_PROPAGATION_RULES(
    table_name              => 'hr.job_history',
    streams_name            => 'dbs2_to_dbs3',
    source_queue_name       => 'strmadmin.streams_queue',
    destination_queue_name  => 'strmadmin.streams_queue@dbs3.example.com',
    include_dml             => TRUE,
    include_ddl             => TRUE,
    source_database         => 'dbs1.example.com',
    inclusion_rule          => TRUE);
END;
/

BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_PROPAGATION_RULES(
    table_name              => 'hr.jobs',
    streams_name            => 'dbs2_to_dbs3',
    source_queue_name       => 'strmadmin.streams_queue',
    destination_queue_name  => 'strmadmin.streams_queue@dbs3.example.com',
    include_dml             => TRUE,
    include_ddl             => TRUE,
    source_database         => 'dbs1.example.com',
    inclusion_rule          => TRUE);
END;
```

```
/

/*
```

Prepare the Four Added Tables for Instantiation at dbs1.example.com
Connect to `dbs1.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@dbs1.example.com

/*
```

Prepare the tables for instantiation. These tables will be instantiated at `dbs3.example.com`. This step marks the lowest SCN of the tables for instantiation. SCNs subsequent to the lowest SCN can be used for instantiation. Also, this preparation is necessary so that the Oracle Streams data dictionary for the relevant propagations and the apply process at `dbs3.example.com` contain information about these tables.

> **Note:**
>
> When the `PREPARE_TABLE_INSTANTIATION` procedure is run in this step, the `supplemental_logging` parameter is not specified. Therefore, the default value (`keys`) is used for this parameter. Supplemental logging already was enabled for any primary key, unique key, bitmap index, and foreign key columns in these tables in Step 3.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide*

```
*/

BEGIN
  DBMS_CAPTURE_ADM.PREPARE_TABLE_INSTANTIATION(
    table_name  => 'hr.departments');
END;
/

BEGIN
  DBMS_CAPTURE_ADM.PREPARE_TABLE_INSTANTIATION(
    table_name  => 'hr.employees');
END;
/

BEGIN
  DBMS_CAPTURE_ADM.PREPARE_TABLE_INSTANTIATION(
    table_name  => 'hr.job_history');
END;
/

BEGIN
```

```
  DBMS_CAPTURE_ADM.PREPARE_TABLE_INSTANTIATION(
    table_name  => 'hr.jobs');
END;
/

/*
```

Instantiate the dbs1.example.com Tables at dbs3.example.com
This example performs a network Data Pump import of the following tables:

- `hr.departments`
- `hr.employees`
- `hr.job_history`
- `hr.jobs`

A network import means that Data Pump imports these tables from `dbs1.example.com` without using an export dump file.

> **See Also:**
>
> *Oracle Database Utilities* for information about performing an import

Connect to `dbs3.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@dbs3.example.com

/*
```

This example will do a table import using the `DBMS_DATAPUMP` package. For simplicity, exceptions from any of the API calls will not be trapped. However, Oracle recommends that you define exception handlers and call `GET_STATUS` to retrieve more detailed error information if a failure occurs. If you want to monitor the import, then query the `DBA_DATAPUMP_JOBS` data dictionary view at the import database.

```
*/

SET SERVEROUTPUT ON
DECLARE
  h1        NUMBER;         -- Data Pump job handle
  sscn      NUMBER;         -- Variable to hold current source SCN
  job_state VARCHAR2(30);   -- To keep track of job state
  js        ku$_JobStatus;  -- The job status from GET_STATUS
  sts       ku$_Status;     -- The status object returned by GET_STATUS
  job_not_exist    exception;
  pragma exception_init(job_not_exist, -31626);
BEGIN
-- Create a (user-named) Data Pump job to do a table-level import.
  h1 := DBMS_DATAPUMP.OPEN(
          operation   => 'IMPORT',
          job_mode    => 'TABLE',
          remote_link => 'DBS1.EXAMPLE.COM',
          job_name    => 'dp_sing3');
-- A metadata filter is used to specify the schema that owns the tables
```

```
-- that will be imported.
  DBMS_DATAPUMP.METADATA_FILTER(
    handle    => h1,
    name      => 'SCHEMA_EXPR',
    value     => '=''HR''');
-- A metadata filter is used to specify the tables that will be imported.
  DBMS_DATAPUMP.METADATA_FILTER(
    handle    => h1,
    name      => 'NAME_EXPR',
    value     => 'IN(''DEPARTMENTS'', ''EMPLOYEES'',
                  ''JOB_HISTORY'', ''JOBS'')');
-- Get the current SCN of the source database, and set the FLASHBACK_SCN
-- parameter to this value to ensure consistency between all of the
-- objects included in the import.
  sscn := DBMS_FLASHBACK.GET_SYSTEM_CHANGE_NUMBER@dbs1.example.com();
  DBMS_DATAPUMP.SET_PARAMETER(
    handle => h1,
    name   => 'FLASHBACK_SCN',
    value  => sscn);
-- Start the job.
  DBMS_DATAPUMP.START_JOB(h1);
-- The import job should be running. In the following loop, the job
-- is monitored until it completes.
  job_state := 'UNDEFINED';
  BEGIN
    WHILE (job_state != 'COMPLETED') AND (job_state != 'STOPPED') LOOP
      sts:=DBMS_DATAPUMP.GET_STATUS(
             handle  => h1,
             mask    => DBMS_DATAPUMP.KU$_STATUS_JOB_ERROR +
                        DBMS_DATAPUMP.KU$_STATUS_JOB_STATUS +
                        DBMS_DATAPUMP.KU$_STATUS_WIP,
             timeout => -1);
      js := sts.job_status;
      DBMS_LOCK.SLEEP(10);
      job_state := js.state;
    END LOOP;
  -- Gets an exception when job no longer exists
    EXCEPTION WHEN job_not_exist THEN
      DBMS_OUTPUT.PUT_LINE('Data Pump job has completed');
      DBMS_OUTPUT.PUT_LINE('Instantiation SCN: ' ||sscn);
  END;
END;
/

/*
```

Start the Apply Process at dbs3.example.com

Start the apply process at `dbs3.example.com`. This apply process was stopped in Step Stop the Apply Process at dbs3.example.com.

Connect to `dbs3.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@dbs3.example.com

/*
```

Start the apply process at `dbs3.example.com`.

```
*/

BEGIN
  DBMS_APPLY_ADM.START_APPLY(
    apply_name  => 'apply');
END;
/

/*
```

Check the Spool Results
Check the `streams_addobjs.out` spool file to ensure that all actions finished successfully after this script is completed.

```
*/

SET ECHO OFF
SPOOL OFF

/************************** END OF SCRIPT ******************************/
```

2.7 Make a DML Change to the hr.employees Table

After completing the examples described in the "Add Objects to an Existing Oracle Streams Replication Environment" section, you can make DML and DDL changes to the tables in the `hr` schema at the `dbs1.example.com` database. These changes will be replicated to `dbs3.example.com`. You can check these tables at `dbs3.example.com` to see that the changes have been replicated.

For example, complete the following steps to make a DML change to the `hr.employees` table at `dbs1.example.com`. Next, query the `hr.employees` table at `dbs3.example.com` to see that the change has been replicated.

Make a DML Change to the hr.employees Table
Make the following change:

```
CONNECT hr@dbs1.example.com
Enter password: password

UPDATE hr.employees SET job_id='ST_MAN' WHERE employee_id=143;
COMMIT;
```

Query the hr.employees Table at dbs3.example.com
After some time passes to allow for capture, propagation, and apply of the change performed in the previous step, run the following query to confirm that the `UPDATE` change made to the `hr.employees` table at `dbs1.example.com` has been applied to the `hr.employees` table at `dbs3.example.com`.

```
CONNECT hr@dbs3.example.com
Enter password: password

SELECT job_id FROM hr.employees WHERE employee_id=143;
```

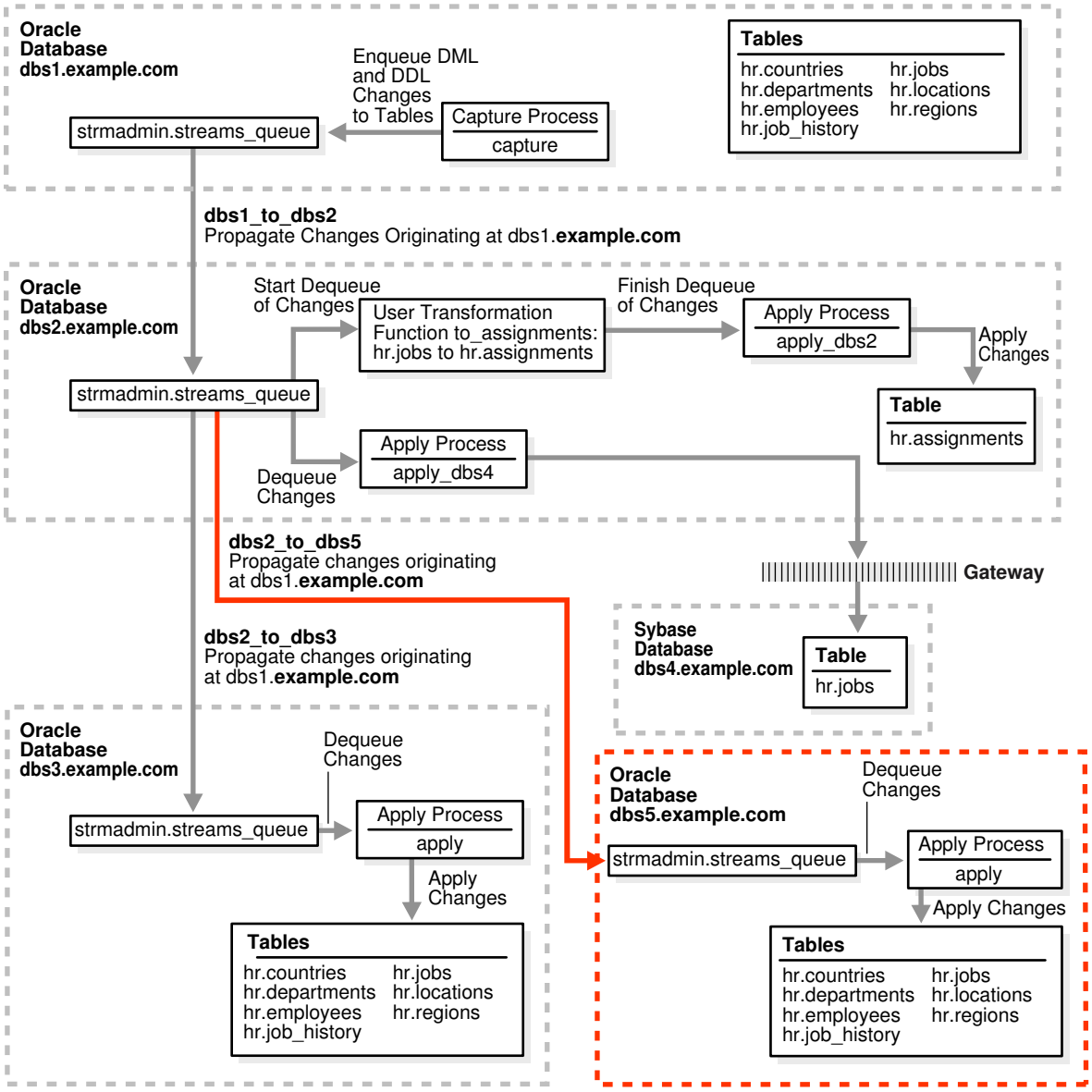
You should see `ST_MAN` for the value of the `job_id`.

2.8 Add a Database to an Existing Oracle Streams Replication Environment

This example extends the Oracle Streams environment configured in the previous sections by adding an additional database to the existing configuration. In this example, an existing Oracle database named `dbs5.example.com` is added to receive changes to the entire `hr` schema from the queue at `dbs2.example.com`.

Figure 2-3 provides an overview of the environment with the added database.

Figure 2-3 Adding the dbs5.example.com Oracle Database to the Environment



To complete this example, you must meet the following prerequisites:

- The `dbs5.example.com` database must exist.
- The `dbs2.example.com` and `dbs5.example.com` databases must be able to communicate with each other through Oracle Net.
- The `dbs5.example.com` and `dbs1.example.com` databases must be able to communicate with each other through Oracle Net (for optional Data Pump network instantiation).
- You must have completed the tasks in the previous examples in this chapter.
- The "Prerequisites" must be met if you want the entire Oracle Streams environment to work properly.
- This examples creates a new user to function as the Oracle Streams administrator (`strmadmin`) at the `dbs5.example.com` database and prompts you for the tablespace you want to use for this user's data. Before you start this example, either create a new tablespace or identify an existing tablespace for the Oracle Streams administrator to use at the `dbs5.example.com` database. The Oracle Streams administrator should not use the `SYSTEM` tablespace.

Complete the following steps to add `dbs5.example.com` to the Oracle Streams environment.

1. Show Output and Spool Results
2. Drop All of the Tables in the hr Schema at dbs5.example.com
3. Set Up Users at dbs5.example.com
4. Create the ANYDATA Queue at dbs5.example.com
5. Create a Database Link at dbs5.example.com to dbs1.example.com
6. Configure the Apply Process at dbs5.example.com
7. Specify hr as the Apply User for the Apply Process at dbs5.example.com
8. Grant the hr User Execute Privilege on the Apply Process Rule Set
9. Create the Database Link Between dbs2.example.com and dbs5.example.com
10. Configure Propagation Between dbs2.example.com and dbs5.example.com
11. Prepare the hr Schema for Instantiation at dbs1.example.com
12. Instantiate the dbs1.example.com Tables at dbs5.example.com
13. Start the Apply Process at dbs5.example.com
14. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect to all of the databases in the environment.

```
/************************ BEGINNING OF SCRIPT ****************************
```

Show Output and Spool Results
Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/

SET ECHO ON
SPOOL streams_adddb.out

/*
```

Drop All of the Tables in the hr Schema at dbs5.example.com
This example illustrates instantiating the tables in the `hr` schema by importing them from `dbs1.example.com` into `dbs5.example.com` using Data Pump. You must delete these tables at `dbs5.example.com` for the instantiation portion of this example to work properly.
Connect as `hr` at `dbs5.example.com`.

```
*/

CONNECT hr@dbs5.example.com

/*
```

Drop all tables in the `hr` schema in the `dbs5.example.com` database.

> **Note:**
>
> If you complete this step and drop all of the tables in the `hr` schema, then you should complete the remaining sections of this example to reinstantiate the `hr` schema at `dbs5.example.com`. If the `hr` schema does not exist in an Oracle database, then some examples in the Oracle documentation set can fail.

```
*/

DROP TABLE hr.countries CASCADE CONSTRAINTS;
DROP TABLE hr.departments CASCADE CONSTRAINTS;
DROP TABLE hr.employees CASCADE CONSTRAINTS;
DROP TABLE hr.job_history CASCADE CONSTRAINTS;
DROP TABLE hr.jobs CASCADE CONSTRAINTS;
DROP TABLE hr.locations CASCADE CONSTRAINTS;
DROP TABLE hr.regions CASCADE CONSTRAINTS;

/*
```

Set Up Users at dbs5.example.com
Connect to `dbs5.example.com` as `SYSTEM` user.

```
*/

CONNECT system@dbs5.example.com

/*
```

Create the Oracle Streams administrator named `strmadmin` and grant this user the necessary privileges. These privileges enable the user to manage queues, execute

subprograms in packages related to Oracle Streams, create rule sets, create rules, and monitor the Oracle Streams environment by querying data dictionary views and queue tables. You can choose a different name for this user.

> **Note:**
>
> The `ACCEPT` command must appear on a single line in the script.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide* for more information about configuring an Oracle Streams administrator

```
*/

ACCEPT password PROMPT 'Enter password for user: ' HIDE

GRANT DBA TO strmadmin IDENTIFIED BY &password;

ACCEPT streams_tbs PROMPT 'Enter Oracle Streams administrator tablespace on
dbs5.example.com: ' HIDE

ALTER USER strmadmin DEFAULT TABLESPACE &streams_tbs
                     QUOTA UNLIMITED ON &streams_tbs;

/*
```

Create the ANYDATA Queue at dbs5.example.com
Connect as the Oracle Streams administrator at the database you are adding. In this example, that database is `dbs5.example.com`.

```
*/

CONNECT strmadmin@dbs5.example.com

/*
```

Run the `SET_UP_QUEUE` procedure to create a queue named `streams_queue` at `dbs5.example.com`. This queue will function as the `ANYDATA` queue by holding the changes that will be applied at this database.
Running the `SET_UP_QUEUE` procedure performs the following actions:

- Creates a queue table named `streams_queue_table`. This queue table is owned by the Oracle Streams administrator (`strmadmin`) and uses the default storage of this user.
- Creates a queue named `streams_queue` owned by the Oracle Streams administrator (`strmadmin`).
- Starts the queue.

```
*/
```

```
EXEC  DBMS_STREAMS_ADM.SET_UP_QUEUE();

/*
```

Create a Database Link at dbs5.example.com to dbs1.example.com
Create a database link from `dbs5.example.com` to `dbs1.example.com`. Later in this example, this database link is used for the instantiation of the database objects that were dropped in Step Drop All of the Tables in the hr Schema at dbs5.example.com. This example uses the `DBMS_DATAPUMP` package to perform a network import of these database objects directly from the `dbs1.example.com` database. Because this example performs a network import, no dump file is required.
Alternatively, you can perform an export at the source database `dbs1.example.com`, transfer the export dump file to the destination database `dbs5.example.com`, and then import the export dump file at the destination database. In this case, the database link created in this step is not required.

```
*/

CREATE DATABASE LINK dbs1.example.com CONNECT TO strmadmin
   IDENTIFIED BY &password USING 'dbs1.example.com';

/*
```

Configure the Apply Process at dbs5.example.com
While still connected as the Oracle Streams administrator at `dbs5.example.com`, configure the apply process to apply changes to the `hr` schema.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_RULES(
    schema_name     => 'hr',
    streams_type    => 'apply',
    streams_name    => 'apply',
    queue_name      => 'strmadmin.streams_queue',
    include_dml     => TRUE,
    include_ddl     => TRUE,
    source_database => 'dbs1.example.com',
    inclusion_rule  => TRUE);
END;
/

/*
```

Specify hr as the Apply User for the Apply Process at dbs5.example.com
In this example, the `hr` user owns all of the database objects for which changes are applied by the apply process at this database. Therefore, `hr` already has the necessary privileges to change these database objects, and it is convenient to make `hr` the apply user.
When the apply process was created in the previous step, the Oracle Streams administrator `strmadmin` was specified as the apply user by default, because `strmadmin` ran the procedure that created the apply process. Instead of specifying hr as the apply user, you could retain `strmadmin` as the apply user, but then you must grant `strmadmin` privileges on all of the database objects for which changes are applied and privileges to execute all user procedures used by the apply process. In an environment where an apply process applies changes to database objects in multiple schemas, it might be more convenient to use the Oracle Streams administrator as the apply user.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide* for more information about configuring an Oracle Streams administrator

```
*/

BEGIN
  DBMS_APPLY_ADM.ALTER_APPLY(
    apply_name => 'apply',
    apply_user => 'hr');
END;
/

/*
```

Grant the hr User Execute Privilege on the Apply Process Rule Set
Because the `hr` user was specified as the apply user in the previous step, the `hr` user requires `EXECUTE` privilege on the positive rule set used by the apply process

```
*/

DECLARE
   rs_name  VARCHAR2(64);   -- Variable to hold rule set name
BEGIN
  SELECT RULE_SET_OWNER||'.'||RULE_SET_NAME
    INTO rs_name
    FROM DBA_APPLY
    WHERE APPLY_NAME='APPLY';
  DBMS_RULE_ADM.GRANT_OBJECT_PRIVILEGE(
    privilege   => SYS.DBMS_RULE_ADM.EXECUTE_ON_RULE_SET,
    object_name => rs_name,
    grantee     => 'hr');
END;
/

/*
```

Create the Database Link Between dbs2.example.com and dbs5.example.com
Connect to `dbs2.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@dbs2.example.com

/*
```

Create the database links to the databases where changes are propagated. In this example, database `dbs2.example.com` propagates changes to `dbs5.example.com`.

```
*/

CREATE DATABASE LINK dbs5.example.com CONNECT TO strmadmin
   IDENTIFIED BY &password USING 'dbs5.example.com';

/*
```

Configure Propagation Between dbs2.example.com and dbs5.example.com
While still connected as the Oracle Streams administrator at `dbs2.example.com`, configure and schedule propagation from the queue at `dbs2.example.com` to the queue at `dbs5.example.com`. Remember, changes to the `hr` schema originated at `dbs1.example.com`.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_PROPAGATION_RULES(
    schema_name             => 'hr',
    streams_name            => 'dbs2_to_dbs5',
    source_queue_name       => 'strmadmin.streams_queue',
    destination_queue_name  => 'strmadmin.streams_queue@dbs5.example.com',
    include_dml             => TRUE,
    include_ddl             => TRUE,
    source_database         => 'dbs1.example.com',
    inclusion_rule          => TRUE,
    queue_to_queue          => TRUE);
END;
/

/*
```

Prepare the hr Schema for Instantiation at dbs1.example.com
Connect to `dbs1.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@dbs1.example.com

/*
```

Prepare the `hr` schema for instantiation. These tables in this schema will be instantiated at `dbs5.example.com`. This preparation is necessary so that the Oracle Streams data dictionary for the relevant propagations and the apply process at `dbs5.example.com` contain information about the `hr` schema and the objects in the schema.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide*

```
*/

BEGIN
  DBMS_CAPTURE_ADM.PREPARE_SCHEMA_INSTANTIATION(
    schema_name          => 'hr',
    supplemental_logging => 'keys');
END;
/

/*
```

Instantiate the dbs1.example.com Tables at dbs5.example.com
This example performs a network Data Pump import of the following tables:

- hr.countries
- hr.departments
- hr.employees
- hr.job_history
- hr.jobs
- hr.locations
- hr.regions

A network import means that Data Pump imports these tables from dbs1.example.com without using an export dump file.

> **See Also:**
>
> *Oracle Database Utilities* for information about performing an import

Connect to dbs5.example.com as the strmadmin user.

```
*/

CONNECT strmadmin@dbs5.example.com

/*
```

This example will do a table import using the DBMS_DATAPUMP package. For simplicity, exceptions from any of the API calls will not be trapped. However, Oracle recommends that you define exception handlers and call GET_STATUS to retrieve more detailed error information if a failure occurs. If you want to monitor the import, then query the DBA_DATAPUMP_JOBS data dictionary view at the import database.

```
*/

SET SERVEROUTPUT ON
DECLARE
  h1        NUMBER;         -- Data Pump job handle
  sscn      NUMBER;         -- Variable to hold current source SCN
  job_state VARCHAR2(30);   -- To keep track of job state
  js        ku$_JobStatus;  -- The job status from GET_STATUS
  sts       ku$_Status;     -- The status object returned by GET_STATUS
  job_not_exist    exception;
  pragma exception_init(job_not_exist, -31626);
BEGIN
-- Create a (user-named) Data Pump job to do a table-level import.
  h1 := DBMS_DATAPUMP.OPEN(
          operation   => 'IMPORT',
          job_mode    => 'TABLE',
          remote_link => 'DBS1.EXAMPLE.COM',
          job_name    => 'dp_sing4');
-- A metadata filter is used to specify the schema that owns the tables
-- that will be imported.
  DBMS_DATAPUMP.METADATA_FILTER(
    handle    => h1,
    name      => 'SCHEMA_EXPR',
```

```
    value     => '=''HR''');
-- Get the current SCN of the source database, and set the FLASHBACK_SCN
-- parameter to this value to ensure consistency between all of the
-- objects included in the import.
  sscn := DBMS_FLASHBACK.GET_SYSTEM_CHANGE_NUMBER@dbs1.example.com();
  DBMS_DATAPUMP.SET_PARAMETER(
    handle => h1,
    name   => 'FLASHBACK_SCN',
    value  => sscn);
-- Start the job.
  DBMS_DATAPUMP.START_JOB(h1);
-- The import job should be running. In the following loop, the job
-- is monitored until it completes.
  job_state := 'UNDEFINED';
  BEGIN
    WHILE (job_state != 'COMPLETED') AND (job_state != 'STOPPED') LOOP
      sts:=DBMS_DATAPUMP.GET_STATUS(
             handle  => h1,
             mask    => DBMS_DATAPUMP.KU$_STATUS_JOB_ERROR +
                        DBMS_DATAPUMP.KU$_STATUS_JOB_STATUS +
                        DBMS_DATAPUMP.KU$_STATUS_WIP,
             timeout => -1);
      js := sts.job_status;
      DBMS_LOCK.SLEEP(10);
      job_state := js.state;
    END LOOP;
  -- Gets an exception when job no longer exists
    EXCEPTION WHEN job_not_exist THEN
      DBMS_OUTPUT.PUT_LINE('Data Pump job has completed');
      DBMS_OUTPUT.PUT_LINE('Instantiation SCN: ' ||sscn);
  END;
END;
/

/*
```

Start the Apply Process at dbs5.example.com

Connect as the Oracle Streams administrator at `dbs5.example.com`.

```
*/

CONNECT strmadmin@dbs5.example.com

/*
```

Set the `disable_on_error` parameter to `n` so that the apply process will not be disabled if it encounters an error, and start apply process at `dbs5.example.com`.

```
*/

BEGIN
  DBMS_APPLY_ADM.SET_PARAMETER(
    apply_name  => 'apply',
    parameter   => 'disable_on_error',
    value       => 'N');
END;
/

BEGIN
```

```
  DBMS_APPLY_ADM.START_APPLY(
    apply_name  => 'apply');
END;
/

/*
```

Check the Spool Results
Check the `streams_adddb.out` spool file to ensure that all actions finished successfully after this script is completed.

```
*/

SET ECHO OFF
SPOOL OFF

/************************** END OF SCRIPT ******************************/
```

2.9 Make a DML Change to the hr.departments Table

After completing the examples described in the "Add a Database to an Existing Oracle Streams Replication Environment" section, you can make DML and DDL changes to the tables in the `hr` schema at the `dbs1.example.com` database. These changes will be replicated to `dbs5.example.com`. You can check these tables at `dbs5.example.com` to see that the changes have been replicated.

For example, complete the following steps to make a DML change to the `hr.departments` table at `dbs1.example.com`. Next, query the `hr.departments` table at `dbs5.example.com` to see that the change has been replicated.

Make a DML Change to the hr.departments Table
Make the following change:

```
CONNECT hr@dbs1.example.com
Enter password: password

UPDATE hr.departments SET location_id=2400 WHERE department_id=270;
COMMIT;
```

Query the hr.departments Table at dbs5.example.com
After some time passes to allow for capture, propagation, and apply of the change performed in the previous step, run the following query to confirm that the `UPDATE` change made to the `hr.departments` table at `dbs1.example.com` has been applied to the `hr.departments` table at `dbs5.example.com`.

```
CONNECT hr@dbs5.example.com
Enter password: password

SELECT location_id FROM hr.departments WHERE department_id=270;
```

You should see `2400` for the value of the `location_id`.

3
N-Way Replication Example

This chapter illustrates an example of an n-way replication environment that can be constructed using Oracle Streams.

This chapter contains these topics:

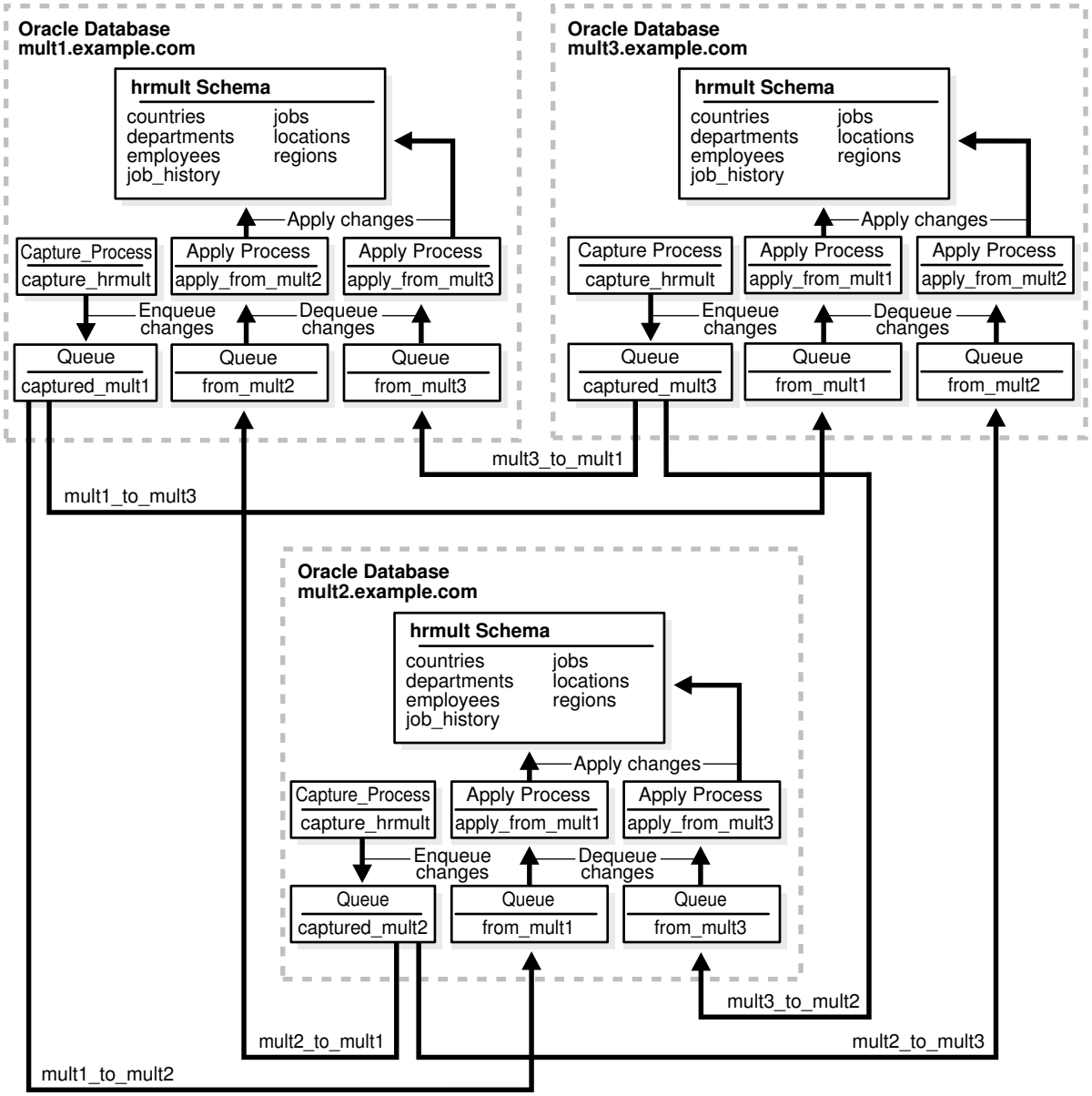
3.1 Overview of the N-Way Replication Example

This example illustrates using Oracle Streams to replicate data for a schema among three Oracle databases. DML and DDL changes made to tables in the `hrmult` schema are captured at all databases in the environment and propagated to each of the other databases in the environment.

This type of environment is called an n-way replication environment. An n-way replication environment is a type of multiple-source replication environment because more than one source database captures and replicates changes.

Figure 3-1 provides an overview of the environment.

Figure 3-1 Sample N-Way Replication Environment



As illustrated in Figure 3-1, all of the databases will contain the `hrmult` schema when the example is complete. However, at the beginning of the example, the `hrmult` schema exists only at `mult1.example.com`. During the example, you instantiate the `hrmult` schema at `mult2.example.com` and `mult3.example.com`.

In this example, Oracle Streams is used to perform the following series of actions:

1. After instantiation, the capture process at each database captures DML and DDL changes for all of the tables in the `hrmult` schema and enqueues them into a local queue.
2. Propagations at each database propagate these changes to all of the other databases in the environment.

3. The apply processes at each database apply changes in the `hrmult` schema received from the other databases in the environment.

This example avoids sending changes back to their source database by using the default apply tag for the apply processes. When you create an apply process, the changes applied by the apply process have redo entries with a tag of `'00'` (double zero) by default. These changes are not recaptured because, by default, rules created by the `DBMS_STREAMS_ADM` package have an `is_null_tag()='Y'` condition by default, and this condition ensures that each capture process captures a change in a redo entry only if the tag for the redo entry is `NULL`.

> **See Also:**
>
> - *Oracle Streams Replication Administrator's Guide* for more information about n-way replication environments
> - *Oracle Streams Replication Administrator's Guide* for more information about tags

3.2 Prerequisites

The following prerequisites must be completed before you begin the example in this chapter.

- Set the following initialization parameters to the values indicated at each database in the Oracle Streams environment:
  - `GLOBAL_NAMES`: This parameter must be set to `TRUE`. Ensure that the global names of the databases are `mult1.example.com`, `mult2.example.com`, and `mult3.example.com`.
  - `COMPATIBLE`: This parameter must be set to `10.2.0` or higher.
  - Ensure that the `PROCESSES` and `SESSIONS` initialization parameters are set high enough for all of the Oracle Streams clients used in this example. This example configures one capture process, two propagations, and two apply processes at each database.
  - `STREAMS_POOL_SIZE`: Optionally set this parameter to an appropriate value for each database in the environment. This parameter specifies the size of the Oracle Streams pool. The Oracle Streams pool stores messages in a buffered queue and is used for internal communications during parallel capture and apply. When the `MEMORY_TARGET`, `MEMORY_MAX_TARGET`, or `SGA_TARGET` initialization parameter is set to a nonzero value, the Oracle Streams pool size is managed automatically.

> **Note:**
>
> You might need to modify other initialization parameter settings for this example to run properly.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide* for information about other initialization parameters that are important in an Oracle Streams environment

- Any database producing changes that will be captured must be running in `ARCHIVELOG` mode. In this example, all databases are capturing changes, and so all databases must be running in `ARCHIVELOG` mode.

> **See Also:**
>
> *Oracle Database Administrator's Guide* for information about running a database in `ARCHIVELOG` mode

- Configure your network and Oracle Net so that all three databases can communicate with each other.

> **See Also:**
>
> *Oracle Database Net Services Administrator's Guide*

- Create an Oracle Streams administrator at each database in the replication environment. In this example, the databases are `mult1.example.com`, `mult2.example.com`, and `mult3.example.com`. This example assumes that the user name of the Oracle Streams administrator is `strmadmin`.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide* for instructions about creating an Oracle Streams administrator

3.3 Create the hrmult Schema at the mult1.example.com Database

For the purposes of this example, create a new schema named `hrmult` at the `mult1.example.com` database. The n-way environment will replicate this new schema.

Complete the following steps to use Data Pump export/import to create an `hrmult` schema that is a copy of the `hr` schema:

1. In SQL*Plus, connect to the `mult1.example.com` database as an administrative user.

   See *Oracle Database Administrator's Guide* for instructions about connecting to a database in SQL*Plus.

2. Create a directory object to hold the export dump file and export log file. The directory object can point to any accessible directory on the computer system. For

example, the following statement creates a directory object named `dp_hrmult_dir` that points to the `/usr/tmp` directory:

```
CREATE DIRECTORY dp_hrmult_dir AS '/usr/tmp';
```

Substitute an appropriate directory on your computer system.

3. Determine the current system change number (SCN) of the source database:

```
SELECT DBMS_FLASHBACK.GET_SYSTEM_CHANGE_NUMBER FROM DUAL;
```

The SCN value returned by this query is specified for the `FLASHBACK_SCN` Data Pump export parameter in Step 5. Because the `hr` schema includes foreign key constraints between tables, the `FLASHBACK_SCN` export parameter, or a similar export parameter, must be specified during export.

4. Exit SQL*Plus.
5. On a command line at the `mult1.example.com` database site, use Data Pump to export the `hr` schema at the `mult1.example.com` database. Ensure that you specify the SCN value returned in Step 3 for the `FLASHBACK_SCN` parameter:

```
expdp system SCHEMAS=hr DIRECTORY=dp_hrmult_dir
DUMPFILE=hrmult_schema.dmp FLASHBACK_SCN=flashback_scn_value
```

6. On a command line at the `mult1.example.com` database site, use Data Pump to import the import dump file `hrmult_schema.dmp`:

```
impdp system SCHEMAS=hr DIRECTORY=dp_hrmult_dir
DUMPFILE=hrmult_schema.dmp REMAP_SCHEMA=hr:hrmult
```

7. In SQL*Plus, connect to the `mult1.example.com` database as an administrative user.
8. Assign a password to the new `hrmult` user at the `mult1.example.com` database using the `ALTER USER` statement.

Remember the password that you assign to the `hrmult` user so that you can log in as the user in the future.

3.4 Create Queues and Database Links

This section illustrates how to create queues and database links for an Oracle Streams replication environment that includes three Oracle databases. The remaining parts of this example depend on the queues and database links that you configure in this section.

Complete the following steps to create the queues and database links at all of the databases.

1. Show Output and Spool Results
2. Create the ANYDATA Queue at mult1.example.com
3. Create the Database Links at mult1.example.com
4. Prepare the Tables at mult1.example.com for Latest Time Conflict Resolution
5. Create the ANYDATA Queue at mult2.example.com
6. Create the Database Links at mult2.example.com
7. Create the ANYDATA Queue at mult3.example.com
8. Create the Database Links at mult3.example.com

9. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect to all of the databases in the environment.

```
/************************ BEGINNING OF SCRIPT ****************************
```

Show Output and Spool Results
Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/

SET ECHO ON
SPOOL streams_setup_mult.out

/*
```

Create the ANYDATA Queue at mult1.example.com
Connect as the Oracle Streams administrator at `mult1.example.com`.

```
*/

CONNECT strmadmin@mult1.example.com

/*
```

Run the `SET_UP_QUEUE` procedure to create the following queues:

- The `captured_mult1` queue to hold changes captured at the `mult1.example.com` database and propagated to other databases.
- The `from_mult2` queue to hold changes captured at the `mult2.example.com` database and propagated to the `mult1.example.com` database to be applied.
- The `from_mult3` queue to hold changes captured at the `mult3.example.com` database and propagated to the `mult1.example.com` database to be applied.

Running the `SET_UP_QUEUE` procedure performs the following actions for each queue:

- Creates a queue table that is owned by the Oracle Streams administrator (`strmadmin`) and that uses the default storage of this user.
- Creates an `ANYDATA` queue that is owned by the Oracle Streams administrator (`strmadmin`).
- Starts the queue.

```
*/

BEGIN
```

```
  DBMS_STREAMS_ADM.SET_UP_QUEUE(
    queue_table  => 'strmadmin.captured_mult1_table',
    queue_name   => 'strmadmin.captured_mult1');
END;
/

BEGIN
  DBMS_STREAMS_ADM.SET_UP_QUEUE(
    queue_table  => 'strmadmin.from_mult2_table',
    queue_name   => 'strmadmin.from_mult2');
END;
/

BEGIN
  DBMS_STREAMS_ADM.SET_UP_QUEUE(
    queue_table  => 'strmadmin.from_mult3_table',
    queue_name   => 'strmadmin.from_mult3');
END;
/

/*
```

Create the Database Links at mult1.example.com
Create database links from the current database to the other databases in the environment.

```
*/

ACCEPT password PROMPT 'Enter password for user: ' HIDE

CREATE DATABASE LINK mult2.example.com CONNECT TO strmadmin
   IDENTIFIED BY &password USING 'mult2.example.com';

CREATE DATABASE LINK mult3.example.com CONNECT TO strmadmin
   IDENTIFIED BY &password USING 'mult3.example.com';

/*
```

Prepare the Tables at mult1.example.com for Latest Time Conflict Resolution
This example will configure the tables in the `hrmult` schema for conflict resolution based on the latest time for a transaction.
Connect to `mult1.example.com` as the `hrmult` user.

```
*/

CONNECT hrmult@mult1.example.com

/*
```

Add a `time` column to each table in the `hrmult` schema.

```
*/

ALTER TABLE hrmult.countries ADD (time TIMESTAMP WITH TIME ZONE);
ALTER TABLE hrmult.departments ADD (time TIMESTAMP WITH TIME ZONE);
ALTER TABLE hrmult.employees ADD (time TIMESTAMP WITH TIME ZONE);
ALTER TABLE hrmult.job_history ADD (time TIMESTAMP WITH TIME ZONE);
ALTER TABLE hrmult.jobs ADD (time TIMESTAMP WITH TIME ZONE);
ALTER TABLE hrmult.locations ADD (time TIMESTAMP WITH TIME ZONE);
```

```
ALTER TABLE hrmult.regions ADD (time TIMESTAMP WITH TIME ZONE);

/*
```

Create a trigger for each table in the `hrmult` schema to insert the time of a transaction for each row inserted or updated by the transaction.

```
*/

CREATE OR REPLACE TRIGGER hrmult.insert_time_countries
BEFORE
  INSERT OR UPDATE ON hrmult.countries FOR EACH ROW
BEGIN
   -- Consider time synchronization problems. The previous update to this
   -- row might have originated from a site with a clock time ahead of the
   -- local clock time.
   IF :OLD.TIME IS NULL OR :OLD.TIME < SYSTIMESTAMP THEN
     :NEW.TIME := SYSTIMESTAMP;
   ELSE
     :NEW.TIME := :OLD.TIME + 1 / 86400;
   END IF;
END;
/

CREATE OR REPLACE TRIGGER hrmult.insert_time_departments
BEFORE
  INSERT OR UPDATE ON hrmult.departments FOR EACH ROW
BEGIN
   IF :OLD.TIME IS NULL OR :OLD.TIME < SYSTIMESTAMP THEN
     :NEW.TIME := SYSTIMESTAMP;
   ELSE
     :NEW.TIME := :OLD.TIME + 1 / 86400;
   END IF;
END;
/

CREATE OR REPLACE TRIGGER hrmult.insert_time_employees
BEFORE
  INSERT OR UPDATE ON hrmult.employees FOR EACH ROW
BEGIN
   IF :OLD.TIME IS NULL OR :OLD.TIME < SYSTIMESTAMP THEN
     :NEW.TIME := SYSTIMESTAMP;
   ELSE
     :NEW.TIME := :OLD.TIME + 1 / 86400;
   END IF;
END;
/

CREATE OR REPLACE TRIGGER hrmult.insert_time_job_history
BEFORE
  INSERT OR UPDATE ON hrmult.job_history FOR EACH ROW
BEGIN
   IF :OLD.TIME IS NULL OR :OLD.TIME < SYSTIMESTAMP THEN
     :NEW.TIME := SYSTIMESTAMP;
   ELSE
     :NEW.TIME := :OLD.TIME + 1 / 86400;
   END IF;
END;
/
```

```
CREATE OR REPLACE TRIGGER hrmult.insert_time_jobs
BEFORE
  INSERT OR UPDATE ON hrmult.jobs FOR EACH ROW
BEGIN
   IF :OLD.TIME IS NULL OR :OLD.TIME < SYSTIMESTAMP THEN
     :NEW.TIME := SYSTIMESTAMP;
   ELSE
     :NEW.TIME := :OLD.TIME + 1 / 86400;
   END IF;
END;
/

CREATE OR REPLACE TRIGGER hrmult.insert_time_locations
BEFORE
  INSERT OR UPDATE ON hrmult.locations FOR EACH ROW
BEGIN
   IF :OLD.TIME IS NULL OR :OLD.TIME < SYSTIMESTAMP THEN
     :NEW.TIME := SYSTIMESTAMP;
   ELSE
     :NEW.TIME := :OLD.TIME + 1 / 86400;
   END IF;
END;
/

CREATE OR REPLACE TRIGGER hrmult.insert_time_regions
BEFORE
  INSERT OR UPDATE ON hrmult.regions FOR EACH ROW
BEGIN
   IF :OLD.TIME IS NULL OR :OLD.TIME < SYSTIMESTAMP THEN
     :NEW.TIME := SYSTIMESTAMP;
   ELSE
     :NEW.TIME := :OLD.TIME + 1 / 86400;
   END IF;
END;
/

/*
```

Create the ANYDATA Queue at mult2.example.com
Connect as the Oracle Streams administrator at `mult2.example.com`.

```
*/

CONNECT strmadmin@mult2.example.com

/*
```

Run the `SET_UP_QUEUE` procedure to create the following queues:

- The `captured_mult2` queue to hold changes captured at the `mult2.example.com` database and propagated to other databases.
- The `from_mult1` queue to hold changes captured at the `mult1.example.com` database and propagated to the `mult2.example.com` database to be applied.
- The `from_mult3` queue to hold changes captured at the `mult3.example.com` database and propagated to the `mult2.example.com` database to be applied.

Running the `SET_UP_QUEUE` procedure performs the following actions for each queue:

- Creates a queue table that is owned by the Oracle Streams administrator (`strmadmin`) and that uses the default storage of this user.
- Creates an `ANYDATA` queue that is owned by the Oracle Streams administrator (`strmadmin`).
- Starts the queue.

```
*/

BEGIN
  DBMS_STREAMS_ADM.SET_UP_QUEUE(
    queue_table  => 'strmadmin.captured_mult2_table',
    queue_name   => 'strmadmin.captured_mult2');
END;
/

BEGIN
  DBMS_STREAMS_ADM.SET_UP_QUEUE(
    queue_table  => 'strmadmin.from_mult1_table',
    queue_name   => 'strmadmin.from_mult1');
END;
/

BEGIN
  DBMS_STREAMS_ADM.SET_UP_QUEUE(
    queue_table  => 'strmadmin.from_mult3_table',
    queue_name   => 'strmadmin.from_mult3');
END;
/

/*
```

Create the Database Links at mult2.example.com
Create database links from the current database to the other databases in the environment.

```
*/

CREATE DATABASE LINK mult1.example.com CONNECT TO strmadmin
   IDENTIFIED BY &password USING 'mult1.example.com';

CREATE DATABASE LINK mult3.example.com CONNECT TO strmadmin
   IDENTIFIED BY &password USING 'mult3.example.com';

/*
```

Create the ANYDATA Queue at mult3.example.com
Connect as the Oracle Streams administrator at `mult3.example.com`.

```
*/

CONNECT strmadmin@mult3.example.com

/*
```

Run the `SET_UP_QUEUE` procedure to create the following queues:

- The `captured_mult3` queue to hold changes captured at the `mult3.example.com` database and propagated to other databases.

- The `from_mult1` queue to hold changes captured at the `mult1.example.com` database and propagated to the `mult3.example.com` database to be applied.
- The `from_mult2` queue to hold changes captured at the `mult2.example.com` database and propagated to the `mult3.example.com` database to be applied.

Running the `SET_UP_QUEUE` procedure performs the following actions for each queue:

- Creates a queue table that is owned by the Oracle Streams administrator (`strmadmin`) and that uses the default storage of this user.
- Creates an `ANYDATA` queue that is owned by the Oracle Streams administrator (`strmadmin`).
- Starts the queue.

```
*/

BEGIN
  DBMS_STREAMS_ADM.SET_UP_QUEUE(
    queue_table  => 'strmadmin.captured_mult3_table',
    queue_name   => 'strmadmin.captured_mult3');
END;
/

BEGIN
  DBMS_STREAMS_ADM.SET_UP_QUEUE(
    queue_table  => 'strmadmin.from_mult1_table',
    queue_name   => 'strmadmin.from_mult1');
END;
/

BEGIN
  DBMS_STREAMS_ADM.SET_UP_QUEUE(
    queue_table  => 'strmadmin.from_mult2_table',
    queue_name   => 'strmadmin.from_mult2');
END;
/

/*
```

Create the Database Links at mult3.example.com

Create database links from the current database to the other databases in the environment.

```
*/

CREATE DATABASE LINK mult1.example.com CONNECT TO strmadmin
   IDENTIFIED BY &password USING 'mult1.example.com';

CREATE DATABASE LINK mult2.example.com CONNECT TO strmadmin
   IDENTIFIED BY &password USING 'mult2.example.com';

/*
```

Check the Spool Results

Check the `streams_setup_mult.out` spool file to ensure that all actions finished successfully after this script is completed.

```
*/

SET ECHO OFF
SPOOL OFF

/************************** END OF SCRIPT ****************************/
```

3.5 Example Script for Configuring N-Way Replication

Complete the following steps to configure an Oracle Streams n-way replication environment.

1. Show Output and Spool Results
2. Specify Supplemental Logging at mult1.example.com
3. Create the Capture Process at mult1.example.com
4. Create One Apply Process at mult1.example.com for Each Source Database
5. Configure Latest Time Conflict Resolution at mult1.example.com
6. Configure Propagation at mult1.example.com
7. Create the Capture Process at mult2.example.com.
8. Set the Instantiation SCN for mult2.example.com at the Other Databases
9. Create One Apply Process at mult2.example.com for Each Source Database
10. Configure Propagation at mult2.example.com
11. Create the Capture Process at mult3.example.com
12. Set the Instantiation SCN for mult3.example.com at the Other Databases
13. Create One Apply Process at mult3.example.com for Each Source Database
14. Configure Propagation at mult3.example.com
15. Instantiate the hrmult Schema at mult2.example.com
16. Instantiate the hrmult Schema at mult3.example.com
17. Configure Latest Time Conflict Resolution at mult2.example.com
18. Start the Apply Processes at mult2.example.com
19. Configure Latest Time Conflict Resolution at mult3.example.com
20. Start the Apply Processes at mult3.example.com
21. Start the Apply Processes at mult1.example.com
22. Start the Capture Process at mult1.example.com
23. Start the Capture Process at mult2.example.com
24. Start the Capture Process at mult3.example.com
25. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect to all of the databases in the environment.

```
/************************ BEGINNING OF SCRIPT ****************************
```

Show Output and Spool Results
Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/

SET ECHO ON
SPOOL streams_mult.out

/*
```

Specify Supplemental Logging at mult1.example.com
Connect to `mult1.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@mult1.example.com

/*
```

Specify an unconditional supplemental log group that includes the primary key for each table and the column list for each table, as specified in "Configure Latest Time Conflict Resolution at mult1.example.com". Because the column list for each table includes all of the columns of each table except for its primary key, this step creates a supplemental log group for each table that includes all of the columns in the table.

> **Note:**
>
> - For convenience, this example includes the primary key column(s) for each table and the columns used for update conflict resolution in a single unconditional log group. You can choose to place the primary key column(s) for each table in an unconditional log group and the columns used for update conflict resolution in a conditional log group.
> - You do not need to specify supplemental logging explicitly at `mult2.example.com` and `mult3.example.com` in this example. When you use Data Pump to instantiate the tables in the `hrmult` schema at these databases later in this example, the supplemental logging specifications at `mult1.example.com` are retained at `mult2.example.com` and `mult3.example.com`.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide*

```
*/

ALTER TABLE hrmult.countries ADD SUPPLEMENTAL LOG DATA (ALL) COLUMNS;

ALTER TABLE hrmult.departments ADD SUPPLEMENTAL LOG DATA (ALL) COLUMNS;

ALTER TABLE hrmult.employees ADD SUPPLEMENTAL LOG DATA (ALL) COLUMNS;

ALTER TABLE hrmult.jobs ADD SUPPLEMENTAL LOG DATA (ALL) COLUMNS;

ALTER TABLE hrmult.job_history ADD SUPPLEMENTAL LOG DATA (ALL) COLUMNS;

ALTER TABLE hrmult.locations ADD SUPPLEMENTAL LOG DATA (ALL) COLUMNS;

ALTER TABLE hrmult.regions ADD SUPPLEMENTAL LOG DATA (ALL) COLUMNS;

/*
```

Create the Capture Process at mult1.example.com

Create the capture process to capture changes to the entire `hrmult` schema at `mult1.example.com`. This step also prepares the `hrmult` schema at `mult1.example.com` for instantiation. After this step is complete, users can modify tables in the `hrmult` schema at `mult1.example.com`.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_RULES(
    schema_name    => 'hrmult',
    streams_type   => 'capture',
    streams_name   => 'capture_hrmult',
    queue_name     => 'strmadmin.captured_mult1',
    include_dml    => TRUE,
    include_ddl    => TRUE,
    inclusion_rule => TRUE);
END;
/

/*
```

Create One Apply Process at mult1.example.com for Each Source Database

Configure `mult1.example.com` to apply changes to the `hrmult` schema at `mult2.example.com`.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_RULES(
    schema_name     => 'hrmult',
    streams_type    => 'apply',
    streams_name    => 'apply_from_mult2',
    queue_name      => 'strmadmin.from_mult2',
    include_dml     => TRUE,
```

```
    include_ddl     => TRUE,
    source_database => 'mult2.example.com',
    inclusion_rule  => TRUE);
END;
/

/*
```

Configure `mult1.example.com` to apply changes to the `hrmult` schema at `mult3.example.com`.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_RULES(
    schema_name     => 'hrmult',
    streams_type    => 'apply',
    streams_name    => 'apply_from_mult3',
    queue_name      => 'strmadmin.from_mult3',
    include_dml     => TRUE,
    include_ddl     => TRUE,
    source_database => 'mult3.example.com',
    inclusion_rule  => TRUE);
END;
/

/*
```

Configure Latest Time Conflict Resolution at mult1.example.com
Specify an update conflict handler for each table in the `hrmult` schema. For each table, designate the `time` column as the resolution column for a `MAXIMUM` conflict handler. When an update conflict occurs, such an update conflict handler applies the transaction with the latest (or greater) time and discards the transaction with the earlier (or lesser) time. The column lists include all columns for each table, except for the primary key, because this example assumes that primary key values are never updated.

```
*/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1) := 'country_name';
  cols(2) := 'region_id';
  cols(3) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.countries',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
    column_list           =>  cols);
END;
/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1) := 'department_name';
  cols(2) := 'manager_id';
  cols(3) := 'location_id';
```

```
  cols(4) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.departments',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
    column_list           =>  cols);
END;
/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1)  := 'first_name';
  cols(2)  := 'last_name';
  cols(3)  := 'email';
  cols(4)  := 'phone_number';
  cols(5)  := 'hire_date';
  cols(6)  := 'job_id';
  cols(7)  := 'salary';
  cols(8)  := 'commission_pct';
  cols(9)  := 'manager_id';
  cols(10) := 'department_id';
  cols(11) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.employees',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
    column_list           =>  cols);
END;
/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1) := 'job_title';
  cols(2) := 'min_salary';
  cols(3) := 'max_salary';
  cols(4) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.jobs',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
    column_list           =>  cols);
END;
/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1) := 'employee_id';
  cols(2) := 'start_date';
  cols(3) := 'end_date';
  cols(4) := 'job_id';
  cols(5) := 'department_id';
  cols(6) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.job_history',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
```

```
    column_list          =>  cols);
END;
/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1) := 'street_address';
  cols(2) := 'postal_code';
  cols(3) := 'city';
  cols(4) := 'state_province';
  cols(5) := 'country_id';
  cols(6) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name          =>  'hrmult.locations',
    method_name          =>  'MAXIMUM',
    resolution_column    =>  'time',
    column_list          =>  cols);
END;
/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1) := 'region_name';
  cols(2) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name          =>  'hrmult.regions',
    method_name          =>  'MAXIMUM',
    resolution_column    =>  'time',
    column_list          =>  cols);
END;
/

/*
```

Configure Propagation at mult1.example.com

Configure and schedule propagation of DML and DDL changes in the `hrmult` schema from the queue at `mult1.example.com` to the queue at `mult2.example.com`.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_PROPAGATION_RULES(
    schema_name              => 'hrmult',
    streams_name             => 'mult1_to_mult2',
    source_queue_name        => 'strmadmin.captured_mult1',
    destination_queue_name   => 'strmadmin.from_mult1@mult2.example.com',
    include_dml              => TRUE,
    include_ddl              => TRUE,
    source_database          => 'mult1.example.com',
    inclusion_rule           => TRUE,
    queue_to_queue           => TRUE);
END;
/

/*
```

Configure and schedule propagation of DML and DDL changes in the `hrmult` schema from the queue at `mult1.example.com` to the queue at `mult3.example.com`.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_PROPAGATION_RULES(
    schema_name                => 'hrmult',
    streams_name               => 'mult1_to_mult3',
    source_queue_name          => 'strmadmin.captured_mult1',
    destination_queue_name     => 'strmadmin.from_mult1@mult3.example.com',
    include_dml                => TRUE,
    include_ddl                => TRUE,
    source_database            => 'mult1.example.com',
    inclusion_rule             => TRUE,
    queue_to_queue             => TRUE);
END;
/

/*
```

Create the Capture Process at mult2.example.com.
Connect to `mult2.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@mult2.example.com

/*
```

Create the capture process to capture changes to the entire `hrmult` schema at `mult2.example.com`. This step also prepares the `hrmult` schema at `mult2.example.com` for instantiation.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_RULES(
    schema_name    => 'hrmult',
    streams_type   => 'capture',
    streams_name   => 'capture_hrmult',
    queue_name     => 'strmadmin.captured_mult2',
    include_dml    => TRUE,
    include_ddl    => TRUE,
    inclusion_rule => TRUE);
END;
/

/*
```

Set the Instantiation SCN for mult2.example.com at the Other Databases
In this example, the `hrmult` schema already exists at all of the databases. The tables in the schema exist only at `mult1.example.com` until they are instantiated at `mult2.example.com` and `mult3.example.com` in Step Instantiate the hrmult Schema at mult3.example.com. The instantiation is done using an import of the tables from `mult1.example.com`. These import operations set the schema instantiation SCNs for `mult1.example.com` at `mult2.example.com` and `mult3.example.com` automatically. However, the instantiation SCNs for `mult2.example.com` and `mult3.example.com` are not set automatically at the other sites in the environment. This step sets the schema instantiation SCN for `mult2.example.com` manually at `mult1.example.com` and `mult3.example.com`. The current SCN at `mult2.example.com` is obtained by using the `GET_SYSTEM_CHANGE_NUMBER` function in the `DBMS_FLASHBACK` package at `mult2.example.com`.

This SCN is used at `mult1.example.com` and `mult3.example.com` to run the `SET_SCHEMA_INSTANTIATION_SCN` procedure in the `DBMS_APPLY_ADM` package.
The `SET_SCHEMA_INSTANTIATION_SCN` procedure controls which DDL LCRs for a schema are ignored by an apply process and which DDL LCRs for a schema are applied by an apply process. If the commit SCN of a DDL LCR for a database object in a schema from a source database is less than or equal to the instantiation SCN for that database object at some destination database, then the apply process at the destination database disregards the DDL LCR. Otherwise, the apply process applies the DDL LCR.
Because you are running the `SET_SCHEMA_INSTANTIATION_SCN` procedure before the tables are instantiated at `mult2.example.com`, and because the local capture process is configured already, you do not need to run the `SET_TABLE_INSTANTIATION_SCN` for each table after the instantiation. In this example, an apply process at both `mult1.example.com` and `mult3.example.com` will apply transactions to the tables in the `hrmult` schema with SCNs that were committed after the SCN obtained in this step.

> **Note:**
>
> - In a case where you are instantiating a schema that does not exist, you can set the global instantiation SCN instead of the schema instantiation SCN.
> - In a case where the tables are instantiated before you set the instantiation SCN, you must set the schema instantiation SCN and the instantiation SCN for each table in the schema.

```
*/

DECLARE
  iscn  NUMBER;         -- Variable to hold instantiation SCN value
BEGIN
  iscn := DBMS_FLASHBACK.GET_SYSTEM_CHANGE_NUMBER();
  DBMS_APPLY_ADM.SET_SCHEMA_INSTANTIATION_SCN@MULT1.EXAMPLE.COM(
    source_schema_name    => 'hrmult',
    source_database_name  => 'mult2.example.com',
    instantiation_scn     => iscn);
  DBMS_APPLY_ADM.SET_SCHEMA_INSTANTIATION_SCN@MULT3.EXAMPLE.COM(
    source_schema_name    => 'hrmult',
    source_database_name  => 'mult2.example.com',
    instantiation_scn     => iscn);
END;
/

/*
```

Create One Apply Process at mult2.example.com for Each Source Database
Configure `mult2.example.com` to apply changes to the `hrmult` schema at `mult1.example.com`.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_RULES(
```

```
    schema_name     => 'hrmult',
    streams_type    => 'apply',
    streams_name    => 'apply_from_mult1',
    queue_name      => 'strmadmin.from_mult1',
    include_dml     => TRUE,
    include_ddl     => TRUE,
    source_database => 'mult1.example.com',
    inclusion_rule  => TRUE);
END;
/

/*
```

Configure `mult2.example.com` to apply changes to the `hrmult` schema at `mult3.example.com`.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_RULES(
    schema_name     => 'hrmult',
    streams_type    => 'apply',
    streams_name    => 'apply_from_mult3',
    queue_name      => 'strmadmin.from_mult3',
    include_dml     => TRUE,
    include_ddl     => TRUE,
    source_database => 'mult3.example.com',
    inclusion_rule  => TRUE);
END;
/

/*
```

Configure Propagation at mult2.example.com

Configure and schedule propagation of DML and DDL changes in the `hrmult` schema from the queue at `mult2.example.com` to the queue at `mult1.example.com`.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_PROPAGATION_RULES(
    schema_name             => 'hrmult',
    streams_name            => 'mult2_to_mult1',
    source_queue_name       => 'strmadmin.captured_mult2',
    destination_queue_name  => 'strmadmin.from_mult2@mult1.example.com',
    include_dml             => TRUE,
    include_ddl             => TRUE,
    source_database         => 'mult2.example.com',
    inclusion_rule          => TRUE,
    queue_to_queue          => TRUE);
END;
/

/*
```

Configure and schedule propagation of DML and DDL changes in the `hrmult` schema from the queue at `mult2.example.com` to the queue at `mult3.example.com`.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_PROPAGATION_RULES(
    schema_name             => 'hrmult',
    streams_name            => 'mult2_to_mult3',
    source_queue_name       => 'strmadmin.captured_mult2',
    destination_queue_name  => 'strmadmin.from_mult2@mult3.example.com',
    include_dml             => TRUE,
    include_ddl             => TRUE,
    source_database         => 'mult2.example.com',
    inclusion_rule          => TRUE,
    queue_to_queue          => TRUE);
END;
/

/*
```

Create the Capture Process at mult3.example.com
Connect to `mult3.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@mult3.example.com

/*
```

Create the capture process to capture changes to the entire `hrmult` schema at `mult3.example.com`. This step also prepares the `hrmult` schema at `mult3.example.com` for instantiation.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_RULES(
    schema_name    => 'hrmult',
    streams_type   => 'capture',
    streams_name   => 'capture_hrmult',
    queue_name     => 'strmadmin.captured_mult3',
    include_dml    => TRUE,
    include_ddl    => TRUE,
    inclusion_rule => TRUE);
END;
/

/*
```

Set the Instantiation SCN for mult3.example.com at the Other Databases
In this example, the `hrmult` schema already exists at all of the databases. The tables in the schema exist only at `mult1.example.com` until they are instantiated at `mult2.example.com` and `mult3.example.com` in Step Instantiate the hrmult Schema at mult3.example.com. The instantiation is done using an import of the tables from `mult1.example.com`. These import operations set the schema instantiation SCNs for `mult1.example.com` at `mult2.example.com` and `mult3.example.com` automatically. However, the instantiation SCNs for `mult2.example.com` and `mult3.example.com` are not set automatically at the other sites in the environment. This step sets the schema instantiation SCN for `mult3.example.com` manually at `mult1.example.com` and `mult2.example.com`. The current SCN at `mult3.example.com` is obtained by using the `GET_SYSTEM_CHANGE_NUMBER` function in the `DBMS_FLASHBACK` package at `mult3.example.com`.

This SCN is used at `mult1.example.com` and `mult2.example.com` to run the `SET_SCHEMA_INSTANTIATION_SCN` procedure in the `DBMS_APPLY_ADM` package.
The `SET_SCHEMA_INSTANTIATION_SCN` procedure controls which DDL LCRs for a schema are ignored by an apply process and which DDL LCRs for a schema are applied by an apply process. If the commit SCN of a DDL LCR for a database object in a schema from a source database is less than or equal to the instantiation SCN for that database object at some destination database, then the apply process at the destination database disregards the DDL LCR. Otherwise, the apply process applies the DDL LCR.
Because you are running the `SET_SCHEMA_INSTANTIATION_SCN` procedure before the tables are instantiated at `mult3.example.com`, and because the local capture process is configured already, you do not need to run the `SET_TABLE_INSTANTIATION_SCN` for each table after the instantiation. In this example, an apply process at both `mult1.example.com` and `mult2.example.com` will apply transactions to the tables in the `hrmult` schema with SCNs that were committed after the SCN obtained in this step.

> **Note:**
>
> - In a case where you are instantiating a schema that does not exist, you can set the global instantiation SCN instead of the schema instantiation SCN.
> - In a case where the tables are instantiated before you set the instantiation SCN, you must set the schema instantiation SCN and the instantiation SCN for each table in the schema.

```
*/

DECLARE
  iscn  NUMBER;         -- Variable to hold instantiation SCN value
BEGIN
  iscn := DBMS_FLASHBACK.GET_SYSTEM_CHANGE_NUMBER();
  DBMS_APPLY_ADM.SET_SCHEMA_INSTANTIATION_SCN@MULT1.EXAMPLE.COM(
    source_schema_name    => 'hrmult',
    source_database_name  => 'mult3.example.com',
    instantiation_scn     => iscn);
  DBMS_APPLY_ADM.SET_SCHEMA_INSTANTIATION_SCN@MULT2.EXAMPLE.COM(
    source_schema_name    => 'hrmult',
    source_database_name  => 'mult3.example.com',
    instantiation_scn     => iscn);
END;
/

/*
```

Create One Apply Process at mult3.example.com for Each Source Database
Configure `mult3.example.com` to apply changes to the `hrmult` schema at `mult1.example.com`.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_RULES(
```

```
    schema_name     => 'hrmult',
    streams_type    => 'apply',
    streams_name    => 'apply_from_mult1',
    queue_name      => 'strmadmin.from_mult1',
    include_dml     => TRUE,
    include_ddl     => TRUE,
    source_database => 'mult1.example.com',
    inclusion_rule  => TRUE);
END;
/

/*
```

Configure `mult3.example.com` to apply changes to the `hrmult` schema at `mult2.example.com`.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_RULES(
    schema_name     => 'hrmult',
    streams_type    => 'apply',
    streams_name    => 'apply_from_mult2',
    queue_name      => 'strmadmin.from_mult2',
    include_dml     => TRUE,
    include_ddl     => TRUE,
    source_database => 'mult2.example.com',
    inclusion_rule  => TRUE);
END;
/

/*
```

Configure Propagation at mult3.example.com

Configure and schedule propagation of DML and DDL changes in the `hrmult` schema from the queue at `mult3.example.com` to the queue at `mult1.example.com`.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_PROPAGATION_RULES(
    schema_name             => 'hrmult',
    streams_name            => 'mult3_to_mult1',
    source_queue_name       => 'strmadmin.captured_mult3',
    destination_queue_name  => 'strmadmin.from_mult3@mult1.example.com',
    include_dml             => TRUE,
    include_ddl             => TRUE,
    source_database         => 'mult3.example.com',
    inclusion_rule          => TRUE,
    queue_to_queue          => TRUE);
END;
/

/*
```

Configure and schedule propagation of DML and DDL changes in the `hrmult` schema from the queue at `mult3.example.com` to the queue at `mult2.example.com`.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_SCHEMA_PROPAGATION_RULES(
    schema_name             => 'hrmult',
    streams_name            => 'mult3_to_mult2',
    source_queue_name       => 'strmadmin.captured_mult3',
    destination_queue_name  => 'strmadmin.from_mult3@mult2.example.com',
    include_dml             => TRUE,
    include_ddl             => TRUE,
    source_database         => 'mult3.example.com',
    inclusion_rule          => TRUE,
    queue_to_queue          => TRUE);
END;
/

/*
```

Instantiate the hrmult Schema at mult2.example.com
This example performs a network Data Pump import of the `hrmult` schema from `mult1.example.com` to `mult2.example.com`. A network import means that Data Pump imports the database objects in the schema from `mult1.example.com` without using an export dump file.

> **See Also:**
>
> *Oracle Database Utilities* for information about performing an import

Connect to `mult2.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@mult2.example.com

/*
```

This example will do a schema-level import using the `DBMS_DATAPUMP` package. For simplicity, exceptions from any of the API calls will not be trapped. However, Oracle recommends that you define exception handlers and call `GET_STATUS` to retrieve more detailed error information if a failure occurs. If you want to monitor the import, then query the `DBA_DATAPUMP_JOBS` data dictionary view at the import database.

```
*/

SET SERVEROUTPUT ON
DECLARE
  h1                NUMBER;         -- Data Pump job handle
  mult2_instantscn  NUMBER;         -- Variable to hold current source SCN
  job_state         VARCHAR2(30);   -- To keep track of job state
  js                ku$_JobStatus;  -- The job status from GET_STATUS
  sts               ku$_Status;     -- The status object returned by GET_STATUS
  job_not_exist    exception;
  pragma exception_init(job_not_exist, -31626);
BEGIN
-- Create a (user-named) Data Pump job to do a schema-level import.
  h1 := DBMS_DATAPUMP.OPEN(
```

```
          operation   => 'IMPORT',
          job_mode    => 'SCHEMA',
          remote_link => 'MULT1.EXAMPLE.COM',
          job_name    => 'dp_mult2');
-- A metadata filter is used to specify the schema that owns the tables
-- that will be imported.
  DBMS_DATAPUMP.METADATA_FILTER(
    handle    => h1,
    name      => 'SCHEMA_EXPR',
    value     => '=''HRMULT''');
-- Get the current SCN of the source database, and set the FLASHBACK_SCN
-- parameter to this value to ensure consistency between all of the
-- objects in the schema.
  mult2_instantscn := DBMS_FLASHBACK.GET_SYSTEM_CHANGE_NUMBER@mult1.example.com();
  DBMS_DATAPUMP.SET_PARAMETER(
    handle => h1,
    name   => 'FLASHBACK_SCN',
    value  => mult2_instantscn);
-- Start the job.
  DBMS_DATAPUMP.START_JOB(h1);
-- The import job should be running. In the following loop, the job
-- is monitored until it completes.
  job_state := 'UNDEFINED';
  BEGIN
    WHILE (job_state != 'COMPLETED') AND (job_state != 'STOPPED') LOOP
      sts:=DBMS_DATAPUMP.GET_STATUS(
             handle  => h1,
             mask    => DBMS_DATAPUMP.KU$_STATUS_JOB_ERROR +
                        DBMS_DATAPUMP.KU$_STATUS_JOB_STATUS +
                        DBMS_DATAPUMP.KU$_STATUS_WIP,
             timeout => -1);
      js := sts.job_status;
      DBMS_LOCK.SLEEP(10);
      job_state := js.state;
    END LOOP;
  -- Gets an exception when job no longer exists
    EXCEPTION WHEN job_not_exist THEN
      DBMS_OUTPUT.PUT_LINE('Data Pump job has completed');
      DBMS_OUTPUT.PUT_LINE('Instantiation SCN: ' ||mult2_instantscn);
  END;
END;
/

/*
```

Instantiate the hrmult Schema at mult3.example.com
This example performs a network Data Pump import of the `hrmult` schema from `mult1.example.com` to `mult3.example.com`. A network import means that Data Pump imports the database objects in the schema from `mult1.example.com` without using an export dump file.

> **See Also:**
>
> *Oracle Database Utilities* for information about performing an import

Connect to `mult3.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@mult3.example.com

/*
```

This example will do a table import using the `DBMS_DATAPUMP` package. For simplicity, exceptions from any of the API calls will not be trapped. However, Oracle recommends that you define exception handlers and call `GET_STATUS` to retrieve more detailed error information if a failure occurs. If you want to monitor the import, then query the `DBA_DATAPUMP_JOBS` data dictionary view at the import database.

```
*/

SET SERVEROUTPUT ON
DECLARE
  h1                NUMBER;         -- Data Pump job handle
  mult3_instantscn  NUMBER;         -- Variable to hold current source SCN
  job_state         VARCHAR2(30);   -- To keep track of job state
  js                ku$_JobStatus;  -- The job status from GET_STATUS
  sts               ku$_Status;     -- The status object returned by GET_STATUS
  job_not_exist    exception;
  pragma exception_init(job_not_exist, -31626);
BEGIN
-- Create a (user-named) Data Pump job to do a schema-level import.
  h1 := DBMS_DATAPUMP.OPEN(
          operation   => 'IMPORT',
          job_mode    => 'SCHEMA',
          remote_link => 'MULT1.EXAMPLE.COM',
          job_name    => 'dp_mult3');
-- A metadata filter is used to specify the schema that owns the tables
-- that will be imported.
  DBMS_DATAPUMP.METADATA_FILTER(
    handle    => h1,
    name      => 'SCHEMA_EXPR',
    value     => '=''HRMULT''');
-- Get the current SCN of the source database, and set the FLASHBACK_SCN
-- parameter to this value to ensure consistency between all of the
-- objects in the schema.
  mult3_instantscn := DBMS_FLASHBACK.GET_SYSTEM_CHANGE_NUMBER@mult1.example.com();
  DBMS_DATAPUMP.SET_PARAMETER(
    handle => h1,
    name   => 'FLASHBACK_SCN',
    value  => mult3_instantscn);
-- Start the job.
  DBMS_DATAPUMP.START_JOB(h1);
-- The import job should be running. In the following loop, the job
-- is monitored until it completes.
  job_state := 'UNDEFINED';
  BEGIN
    WHILE (job_state != 'COMPLETED') AND (job_state != 'STOPPED') LOOP
      sts:=DBMS_DATAPUMP.GET_STATUS(
             handle  => h1,
             mask    => DBMS_DATAPUMP.KU$_STATUS_JOB_ERROR +
                        DBMS_DATAPUMP.KU$_STATUS_JOB_STATUS +
                        DBMS_DATAPUMP.KU$_STATUS_WIP,
             timeout => -1);
      js := sts.job_status;
      DBMS_LOCK.SLEEP(10);
```

```
      job_state := js.state;
    END LOOP;
  -- Gets an exception when job no longer exists
    EXCEPTION WHEN job_not_exist THEN
      DBMS_OUTPUT.PUT_LINE('Data Pump job has completed');
      DBMS_OUTPUT.PUT_LINE('Instantiation SCN: ' ||mult3_instantscn);
  END;
END;
/

/*
```

Configure Latest Time Conflict Resolution at mult2.example.com
Connect to `mult2.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@mult2.example.com

/*
```

Specify an update conflict handler for each table in the `hrmult` schema. For each table, designate the `time` column as the resolution column for a `MAXIMUM` conflict handler. When an update conflict occurs, such an update conflict handler applies the transaction with the latest (or greater) time and discards the transaction with the earlier (or lesser) time.

```
*/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1) := 'country_name';
  cols(2) := 'region_id';
  cols(3) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.countries',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
    column_list           =>  cols);
END;
/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1) := 'department_name';
  cols(2) := 'manager_id';
  cols(3) := 'location_id';
  cols(4) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.departments',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
    column_list           =>  cols);
END;
/

DECLARE
```

```
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1)  := 'first_name';
  cols(2)  := 'last_name';
  cols(3)  := 'email';
  cols(4)  := 'phone_number';
  cols(5)  := 'hire_date';
  cols(6)  := 'job_id';
  cols(7)  := 'salary';
  cols(8)  := 'commission_pct';
  cols(9)  := 'manager_id';
  cols(10) := 'department_id';
  cols(11) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.employees',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
    column_list           =>  cols);
END;
/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1) := 'job_title';
  cols(2) := 'min_salary';
  cols(3) := 'max_salary';
  cols(4) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.jobs',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
    column_list           =>  cols);
END;
/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1) := 'employee_id';
  cols(2) := 'start_date';
  cols(3) := 'end_date';
  cols(4) := 'job_id';
  cols(5) := 'department_id';
  cols(6) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.job_history',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
    column_list           =>  cols);
END;
/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1) := 'street_address';
  cols(2) := 'postal_code';
  cols(3) := 'city';
```

```
  cols(4) := 'state_province';
  cols(5) := 'country_id';
  cols(6) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.locations',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
    column_list           =>  cols);
END;
/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1) := 'region_name';
  cols(2) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.regions',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
    column_list           =>  cols);
END;
/

/*
```

Start the Apply Processes at mult2.example.com
Start both of the apply processes at `mult2.example.com`.

```
*/

BEGIN
  DBMS_APPLY_ADM.START_APPLY(
    apply_name  => 'apply_from_mult1');
END;
/

BEGIN
  DBMS_APPLY_ADM.START_APPLY(
    apply_name  => 'apply_from_mult3');
END;
/

/*
```

Configure Latest Time Conflict Resolution at mult3.example.com
Connect to `mult3.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@mult3.example.com

/*
```

Specify an update conflict handler for each table in the `hrmult` schema. For each table, designate the `time` column as the resolution column for a `MAXIMUM` conflict handler. When an update conflict occurs, such an update conflict handler applies the transaction with the latest (or greater) time and discards the transaction with the earlier (or lesser) time.

```
*/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1) := 'country_name';
  cols(2) := 'region_id';
  cols(3) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.countries',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
    column_list           =>  cols);
END;
/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1) := 'department_name';
  cols(2) := 'manager_id';
  cols(3) := 'location_id';
  cols(4) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.departments',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
    column_list           =>  cols);
END;
/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1)  := 'first_name';
  cols(2)  := 'last_name';
  cols(3)  := 'email';
  cols(4)  := 'phone_number';
  cols(5)  := 'hire_date';
  cols(6)  := 'job_id';
  cols(7)  := 'salary';
  cols(8)  := 'commission_pct';
  cols(9)  := 'manager_id';
  cols(10) := 'department_id';
  cols(11) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.employees',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
    column_list           =>  cols);
END;
/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1) := 'job_title';
  cols(2) := 'min_salary';
  cols(3) := 'max_salary';
```

```
  cols(4) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.jobs',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
    column_list           =>  cols);
END;
/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1) := 'employee_id';
  cols(2) := 'start_date';
  cols(3) := 'end_date';
  cols(4) := 'job_id';
  cols(5) := 'department_id';
  cols(6) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.job_history',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
    column_list           =>  cols);
END;
/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1) := 'street_address';
  cols(2) := 'postal_code';
  cols(3) := 'city';
  cols(4) := 'state_province';
  cols(5) := 'country_id';
  cols(6) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.locations',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
    column_list           =>  cols);
END;
/

DECLARE
  cols  DBMS_UTILITY.NAME_ARRAY;
BEGIN
  cols(1) := 'region_name';
  cols(2) := 'time';
  DBMS_APPLY_ADM.SET_UPDATE_CONFLICT_HANDLER(
    object_name           =>  'hrmult.regions',
    method_name           =>  'MAXIMUM',
    resolution_column     =>  'time',
    column_list           =>  cols);
END;
/

/*
```

Start the Apply Processes at mult3.example.com

Start both of the apply processes at `mult3.example.com`.

```
*/

BEGIN
  DBMS_APPLY_ADM.START_APPLY(
    apply_name  => 'apply_from_mult1');
END;
/

BEGIN
  DBMS_APPLY_ADM.START_APPLY(
    apply_name  => 'apply_from_mult2');
END;
/

/*
```

Start the Apply Processes at mult1.example.com
Connect to `mult1.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@mult1.example.com

/*
```

Start both of the apply processes at `mult1.example.com`.

```
*/

BEGIN
  DBMS_APPLY_ADM.START_APPLY(
    apply_name  => 'apply_from_mult2');
END;
/

BEGIN
  DBMS_APPLY_ADM.START_APPLY(
    apply_name  => 'apply_from_mult3');
END;
/

/*
```

Start the Capture Process at mult1.example.com
Start the capture process at `mult1.example.com`.

```
*/

BEGIN
  DBMS_CAPTURE_ADM.START_CAPTURE(
    capture_name  => 'capture_hrmult');
END;
/

/*
```

Start the Capture Process at mult2.example.com
Connect to `mult2.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@mult2.example.com

/*
```

Start the capture process at `mult2.example.com`.

```
*/

BEGIN
  DBMS_CAPTURE_ADM.START_CAPTURE(
    capture_name  => 'capture_hrmult');
END;
/

/*
```

Start the Capture Process at mult3.example.com
Connect to `mult3.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@mult3.example.com

/*
```

Start the capture process at `mult3.example.com`.

```
*/

BEGIN
  DBMS_CAPTURE_ADM.START_CAPTURE(
    capture_name  => 'capture_hrmult');
END;
/

SET ECHO OFF

/*
```

Check the Spool Results
Check the `streams_mult.out` spool file to ensure that all actions finished successfully after this script is completed.

```
*/

SET ECHO OFF
SPOOL OFF

/************************** END OF SCRIPT ******************************/
```

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide* for general instructions that explain how to add database objects or databases to the replication environment

3.6 Make DML and DDL Changes to Tables in the hrmult Schema

You can make DML and DDL changes to the tables in the `hrmult` schema at any of the databases in the environment. These changes will be replicated to the other databases in the environment, and you can run queries to view the replicated data.

For example, complete the following steps to make DML changes to the `hrmult.employees` table at `mult1.example.com` and `mult2.example.com`. To see the update conflict handler you configured earlier resolve an update conflict, you can make a change to the same row in these two databases and commit the changes at nearly the same time. You can query the changed row at each database in the environment to confirm that the changes were captured, propagated, and applied correctly.

You can also make a DDL change to the `hrmult.jobs` table at `mult3.example.com` and then confirm that the change was captured at `mult3.example.com`, propagated to the other databases in the environment, and applied at these databases.

Make a DML Change to hrmult.employees at mult.example.com and mult2.example.com
Make the following changes. To simulate a conflict, try to commit them at nearly the same time, but commit the change at `mult2.example.com` after you commit the change at `mult1.example.com`. The update conflict handler at each database will resolve the conflict.

```
CONNECT hrmult@mult1.example.com
Enter password: password

UPDATE hrmult.employees SET salary=9000 WHERE employee_id=206;
COMMIT;

CONNECT hrmult@mult2.example.com
Enter password: password

UPDATE hrmult.employees SET salary=10000 WHERE employee_id=206;
COMMIT;
```

Alter the hrmult.jobs Table at mult3.example.com
Alter the `hrmult.jobs` table by renaming the `job_title` column to `job_name`:

```
CONNECT hrmult@mult3.example.com
Enter password: password

ALTER TABLE hrmult.jobs RENAME COLUMN job_title TO job_name;
```

Query the hrmult.employees Table at Each Database
After some time passes to allow for capture, propagation, and apply of the changes performed in Step Make a DML Change to hrmult.employees at mult.example.com and mult2.example.com, run the following query to confirm that the `UPDATE` changes have been applied at each database.

```
CONNECT hrmult@mult1.example.com
Enter password: password

SELECT salary FROM hrmult.employees WHERE employee_id=206;
```

```
CONNECT hrmult@mult2.example.com
Enter password: password

SELECT salary FROM hrmult.employees WHERE employee_id=206;

CONNECT hrmult@mult3.example.com
Enter password: password

SELECT salary FROM hrmult.employees WHERE employee_id=206;
```

All of the queries should show `10000` for the value of the salary. The update conflict handler at each database has resolved the conflict by using the latest change to the row. In this case, the latest change to the row was made at the `mult2.example.com` database in Step Make a DML Change to hrmult.employees at mult.example.com and mult2.example.com.

Describe the hrmult.jobs Table at Each Database

After some time passes to allow for capture, propagation, and apply of the change performed in Step Alter the hrmult.jobs Table at mult3.example.com, describe the `hrmult.jobs` table at each database to confirm that the `ALTER TABLE` change was propagated and applied correctly.

```
CONNECT hrmult@mult1.example.com
Enter password: password

DESC hrmult.jobs

CONNECT hrmult@mult2.example.com
Enter password: password

DESC hrmult.jobs

CONNECT hrmult@mult3.example.com
Enter password: password

DESC hrmult.jobs
```

Each database should show `job_name` as the second column in the table.

4

Single-Database Capture and Apply Example

This chapter illustrates an example of a single database that captures changes to a table with a capture process, reenqueues the captured changes into a queue, and then uses a procedure DML handler during apply to insert a subset of the changes into a different table.

The following topics describe configuring an example single-database capture and apply example:

4.1 Overview of the Single-Database Capture and Apply Example

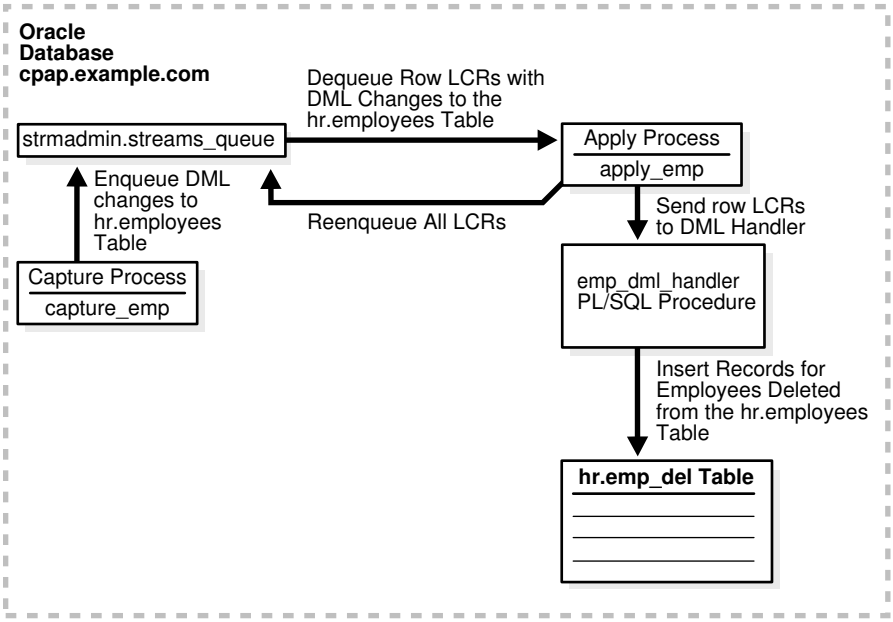
The example in this chapter illustrates using Oracle Streams to capture and apply data manipulation language (DML) changes at a single database named `cpap.example.com`. Specifically, this example captures DML changes to the `employees` table in the `hr` schema, placing row logical change records (LCRs) into a queue named `streams_queue`. Next, an apply process dequeues these row LCRs from the same queue, reenqueues them into this queue, and sends them to a procedure DML handler.

When the row LCRs are captured, they reside in the buffered queue and cannot be dequeued explicitly. After the row LCRs are reenqueued during apply, they are available for explicit dequeue by an application. This example does not create the application that dequeues these row LCRs.

This example illustrates a procedure DML handler that inserts records of deleted employees into an `emp_del` table in the `hr` schema. This example assumes that the `emp_del` table is used to retain the records of all deleted employees. The procedure DML handler is used to determine whether each row LCR contains a `DELETE` statement. When the procedure DML handler finds a row LCR containing a `DELETE` statement, it converts the `DELETE` into an `INSERT` on the `emp_del` table and then inserts the row.

Figure 4-1 provides an overview of the environment.

Figure 4-1 Single Database Capture and Apply Example



> **See Also:**
>
> *Oracle Streams Concepts and Administration*

4.2 Prerequisites

The following prerequisites must be completed before you begin the example in this chapter.

- Optionally set the `STREAMS_POOL_SIZE` initialization parameter to an appropriate value. This parameter specifies the size of the Oracle Streams pool. The Oracle Streams pool stores messages in a buffered queue and is used for internal communications during parallel capture and apply. When the `MEMORY_TARGET`, `MEMORY_MAX_TARGET`, or `SGA_TARGET` initialization parameter is set to a nonzero value, the Oracle Streams pool size is managed automatically.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide* for information about setting initialization parameters that are relevant to Oracle Streams

- Set the database to run in `ARCHIVELOG` mode. Any database producing changes that will be captured must run in `ARCHIVELOG` mode.

> **See Also:**
>
> *Oracle Database Administrator's Guide* for information about running a database in `ARCHIVELOG` mode

- Create an Oracle Streams administrator at the database. This example assumes that the user name of the Oracle Streams administrator is `strmadmin`.

  This example executes a subprogram in an Oracle Streams packages within a stored procedure. Specifically, the `emp_dq` procedure created in Step Create a Procedure to Dequeue the Messages runs the `DEQUEUE` procedure in the `DBMS_STREAMS_MESSAGING` package. Therefore, the Oracle Streams administrator must be granted `EXECUTE` privilege explicitly on the package. In this case, `EXECUTE` privilege cannot be granted through a role. The `DBMS_STREAMS_AUTH.GRANT_ADMIN_PRIVILEGE` procedure grants `EXECUTE` on all Oracle Streams packages, as well as other privileges relevant to Oracle Streams. You can either grant the `EXECUTE` privilege on the package directly, or use the `GRANT_ADMIN_PRIVILEGE` procedure to grant it.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide* for information about creating an Oracle Streams administrator

4.3 Set Up the Environment

Complete the following steps to create the `hr.emp_del` table, set up the Oracle Streams administrator, and create the queue.

1. Set Up the Environment
2. Create the hr.emp_del Table
3. Grant Additional Privileges to the Oracle Streams Administrator
4. Create the ANYDATA Queue at cpap.example.com
5. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect to the database.

```
/************************ BEGINNING OF SCRIPT ****************************
```

Show Output and Spool Results
Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/

SET ECHO ON
SPOOL streams_setup_capapp.out

/*
```

Create the hr.emp_del Table
Connect to `cpap.example.com` as the `hr` user.

```
*/

CONNECT hr@cpap.example.com

/*
```

Create the `hr.emp_del` table. The columns in the `emp_del` table is the same as the columns in the `employees` table, except for one added `timestamp` column that will record the date when a row is inserted into the `emp_del` table.

```
*/

CREATE TABLE emp_del(
  employee_id    NUMBER(6),
  first_name     VARCHAR2(20),
  last_name      VARCHAR2(25),
  email          VARCHAR2(25),
  phone_number   VARCHAR2(20),
  hire_date      DATE,
  job_id         VARCHAR2(10),
  salary         NUMBER(8,2),
  commission_pct NUMBER(2,2),
  manager_id     NUMBER(6),
  department_id  NUMBER(4),
  timestamp      DATE);

CREATE UNIQUE INDEX emp_del_id_pk ON emp_del (employee_id);

ALTER TABLE emp_del ADD (CONSTRAINT emp_del_id_pk PRIMARY KEY (employee_id));

/*
```

Grant Additional Privileges to the Oracle Streams Administrator
Connect to `cpap.example.com` as `SYSTEM` user.

```
*/

CONNECT SYSTEM@cpap.example.com

/*
```

Grant the Oracle Streams administrator all privileges on the `emp_del` table, because the Oracle Streams administrator will be the apply user and must be able to insert records into this table. Alternatively, you can alter the apply process to specify that `hr` is the apply user.

```
*/

GRANT ALL ON hr.emp_del TO STRMADMIN;

/*
```

Create the ANYDATA Queue at cpap.example.com
Connect to `cpap.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@cpap.example.com

/*
```

Run the `SET_UP_QUEUE` procedure to create a queue named `streams_queue` at `cpap.example.com`. This queue is an `ANYDATA` queue that will stage the captured changes to be dequeued by an apply process and the user-constructed changes to be dequeued by a dequeue procedure.
Running the `SET_UP_QUEUE` procedure performs the following actions:

- Creates a queue table named `streams_queue_table`. This queue table is owned by the Oracle Streams administrator (`strmadmin`) and uses the default storage of this user.
- Creates a queue named `streams_queue` owned by the Oracle Streams administrator (`strmadmin`).
- Starts the queue.

```
*/

BEGIN
  DBMS_STREAMS_ADM.SET_UP_QUEUE(
    queue_table  => 'strmadmin.streams_queue_table',
    queue_name   => 'strmadmin.streams_queue');
END;
/

/*
```

Check the Spool Results
Check the `streams_setup_capapp.out` spool file to ensure that all actions finished successfully after this script is completed.

```
*/

SET ECHO OFF
SPOOL OFF

/************************** END OF SCRIPT ******************************/
```

4.4 Configure Capture and Apply

Complete the following steps to capture changes to the `hr.employees` table and apply these changes on single database in a customized way using a procedure DML handler.

1. Show Output and Spool Results

2. Configure the Capture Process at cpap.example.com
3. Set the Instantiation SCN for the hr.employees Table
4. Create the Procedure DML Handler handler Procedure
5. Set the Procedure DML Handler for the hr.employees Table
6. Create a Messaging Client for the Queue
7. Configure the Apply Process at cpap.example.com
8. Create a Procedure to Dequeue the Messages
9. Start the Apply Process at cpap.example.com
10. Start the Capture Process at cpap.example.com
11. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect the database.

```
/************************* BEGINNING OF SCRIPT ******************************
```

Show Output and Spool Results
Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/

SET ECHO ON
SPOOL streams_config_capapp.out

/*
```

Configure the Capture Process at cpap.example.com
Connect to `cpap.example.com` as the `strmadmin` user.

```
*/

CONNECT strmadmin@cpap.example.com

/*
```

Configure the capture process to capture DML changes to the `hr.employees` table at `cpap.example.com`. This step creates the capture process and adds a rule to its positive rule set that instructs the capture process to capture DML changes to this table. This step also prepares the `hr.employees` table for instantiation and enables supplemental logging for any primary key, unique key, bitmap index, and foreign key columns in the table.

Supplemental logging places additional information in the redo log for changes made to tables. The apply process needs this extra information to perform some operations, such as unique row identification.

> **See Also:**
>
> *Oracle Streams Replication Administrator's Guide*

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_RULES(
    table_name     => 'hr.employees',
    streams_type   => 'capture',
    streams_name   => 'capture_emp',
    queue_name     => 'strmadmin.streams_queue',
    include_dml    =>  TRUE,
    include_ddl    =>  FALSE,
    inclusion_rule =>  TRUE);
END;
/

/*
```

Set the Instantiation SCN for the hr.employees Table

Because this example captures and applies changes in a single database, no instantiation is necessary. However, the apply process at the `cpap.example.com` database still must be instructed to apply changes that were made to the `hr.employees` table after a specific system change number (SCN).

This example uses the `GET_SYSTEM_CHANGE_NUMBER` function in the `DBMS_FLASHBACK` package to obtain the current SCN for the database. This SCN is used to run the `SET_TABLE_INSTANTIATION_SCN` procedure in the `DBMS_APPLY_ADM` package.

The `SET_TABLE_INSTANTIATION_SCN` procedure controls which LCRs for a table are ignored by an apply process and which LCRs for a table are applied by an apply process. If the commit SCN of an LCR for a table from a source database is less than or equal to the instantiation SCN for that table at a destination database, then the apply process at the destination database discards the LCR. Otherwise, the apply process applies the LCR. In this example, the `cpap.example.com` database is both the source database and the destination database.

The apply process will apply transactions to the `hr.employees` table with SCNs that were committed after SCN obtained in this step.

> **Note:**
>
> The `hr.employees` table also must be prepared for instantiation. This preparation was done automatically when the capture process was configured with a rule to capture DML changes to the `hr.employees` table in Step Configure the Capture Process at cpap.example.com.

```
*/
```

```
DECLARE
  iscn  NUMBER;         -- Variable to hold instantiation SCN value
BEGIN
  iscn := DBMS_FLASHBACK.GET_SYSTEM_CHANGE_NUMBER();
  DBMS_APPLY_ADM.SET_TABLE_INSTANTIATION_SCN(
    source_object_name    => 'hr.employees',
    source_database_name  => 'cpap.example.com',
    instantiation_scn     => iscn);
END;
/

/*
```

Create the Procedure DML Handler handler Procedure

This step creates the `emp_dml_handler` procedure. This procedure will be the procedure DML handler for `DELETE` changes to the `hr.employees` table. It converts any row LCR containing a `DELETE` command type into an `INSERT` row LCR and then inserts the converted row LCR into the `hr.emp_del` table by executing the row LCR.

```
*/

CREATE OR REPLACE PROCEDURE emp_dml_handler(in_any IN ANYDATA) IS
  lcr          SYS.LCR$_ROW_RECORD;
  rc           PLS_INTEGER;
  command      VARCHAR2(30);
  old_values   SYS.LCR$_ROW_LIST;
BEGIN
  -- Access the LCR
  rc := in_any.GETOBJECT(lcr);
  -- Get the object command type
  command := lcr.GET_COMMAND_TYPE();
  -- Check for DELETE command on the hr.employees table
  IF command = 'DELETE' THEN
    -- Set the command_type in the row LCR to INSERT
    lcr.SET_COMMAND_TYPE('INSERT');
    -- Set the object_name in the row LCR to EMP_DEL
    lcr.SET_OBJECT_NAME('EMP_DEL');
    -- Get the old values in the row LCR
    old_values := lcr.GET_VALUES('old');
    -- Set the old values in the row LCR to the new values in the row LCR
    lcr.SET_VALUES('new', old_values);
    -- Set the old values in the row LCR to NULL
    lcr.SET_VALUES('old', NULL);
    -- Add a SYSDATE value for the timestamp column
    lcr.ADD_COLUMN('new', 'TIMESTAMP', ANYDATA.ConvertDate(SYSDATE));
    -- Apply the row LCR as an INSERT into the hr.emp_del table
    lcr.EXECUTE(TRUE);
  END IF;
END;
/

/*
```

Set the Procedure DML Handler for the hr.employees Table

Set the procedure DML handler for the `hr.employees` table to the procedure created in Step Create the Procedure DML Handler handler Procedure. Notice that the `operation_name` parameter is set to `DEFAULT` so that the procedure DML handler is used for each possible operation on the table, including `INSERT`, `UPDATE`, and `DELETE`.

```
*/

BEGIN
  DBMS_APPLY_ADM.SET_DML_HANDLER(
    object_name         => 'hr.employees',
    object_type         => 'TABLE',
    operation_name      => 'DEFAULT',
    error_handler       => FALSE,
    user_procedure      => 'strmadmin.emp_dml_handler',
    apply_database_link => NULL,
    apply_name          => NULL);
END;
/

/*
```

Create a Messaging Client for the Queue

Create a messaging client that can be used by an application to dequeue the reenqueued messages. A messaging client must be specified before the messages can be reenqueued into the queue.

```
*/

BEGIN
  DBMS_STREAMS_ADM.ADD_TABLE_RULES(
    table_name     => 'hr.employees',
    streams_type   => 'dequeue',
    streams_name   => 'hr',
    queue_name     => 'strmadmin.streams_queue',
    include_dml    =>  TRUE,
    include_ddl    =>  FALSE,
    inclusion_rule =>  TRUE);
END;
/

/*
```

Configure the Apply Process at cpap.example.com

Create an apply process to apply DML changes to the `hr.employees` table. Although the procedure DML handler for the apply process causes deleted employees to be inserted into the `emp_del` table, this rule specifies the `employees` table, because the row LCRs in the queue contain changes to the `employees` table, not the `emp_del` table.

When you run the `ADD_TABLE_RULES` procedure to create the apply process, the out parameter `dml_rule_name` contains the name of the DML rule created. This rule name is then passed to the `SET_ENQUEUE_DESTINATION` procedure.

The `SET_ENQUEUE_DESTINATION` procedure in the `DBMS_APPLY_ADM` package specifies that any apply process using the DML rule generated by `ADD_TABLE_RULES` will enqueue messages that satisfy this rule into `streams_queue`. In this case, the DML rule is for row LCRs with DML changes to the `hr.employees` table. A local queue other than the apply process queue can be specified if appropriate.

```
*/

DECLARE
      emp_rule_name_dml  VARCHAR2(30);
      emp_rule_name_ddl  VARCHAR2(30);
BEGIN
```

```
  DBMS_STREAMS_ADM.ADD_TABLE_RULES(
    table_name      => 'hr.employees',
    streams_type    => 'apply',
    streams_name    => 'apply_emp',
    queue_name      => 'strmadmin.streams_queue',
    include_dml     =>  TRUE,
    include_ddl     =>  FALSE,
    source_database => 'cpap.example.com',
    dml_rule_name   => emp_rule_name_dml,
    ddl_rule_name   => emp_rule_name_ddl);
  DBMS_APPLY_ADM.SET_ENQUEUE_DESTINATION(
    rule_name               =>  emp_rule_name_dml,
    destination_queue_name  =>  'strmadmin.streams_queue');
END;
/

/*
```

Create a Procedure to Dequeue the Messages

The `emp_dq` procedure created in this step can be used to dequeue the messages that are reenqueued by the apply process. In Step Configure the Apply Process at cpap.example.com, the `SET_ENQUEUE_DESTINATION` procedure was used to instruct the apply process to enqueue row LCRs containing changes to the `hr.employees` table into `streams_queue`. When the `emp_dq` procedure is executed, it dequeues each row LCR in the queue and displays the type of command in the row LCR, either `INSERT`, `UPDATE`, or `DELETE`. Any information in the row LCRs can be accessed and displayed, not just the command type.

> **See Also:**
>
> *Oracle Streams Concepts and Administration* for more information about displaying information in LCRs

```
*/

CREATE OR REPLACE PROCEDURE emp_dq (consumer IN VARCHAR2) AS
  msg            ANYDATA;
  row_lcr        SYS.LCR$_ROW_RECORD;
  num_var        pls_integer;
  more_messages  BOOLEAN := TRUE;
  navigation     VARCHAR2(30);
BEGIN
  navigation := 'FIRST MESSAGE';
  WHILE (more_messages) LOOP
    BEGIN
      DBMS_STREAMS_MESSAGING.DEQUEUE(
        queue_name   => 'strmadmin.streams_queue',
        streams_name => consumer,
        payload      => msg,
        navigation   => navigation,
        wait         => DBMS_STREAMS_MESSAGING.NO_WAIT);
      IF msg.GETTYPENAME() = 'SYS.LCR$_ROW_RECORD' THEN
        num_var := msg.GetObject(row_lcr);
        DBMS_OUTPUT.PUT_LINE(row_lcr.GET_COMMAND_TYPE || ' row LCR dequeued');
      END IF;
```

```
      navigation := 'NEXT MESSAGE';
    COMMIT;
    EXCEPTION WHEN SYS.DBMS_STREAMS_MESSAGING.ENDOFCURTRANS THEN
                navigation := 'NEXT TRANSACTION';
              WHEN DBMS_STREAMS_MESSAGING.NOMOREMSGS THEN
                more_messages := FALSE;
                DBMS_OUTPUT.PUT_LINE('No more messages.');
              WHEN OTHERS THEN
                RAISE;
    END;
  END LOOP;
END;
/

/*
```

Start the Apply Process at cpap.example.com
Set the `disable_on_error` parameter to `n` so that the apply process will not be disabled if it encounters an error, and start the apply process at `cpap.example.com`.

```
*/

BEGIN
  DBMS_APPLY_ADM.SET_PARAMETER(
    apply_name  => 'apply_emp',
    parameter   => 'disable_on_error',
    value       => 'N');
END;
/

BEGIN
  DBMS_APPLY_ADM.START_APPLY(
    apply_name  => 'apply_emp');
END;
/

/*
```

Start the Capture Process at cpap.example.com
Start the capture process at `cpap.example.com`.

```
*/

BEGIN
  DBMS_CAPTURE_ADM.START_CAPTURE(
    capture_name  => 'capture_emp');
END;
/

/*
```

Check the Spool Results
Check the `streams_config_capapp.out` spool file to ensure that all actions finished successfully after this script is completed.

```
*/

SET ECHO OFF
SPOOL OFF
```

```
/************************** END OF SCRIPT ****************************/
```

4.5 Make DML Changes, Query for Results, and Dequeue Messages

Complete the following steps to confirm that apply process is configured correctly, make DML changes to the `hr.employees` table, query for the resulting inserts into the `hr.emp_del` table and the reenqueued messages in the `streams_queue_table`, and dequeue the messages that were reenqueued by the apply process:

1. Confirm the Rule Action Context
2. Perform an INSERT, UPDATE, and DELETE on hr.employees
3. Query the hr.emp_del Table and the streams_queue_table
4. Dequeue Messages Reenqueued by the Procedure DML Handler

Confirm the Rule Action Context

Step Configure the Apply Process at cpap.example.com creates an apply process rule that specifies a destination queue into which LCRs that satisfy the rule are enqueued. In this case, LCRs that satisfy the rule are row LCRs with changes to the `hr.employees` table.

Complete the following steps to confirm that the rule specifies a destination queue:

1. Run the following query to determine the name of the rule for DML changes to the `hr.employees` table used by the apply process `apply_emp`:

```
CONNECT strmadmin@cpap.example.com
Enter password: password

SELECT RULE_OWNER, RULE_NAME FROM DBA_STREAMS_RULES
  WHERE STREAMS_NAME = 'APPLY_EMP' AND
        STREAMS_TYPE = 'APPLY' AND
        SCHEMA_NAME  = 'HR' AND
        OBJECT_NAME  = 'EMPLOYEES' AND
        RULE_TYPE    = 'DML'
  ORDER BY RULE_NAME;
```

   Your output looks similar to the following:

```
RULE_OWNER                     RULE_NAME
------------------------------ ------------------------------
STRMADMIN                      EMPLOYEES3
```

2. View the action context for the rule returned by the query in Step 1:

```
COLUMN RULE_OWNER HEADING 'Rule Owner' FORMAT A15
COLUMN DESTINATION_QUEUE_NAME HEADING 'Destination Queue' FORMAT A30

SELECT RULE_OWNER, DESTINATION_QUEUE_NAME
  FROM DBA_APPLY_ENQUEUE
  WHERE RULE_NAME = 'EMPLOYEES3'
  ORDER BY DESTINATION_QUEUE_NAME;
```

Ensure that you substitute the rule name returned in Step 1 in the `WHERE` clause. Your output looks similar to the following:

```
Rule Owner      Destination Queue
--------------- ------------------------------
STRMADMIN       "STRMADMIN"."STREAMS_QUEUE"
```

The output should show that LCRs that satisfy the apply process rule are enqueued into `streams_queue`.

Perform an INSERT, UPDATE, and DELETE on hr.employees
Make the following DML changes to the `hr.employees` table.

```
CONNECT hr@cpap.example.com
Enter password: password

INSERT INTO hr.employees VALUES(207, 'JOHN', 'SMITH', 'JSMITH@EXAMPLE.COM',
  NULL, '07-JUN-94', 'AC_ACCOUNT', 777, NULL, NULL, 110);
COMMIT;

UPDATE hr.employees SET salary=5999 WHERE employee_id=207;
COMMIT;

DELETE FROM hr.employees WHERE employee_id=207;
COMMIT;
```

Query the hr.emp_del Table and the streams_queue_table
After some time passes to allow for capture and apply of the changes performed in the previous step, run the following queries to see the results:

```
CONNECT strmadmin@cpap.example.com
Enter password: password

SELECT employee_id, first_name, last_name, timestamp
  FROM hr.emp_del ORDER BY employee_id;

SELECT MSG_ID, MSG_STATE, CONSUMER_NAME
  FROM AQ$STREAMS_QUEUE_TABLE ORDER BY MSG_ID;
```

When you run the first query, you should see a record for the employee with an `employee_id` of `207`. This employee was deleted in the previous step. When you run the second query, you should see the reenqueued messages resulting from all of the changes in the previous step, and the `MSG_STATE` should be `READY` for these messages.

Dequeue Messages Reenqueued by the Procedure DML Handler
Use the `emp_dq` procedure to dequeue the messages that were reenqueued by the procedure DML handler.

```
SET SERVEROUTPUT ON SIZE 100000

EXEC emp_dq('HR');
```

For each row changed by a DML statement, one line is returned, and each line states the command type of the change (either `INSERT`, `UPDATE`, or `DELETE`). If you repeat the query on the queue table in Step Query the hr.emp_del Table and the streams_queue_table after the messages are dequeued, then the dequeued messages should have been consumed. That is, either the `MSG_STATE` should be `PROCESSED` for these messages, or the messages should no longer be in the queue.

```
SELECT MSG_ID, MSG_STATE, CONSUMER_NAME
  FROM AQ$STREAMS_QUEUE_TABLE ORDER BY MSG_ID;
```

5
Logical Change Records with LOBs Example

This chapter illustrates an example that creates a PL/SQL procedure for constructing and enqueuing LCRs that contain LOBs.

This chapter contains this topic:

- Example Script for Constructing and Enqueuing LCRs Containing LOBs

5.1 Example Script for Constructing and Enqueuing LCRs Containing LOBs

1. Show Output and Spool Results
2. Grant the Oracle Streams Administrator EXECUTE Privilege on DBMS_STREAMS_MESSAGING
3. Connect as the Oracle Streams Administrator
4. Create an ANYDATA Queue
5. Create and Start an Apply Process
6. Create a Schema with Tables Containing LOB Columns
7. Grant the Oracle Streams Administrator Necessary Privileges on the Tables
8. Create a PL/SQL Procedure to Enqueue LCRs Containing LOBs
9. Create the do_enq_clob Function to Enqueue CLOB Data
10. Enqueue CLOB Data Using the do_enq_clob Function
11. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect to all of the databases in the environment.

```
/************************ BEGINNING OF SCRIPT ******************************
```

Show Output and Spool Results

Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/

SET ECHO ON
SPOOL lob_construct.out

/*
```

Grant the Oracle Streams Administrator EXECUTE Privilege on DBMS_STREAMS_MESSAGING

Explicit `EXECUTE` privilege on the package is required because a procedure in the package is called in within a PL/SQL procedure in Step Create a PL/SQL Procedure to Enqueue LCRs Containing LOBs.

```
*/

CONNECT / AS SYSDBA;

GRANT EXECUTE ON DBMS_STREAMS_MESSAGING TO strmadmin;

/*
```

Connect as the Oracle Streams Administrator

```
*/


SET ECHO ON
SET FEEDBACK 1
SET NUMWIDTH 10
SET LINESIZE 80
SET TRIMSPOOL ON
SET TAB OFF
SET PAGESIZE 100
SET SERVEROUTPUT ON SIZE 100000

CONNECT strmadmin

/*
```

Create an ANYDATA Queue

```
*/


BEGIN
  DBMS_STREAMS_ADM.SET_UP_QUEUE(
    queue_table => 'lobex_queue_table',
    queue_name  => 'lobex_queue');
END;
/

/*
```

Create and Start an Apply Process

```
*/
```

```
BEGIN
  DBMS_APPLY_ADM.CREATE_APPLY(
    queue_name      => 'strmadmin.lobex_queue',
    apply_name      => 'apply_lob',
    apply_captured  => FALSE);
END;
/

BEGIN
  DBMS_APPLY_ADM.SET_PARAMETER(
    apply_name => 'apply_lob',
    parameter  => 'disable_on_error',
    value      => 'N');
END;
/

BEGIN
  DBMS_APPLY_ADM.START_APPLY(
    'apply_lob');
END;
/

/*
```

Create a Schema with Tables Containing LOB Columns

```
*/


CONNECT system

CREATE TABLESPACE lob_user_tbs DATAFILE 'lob_user_tbs.dbf'
  SIZE 5M REUSE AUTOEXTEND ON MAXSIZE UNLIMITED;

ACCEPT password PROMPT 'Enter password for user: ' HIDE

CREATE USER lob_user
IDENTIFIED BY &password
  DEFAULT TABLESPACE lob_user_tbs
  QUOTA UNLIMITED ON lob_user_tbs;

GRANT ALTER SESSION, CREATE CLUSTER, CREATE DATABASE LINK, CREATE SEQUENCE,
  CREATE SESSION, CREATE SYNONYM, CREATE TABLE, CREATE VIEW, CREATE INDEXTYPE,
  CREATE OPERATOR, CREATE PROCEDURE, CREATE TRIGGER, CREATE TYPE
TO lob_user;

CONNECT lob_user/lob_user_pw

CREATE TABLE with_clob (a  NUMBER PRIMARY KEY,
                        c1 CLOB,
                        c2 CLOB,
                        c3 CLOB);

CREATE TABLE with_blob (a NUMBER PRIMARY KEY,
                        b BLOB);

/*
```

Grant the Oracle Streams Administrator Necessary Privileges on the Tables
Granting these privileges enables the Oracle Streams administrator to get the LOB length for offset and to perform DML operations on the tables.

```
*/

GRANT ALL ON with_clob TO strmadmin;
GRANT ALL ON with_blob TO strmadmin;
COMMIT;

/*
```

Create a PL/SQL Procedure to Enqueue LCRs Containing LOBs

```
*/


CONNECT strmadmin

CREATE OR REPLACE PROCEDURE enq_row_lcr(source_dbname  VARCHAR2,
                                        cmd_type       VARCHAR2,
                                        obj_owner      VARCHAR2,
                                        obj_name       VARCHAR2,
                                        old_vals       SYS.LCR$_ROW_LIST,
                                        new_vals       SYS.LCR$_ROW_LIST) AS
  xr_lcr         SYS.LCR$_ROW_RECORD;
BEGIN
  xr_lcr := SYS.LCR$_ROW_RECORD.CONSTRUCT(
              source_database_name => source_dbname,
              command_type         => cmd_type,
              object_owner         => obj_owner,
              object_name          => obj_name,
              old_values           => old_vals,
              new_values           => new_vals);
  -- Enqueue a row lcr
  DBMS_STREAMS_MESSAGING.ENQUEUE(
        queue_name         => 'lobex_queue',
        payload            => ANYDATA.ConvertObject(xr_lcr));
END enq_row_lcr;
/
SHOW ERRORS

/*
```

Create the do_enq_clob Function to Enqueue CLOB Data

```
*/


-- Description of each variable:
-- src_dbname  : Source database name
-- tab_owner   : Table owner
-- tab_name    : Table name
-- col_name    : Name of the CLOB column
-- new_vals    : SYS.LCR$_ROW_LIST containing primary key and supplementally
--               logged colums
-- clob_data   : CLOB that contains data to be sent
-- offset      : Offset from which data should be sent, default is 1
-- lsize       : Size of data to be sent, default is 0
-- chunk_size  : Size used for creating LOB chunks, default is 2048
```

```
CREATE OR REPLACE FUNCTION do_enq_clob(src_dbname     VARCHAR2,
                                       tab_owner      VARCHAR2,
                                       tab_name       VARCHAR2,
                                       col_name       VARCHAR2,
                                       new_vals       SYS.LCR$_ROW_LIST,
                                       clob_data      CLOB,
                                       offset         NUMBER default 1,
                                       lsize          NUMBER default 0,
                                       chunk_size     NUMBER default 2048)
RETURN NUMBER IS
  lob_offset NUMBER; -- maintain lob offset
  newunit    SYS.LCR$_ROW_UNIT;
  tnewvals   SYS.LCR$_ROW_LIST;
  lob_flag   NUMBER;
  lob_data   VARCHAR2(32767);
  lob_size   NUMBER;
  unit_pos   NUMBER;
  final_size NUMBER;
  exit_flg   BOOLEAN;
  c_size     NUMBER;
  i          NUMBER;
BEGIN
  lob_size := DBMS_LOB.GETLENGTH(clob_data);
  unit_pos := new_vals.count + 1;
  tnewvals := new_vals;
  c_size   := chunk_size;
  i := 0;
  -- validate parameters
  IF (unit_pos <= 1) THEN
    DBMS_OUTPUT.PUT_LINE('Invalid new_vals list');
    RETURN 1;
  END IF;

  IF (c_size < 1) THEN
    DBMS_OUTPUT.PUT_LINE('Invalid LOB chunk size');
    RETURN 1;
  END IF;

  IF (lsize < 0 OR lsize > lob_size) THEN
    DBMS_OUTPUT.PUT_LINE('Invalid LOB size');
    RETURN 1;
  END IF;

  IF (offset < 1 OR offset >= lob_size) THEN
    DBMS_OUTPUT.PUT_LINE('Invalid lob offset');
    RETURN 1;
  ELSE
    lob_offset := offset;
  END IF;

  -- calculate final size
  IF (lsize = 0) THEN
    final_size := lob_size;
  ELSE
    final_size := lob_offset + lsize;
  END IF;

  --  The following output lines are for debugging purposes only.
```

```
-- DBMS_OUTPUT.PUT_LINE('Final size: ' || final_size);
-- DBMS_OUTPUT.PUT_LINE('Lob size: ' || lob_size);

IF (final_size < 1 OR final_size > lob_size) THEN
  DBMS_OUTPUT.PUT_LINE('Invalid lob size');
  RETURN 1;
END IF;

-- expand new_vals list for LOB column
tnewvals.extend();

exit_flg := FALSE;

-- Enqueue all LOB chunks
LOOP
  --  The following output line is for debugging purposes only.
  DBMS_OUTPUT.PUT_LINE('About to write chunk#' || i);
  i := i + 1;

  -- check if last LOB chunk
  IF ((lob_offset + c_size) < final_size) THEN
    lob_flag := DBMS_LCR.LOB_CHUNK;
  ELSE
    lob_flag := DBMS_LCR.LAST_LOB_CHUNK;
    exit_flg := TRUE;
    --  The following output line is for debugging purposes only.
    DBMS_OUTPUT.PUT_LINE('Last LOB chunk');
  END IF;

  --  The following output lines are for debugging purposes only.
  DBMS_OUTPUT.PUT_LINE('lob offset: ' || lob_offset);
  DBMS_OUTPUT.PUT_LINE('Chunk size: ' || to_char(c_size));

  lob_data := DBMS_LOB.SUBSTR(clob_data, c_size, lob_offset);

  -- create row unit for clob
  newunit := SYS.LCR$_ROW_UNIT(col_name,
                               ANYDATA.ConvertVarChar2(lob_data),
                               lob_flag,
                               lob_offset,
                               NULL);

  -- insert new LCR$_ROW_UNIT
  tnewvals(unit_pos) := newunit;

  -- enqueue lcr
  enq_row_lcr(
        source_dbname => src_dbname,
        cmd_type      => 'LOB WRITE',
        obj_owner     => tab_owner,
        obj_name      => tab_name,
        old_vals      => NULL,
        new_vals      => tnewvals);

  -- calculate next chunk size
  lob_offset := lob_offset + c_size;

  IF ((final_size - lob_offset) < c_size) THEN
    c_size := final_size - lob_offset + 1;
```

```
    END IF;

    --  The following output line is for debugging purposes only.
    DBMS_OUTPUT.PUT_LINE('Next chunk size : ' || TO_CHAR(c_size));

    IF (c_size < 1) THEN
      exit_flg := TRUE;
    END IF;

    EXIT WHEN exit_flg;

  END LOOP;

  RETURN 0;
END do_enq_clob;
/

SHOW ERRORS

/*
```

Enqueue CLOB Data Using the do_enq_clob Function

The `DBMS_OUTPUT` lines in the following example can be used for debugging purposes if necessary. If they are not needed, then they can be commented out or deleted.

```
*/

SET SERVEROUTPUT ON SIZE 100000
DECLARE
  c1_data CLOB;
  c2_data CLOB;
  c3_data CLOB;
  newunit1 SYS.LCR$_ROW_UNIT;
  newunit2 SYS.LCR$_ROW_UNIT;
  newunit3 SYS.LCR$_ROW_UNIT;
  newunit4 SYS.LCR$_ROW_UNIT;
  newvals  SYS.LCR$_ROW_LIST;
  big_data VARCHAR(22000);
  n        NUMBER;
BEGIN
  -- Create primary key for LCR$_ROW_UNIT
  newunit1 := SYS.LCR$_ROW_UNIT('A',
                                ANYDATA.ConvertNumber(3),
                                NULL,
                                NULL,
                                NULL);
  -- Create empty CLOBs
  newunit2 := sys.lcr$_row_unit('C1',
                                ANYDATA.ConvertVarChar2(NULL),
                                DBMS_LCR.EMPTY_LOB,
                                NULL,
                                NULL);
  newunit3 := SYS.LCR$_ROW_UNIT('C2',
                                ANYDATA.ConvertVarChar2(NULL),
                                DBMS_LCR.EMPTY_LOB,
                                NULL,
                                NULL);
  newunit4 := SYS.LCR$_ROW_UNIT('C3',
                                ANYDATA.ConvertVarChar2(NULL),
```

```
                              DBMS_LCR.EMPTY_LOB,
                              NULL,
                              NULL);
newvals := SYS.LCR$_ROW_LIST(newunit1,newunit2,newunit3,newunit4);

-- Perform an insert
enq_row_lcr(
  source_dbname => 'MYDB.EXAMPLE.COM',
  cmd_type      => 'INSERT',
  obj_owner     => 'LOB_USER',
  obj_name      => 'WITH_CLOB',
  old_vals      => NULL,
  new_vals      => newvals);

-- construct clobs
big_data := RPAD('Hello World', 1000, '_');
big_data := big_data || '#';
big_data := big_data || big_data || big_data || big_data || big_data;
DBMS_LOB.CREATETEMPORARY(
  lob_loc => c1_data,
  cache   => TRUE);
DBMS_LOB.WRITEAPPEND(
  lob_loc => c1_data,
  amount  => length(big_data),
  buffer  => big_data);

big_data := RPAD('1234567890#', 1000, '_');
big_data := big_data || big_data || big_data || big_data;
DBMS_LOB.CREATETEMPORARY(
  lob_loc => c2_data,
  cache   => TRUE);
DBMS_LOB.WRITEAPPEND(
  lob_loc => c2_data,
  amount  => length(big_data),
  buffer  => big_data);

big_data := RPAD('ASDFGHJKLQW', 2000, '_');
big_data := big_data || '#';
big_data := big_data || big_data || big_data || big_data || big_data;
DBMS_LOB.CREATETEMPORARY(
  lob_loc => c3_data,
  cache   => TRUE);
DBMS_LOB.WRITEAPPEND(
  lob_loc => c3_data,
  amount  => length(big_data),
  buffer  => big_data);

-- pk info
newunit1 := SYS.LCR$_ROW_UNIT('A',
                              ANYDATA.ConvertNumber(3),
                              NULL,
                              NULL,
                              NULL);
newvals  := SYS.LCR$_ROW_LIST(newunit1);

-- write c1 clob
n := do_enq_clob(
       src_dbname => 'MYDB.EXAMPLE.COM',
       tab_owner  => 'LOB_USER',
```

```
        tab_name   => 'WITH_CLOB',
        col_name   => 'C1',
        new_vals   => newvals,
        clob_data  => c1_data,
        offset     => 1,
        chunk_size => 1024);
  DBMS_OUTPUT.PUT_LINE('n=' || n);

  -- write c2 clob
  newvals  := SYS.LCR$_ROW_LIST(newunit1);
  n := do_enq_clob(
        src_dbname => 'MYDB.EXAMPLE.COM',
        tab_owner  => 'LOB_USER',
        tab_name   => 'WITH_CLOB',
        col_name   => 'C2',
        new_vals   => newvals,
        clob_data  => c2_data,
        offset     => 1,
        chunk_size => 2000);
  DBMS_OUTPUT.PUT_LINE('n=' || n);

  -- write c3 clob
  newvals  := SYS.LCR$_ROW_LIST(newunit1);
  n := do_enq_clob(src_dbname=>'MYDB.EXAMPLE.COM',
        tab_owner  => 'LOB_USER',
        tab_name   => 'WITH_CLOB',
        col_name   => 'C3',
        new_vals   => newvals,
        clob_data  => c3_data,
        offset     => 1,
        chunk_size => 500);
  DBMS_OUTPUT.PUT_LINE('n=' || n);

  COMMIT;

END;
/

/*
```

Check the Spool Results

Check the `lob_construct.out` spool file to ensure that all actions completed successfully after this script completes.

```
*/

SET ECHO OFF
SPOOL OFF

/************************** END OF SCRIPT ******************************/
```

After you run the script, you can check the `lob_user.with_clob` table to list the rows applied by the apply process. The `DBMS_LOCK.SLEEP` statement is used to give the apply process time to apply the enqueued rows.

```
CONNECT lob_user/lob_user_pw

EXECUTE DBMS_LOCK.SLEEP(10);
```

```
SELECT a, c1, c2, c3 FROM with_clob ORDER BY a;

SELECT a, LENGTH(c1), LENGTH(c2), LENGTH(c3) FROM with_clob ORDER BY a;
```

6
Rule-Based Application Example

This chapter illustrates a rule-based application that uses the Oracle rules engine.

The examples in this chapter are independent of Oracle Streams. That is, no Oracle Streams capture processes, propagations, apply processes, or messaging clients are clients of the rules engine in these examples, and no queues are used.

The following topics describe configuring examples of rules-based applications:

> **See Also:**
>
> *Oracle Streams Concepts and Administration*

6.1 Overview of the Rule-Based Application

Each example in this chapter creates a rule-based application that handles customer problems. The application uses rules to determine actions that must be completed based on the problem priority when a new problem is reported. For example, the application assigns each problem to a particular company center based on the problem priority.

The application enforces these rules using the rules engine. An evaluation context named `evalctx` is created to define the information surrounding a support problem. Rules are created based on the requirements described previously, and they are added to a rule set named `rs`.

The task of assigning problems is done by a user-defined procedure named `problem_dispatch`, which calls the rules engine to evaluate rules in the rule set `rs` and then takes appropriate action based on the rules that evaluate to `TRUE`.

6.2 Using Rules on Nontable Data Stored in Explicit Variables

This example illustrates how to use rules to evaluate data stored in explicit variables. This example handles customer problems based on priority and uses the following rules for handling customer problems:

- Assign all problems with priority greater than 2 to the San Jose Center.
- Assign all problems with priority less than or equal to 2 to the New York Center.
- Send an alert to the vice president of support for a problem with priority equal to 1.

The evaluation context contains only one explicit variable named `priority`, which refers to the priority of the problem being dispatched. The value for this variable is passed to `DBMS_RULE.EVALUATE` procedure by the `problem_dispatch` procedure.

Complete the following steps:

1. Show Output and Spool Results
2. Create the support User
3. Grant the support User the Necessary System Privileges on Rules
4. Create the evalctx Evaluation Context
5. Create the Rules that Correspond to Problem Priority
6. Create the rs Rule Set
7. Add the Rules to the Rule Set
8. Query the Data Dictionary
9. Create the problem_dispatch PL/SQL Procedure
10. Dispatch Sample Problems
11. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect to all of the databases in the environment.

```
/************************ BEGINNING OF SCRIPT ****************************
```

Show Output and Spool Results
Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/

SET ECHO ON
SPOOL rules_stored_variables.out

/*
```

Create the support User

```
*/


CONNECT SYSTEM

ACCEPT password PROMPT 'Enter password for user: ' HIDE

GRANT ALTER SESSION, CREATE CLUSTER, CREATE DATABASE LINK, CREATE SEQUENCE,
  CREATE SESSION, CREATE SYNONYM, CREATE TABLE, CREATE VIEW, CREATE INDEXTYPE,
  CREATE OPERATOR, CREATE PROCEDURE, CREATE TRIGGER, CREATE TYPE
TO support IDENTIFIED BY &password;

/*
```

Grant the support User the Necessary System Privileges on Rules

```
*/


BEGIN
  DBMS_RULE_ADM.GRANT_SYSTEM_PRIVILEGE(
    privilege    => DBMS_RULE_ADM.CREATE_RULE_SET_OBJ,
    grantee      => 'support',
    grant_option => FALSE);
  DBMS_RULE_ADM.GRANT_SYSTEM_PRIVILEGE(
    privilege    => DBMS_RULE_ADM.CREATE_RULE_OBJ,
    grantee      => 'support',
    grant_option => FALSE);
  DBMS_RULE_ADM.GRANT_SYSTEM_PRIVILEGE(
    privilege    => DBMS_RULE_ADM.CREATE_EVALUATION_CONTEXT_OBJ,
    grantee      => 'support',
    grant_option => FALSE);
END;
/

/*
```

Create the evalctx Evaluation Context

```
*/


CONNECT support

SET FEEDBACK 1
SET NUMWIDTH 10
SET LINESIZE 80
SET TRIMSPOOL ON
SET TAB OFF
SET PAGESIZE 100
SET SERVEROUTPUT ON
```

```
DECLARE
  vt SYS.RE$VARIABLE_TYPE_LIST;
BEGIN
  vt := SYS.RE$VARIABLE_TYPE_LIST(
    SYS.RE$VARIABLE_TYPE('priority', 'NUMBER', NULL, NULL));
  DBMS_RULE_ADM.CREATE_EVALUATION_CONTEXT(
    evaluation_context_name    => 'evalctx',
    variable_types             => vt,
    evaluation_context_comment => 'support problem definition');
END;
/

/*
```

Create the Rules that Correspond to Problem Priority

The following code creates one action context for each rule, and one name-value pair in each action context.

```
*/

DECLARE
  ac  SYS.RE$NV_LIST;
BEGIN
  ac := SYS.RE$NV_LIST(NULL);
  ac.ADD_PAIR('CENTER', ANYDATA.CONVERTVARCHAR2('San Jose'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name      => 'r1',
    condition      => ':priority > 2',
    action_context => ac,
    rule_comment   => 'Low priority problems');
  ac := SYS.RE$NV_LIST(NULL);
  ac.ADD_PAIR('CENTER', ANYDATA.CONVERTVARCHAR2('New York'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name      => 'r2',
    condition      => ':priority <= 2',
    action_context => ac,
    rule_comment   => 'High priority problems');
  ac := SYS.RE$NV_LIST(NULL);
  ac.ADD_PAIR('ALERT', ANYDATA.CONVERTVARCHAR2('John Doe'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name      => 'r3',
    condition      => ':priority = 1',
    action_context => ac,
    rule_comment   => 'Urgent problems');
END;
/

/*
```

Create the rs Rule Set

```
*/


BEGIN
  DBMS_RULE_ADM.CREATE_RULE_SET(
    rule_set_name      => 'rs',
    evaluation_context => 'evalctx',
    rule_set_comment   => 'support rules');
END;
```

```
/

/*
```

Add the Rules to the Rule Set

```
*/


BEGIN
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r1',
    rule_set_name => 'rs');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r2',
    rule_set_name => 'rs');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r3',
    rule_set_name => 'rs');
END;
/

/*
```

Query the Data Dictionary

At this point, you can view the evaluation context, rules, and rule set you created in the previous steps.

```
*/

COLUMN EVALUATION_CONTEXT_NAME HEADING 'Eval Context Name' FORMAT A30
COLUMN EVALUATION_CONTEXT_COMMENT HEADING 'Eval Context Comment' FORMAT A40

SELECT EVALUATION_CONTEXT_NAME, EVALUATION_CONTEXT_COMMENT
  FROM USER_EVALUATION_CONTEXTS
  ORDER BY EVALUATION_CONTEXT_NAME;

SET LONGCHUNKSIZE 4000
SET LONG 4000
COLUMN RULE_NAME HEADING 'Rule|Name' FORMAT A5
COLUMN RULE_CONDITION HEADING 'Rule Condition' FORMAT A35
COLUMN ACTION_CONTEXT_NAME HEADING 'Action|Context|Name' FORMAT A10
COLUMN ACTION_CONTEXT_VALUE HEADING 'Action|Context|Value' FORMAT A10

SELECT RULE_NAME,
       RULE_CONDITION,
       AC.NVN_NAME ACTION_CONTEXT_NAME,
       AC.NVN_VALUE.ACCESSVARCHAR2() ACTION_CONTEXT_VALUE
  FROM USER_RULES R, TABLE(R.RULE_ACTION_CONTEXT.ACTX_LIST) AC
  ORDER BY RULE_NAME;

COLUMN RULE_SET_NAME HEADING 'Rule Set Name' FORMAT A20
COLUMN RULE_SET_EVAL_CONTEXT_OWNER HEADING 'Eval Context|Owner' FORMAT A12
COLUMN RULE_SET_EVAL_CONTEXT_NAME HEADING 'Eval Context Name' FORMAT A25
COLUMN RULE_SET_COMMENT HEADING 'Rule Set|Comment' FORMAT A15

SELECT RULE_SET_NAME,
       RULE_SET_EVAL_CONTEXT_OWNER,
       RULE_SET_EVAL_CONTEXT_NAME,
       RULE_SET_COMMENT
```

```
  FROM USER_RULE_SETS
  ORDER BY RULE_SET_NAME;

/*
```

Create the problem_dispatch PL/SQL Procedure

```
*/


CREATE OR REPLACE PROCEDURE problem_dispatch (priority NUMBER)
IS
    vv        SYS.RE$VARIABLE_VALUE;
    vvl       SYS.RE$VARIABLE_VALUE_LIST;
    truehits  SYS.RE$RULE_HIT_LIST;
    maybehits SYS.RE$RULE_HIT_LIST;
    ac        SYS.RE$NV_LIST;
    namearray SYS.RE$NAME_ARRAY;
    name      VARCHAR2(30);
    cval      VARCHAR2(100);
    rnum      INTEGER;
    i         INTEGER;
    status    PLS_INTEGER;
BEGIN
  vv  := SYS.RE$VARIABLE_VALUE('priority',
                               ANYDATA.CONVERTNUMBER(priority));
  vvl := SYS.RE$VARIABLE_VALUE_LIST(vv);
  truehits := SYS.RE$RULE_HIT_LIST();
  maybehits := SYS.RE$RULE_HIT_LIST();
  DBMS_RULE.EVALUATE(
      rule_set_name        => 'support.rs',
      evaluation_context   => 'evalctx',
      variable_values      => vvl,
      true_rules           => truehits,
      maybe_rules          => maybehits);
  FOR rnum IN 1..truehits.COUNT LOOP
    DBMS_OUTPUT.PUT_LINE('Using rule '|| truehits(rnum).rule_name);
    ac := truehits(rnum).rule_action_context;
    namearray := ac.GET_ALL_NAMES;
      FOR i IN 1..namearray.count loop
        name := namearray(i);
        status := ac.GET_VALUE(name).GETVARCHAR2(cval);
        IF (name = 'CENTER') then
          DBMS_OUTPUT.PUT_LINE('Assigning problem to ' || cval);
        ELSIF (name = 'ALERT') THEN
          DBMS_OUTPUT.PUT_LINE('Sending alert to: '|| cval);
        END IF;
      END LOOP;
  END LOOP;
END;
/

/*
```

Dispatch Sample Problems

```
*/


EXECUTE problem_dispatch(1);
```

```
EXECUTE problem_dispatch(2);
EXECUTE problem_dispatch(3);
EXECUTE problem_dispatch(5);

/*
```

Check the Spool Results
Check the `rules_stored_variables.out` spool file to ensure that all actions completed successfully after this script completes.

```
*/

SET ECHO OFF
SPOOL OFF

/************************** END OF SCRIPT ******************************/
```

6.3 Using Rules on Data in Explicit Variables with Iterative Results

This example is the same as the previous example "Using Rules on Nontable Data Stored in Explicit Variables", except that this example returns evaluation results iteratively instead of all at once.

Complete the following steps:

1. Show Output and Spool Results
2. Ensure That You Have Completed the Preliminary Steps
3. Replace the problem_dispatch PL/SQL Procedure
4. Dispatch Sample Problems
5. Clean Up the Environment (Optional)
6. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect to all of the databases in the environment.

```
/************************ BEGINNING OF SCRIPT ****************************
```

Show Output and Spool Results
Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/
```

```
SET ECHO ON
SPOOL rules_stored_variables_iterative.out

/*
```

Ensure That You Have Completed the Preliminary Steps
Ensure that you have completed Steps Show Output and Spool Results to Query the Data Dictionary in the "Using Rules on Nontable Data Stored in Explicit Variables". If you have not completed these steps, then complete them before you continue.

```
*/

PAUSE Press <RETURN> to continue when the preliminary steps have been completed.

/*
```

Replace the problem_dispatch PL/SQL Procedure
Replace the `problem_dispatch` procedure created in Step Create the problem_dispatch PL/SQL Procedure with the procedure in this step. The difference between the two procedures is that the procedure created in Step Create the problem_dispatch PL/SQL Procedure returns all evaluation results at once while the procedure in this step returns evaluation results iteratively.

```
*/

CONNECT support

SET SERVEROUTPUT ON
CREATE OR REPLACE PROCEDURE problem_dispatch (priority NUMBER)
IS
    vv          SYS.RE$VARIABLE_VALUE;
    vvl         SYS.RE$VARIABLE_VALUE_LIST;
    truehits    BINARY_INTEGER;
    maybehits   BINARY_INTEGER;
    hit         SYS.RE$RULE_HIT;
    ac          SYS.RE$NV_LIST;
    namearray   SYS.RE$NAME_ARRAY;
    name        VARCHAR2(30);
    cval        VARCHAR2(100);
    i           INTEGER;
    status      PLS_INTEGER;
    iter_closed EXCEPTION;
    pragma exception_init(iter_closed, -25453);
BEGIN
  vv  := SYS.RE$VARIABLE_VALUE('priority',
                               ANYDATA.CONVERTNUMBER(priority));
  vvl := SYS.RE$VARIABLE_VALUE_LIST(vv);
  DBMS_RULE.EVALUATE(
      rule_set_name        => 'support.rs',
      evaluation_context   => 'evalctx',
      variable_values      => vvl,
      true_rules_iterator  => truehits,
      maybe_rules_iterator => maybehits);
  LOOP
    hit := DBMS_RULE.GET_NEXT_HIT(truehits);
    EXIT WHEN hit IS NULL;
    DBMS_OUTPUT.PUT_LINE('Using rule '|| hit.rule_name);
    ac := hit.rule_action_context;
    namearray := ac.GET_ALL_NAMES;
```

```
      FOR i IN 1..namearray.COUNT LOOP
        name := namearray(i);
        status := ac.GET_VALUE(name).GETVARCHAR2(cval);
        IF (name = 'CENTER') then
          DBMS_OUTPUT.PUT_LINE('Assigning problem to ' || cval);
        ELSIF (name = 'ALERT') THEN
          DBMS_OUTPUT.PUT_LINE('Sending alert to: '|| cval);
        END IF;
      END LOOP;
  END LOOP;
  -- Close iterators
  BEGIN
    DBMS_RULE.CLOSE_ITERATOR(truehits);
  EXCEPTION
    WHEN iter_closed THEN
      NULL;
  END;
  BEGIN
    DBMS_RULE.CLOSE_ITERATOR(maybehits);
  EXCEPTION
    WHEN iter_closed THEN
      NULL;
  END;
END;
/

/*
```

Dispatch Sample Problems

```
*/


EXECUTE problem_dispatch(1);
EXECUTE problem_dispatch(2);
EXECUTE problem_dispatch(3);
EXECUTE problem_dispatch(5);

/*
```

Clean Up the Environment (Optional)

You can clean up the sample environment by dropping the `support` user.

```
*/

CONNECT SYSTEM

DROP USER support CASCADE;

/*
```

Check the Spool Results

Check the `rules_stored_variables_iterative.out` spool file to ensure that all actions completed successfully after this script completes.

```
*/

SET ECHO OFF
SPOOL OFF

/************************** END OF SCRIPT *****************************/
```

6.4 Using Partial Evaluation of Rules on Data in Explicit Variables

This example illustrates how to use partial evaluation when an event causes rules to evaluate to `MAYBE` instead of `TRUE` or `FALSE`. This example handles customer problems based on priority and problem type, and uses the following rules for handling customer problems:

- Assign all problems whose problem type is `HARDWARE` to the San Jose Center.
- Assign all problems whose problem type is `SOFTWARE` to the New York Center.
- Assign all problems whose problem type is `NULL` (unknown) to the Texas Center.
- Send an alert to the vice president of support for a problem with priority equal to 1.

Problems whose problem type is `NULL` evaluate to `MAYBE`. This example uses partial evaluation to take an action when `MAYBE` rules are returned to the rules engine client. In this case, the action is to assign the problem to the Texas Center.

The evaluation context contains an explicit variable named `priority`, which refers to the priority of the problem being dispatched. The evaluation context also contains an explicit variable named `problem_type`, which refers to the type of problem being dispatched (either `HARDWARE` or `SOFTWARE`). The values for these variables are passed to `DBMS_RULE.EVALUATE` procedure by the `problem_dispatch` procedure.

Complete the following steps:

1. Show Output and Spool Results
2. Create the support User
3. Grant the support User the Necessary System Privileges on Rules
4. Create the evalctx Evaluation Context
5. Create the Rules that Correspond to Problem Priority
6. Create the rs Rule Set
7. Add the Rules to the Rule Set
8. Query the Data Dictionary
9. Create the problem_dispatch PL/SQL Procedure
10. Dispatch Sample Problems
11. Clean Up the Environment (Optional)
12. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect to all of the databases in the environment.

```
/************************ BEGINNING OF SCRIPT ******************************
```

Show Output and Spool Results

Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/

SET ECHO ON
SPOOL rules_stored_variables_partial.out

/*
```

Create the support User

```
*/


CONNECT SYSTEM

ACCEPT password PROMPT 'Enter password for user: ' HIDE

GRANT ALTER SESSION, CREATE CLUSTER, CREATE DATABASE LINK, CREATE SEQUENCE,
  CREATE SESSION, CREATE SYNONYM, CREATE TABLE, CREATE VIEW, CREATE INDEXTYPE,
  CREATE OPERATOR, CREATE PROCEDURE, CREATE TRIGGER, CREATE TYPE
TO support IDENTIFIED BY &password;

/*
```

Grant the support User the Necessary System Privileges on Rules

```
*/


BEGIN
  DBMS_RULE_ADM.GRANT_SYSTEM_PRIVILEGE(
    privilege    => DBMS_RULE_ADM.CREATE_RULE_SET_OBJ,
    grantee      => 'support',
    grant_option => FALSE);
  DBMS_RULE_ADM.GRANT_SYSTEM_PRIVILEGE(
    privilege    => DBMS_RULE_ADM.CREATE_RULE_OBJ,
    grantee      => 'support',
    grant_option => FALSE);
  DBMS_RULE_ADM.GRANT_SYSTEM_PRIVILEGE(
    privilege    => DBMS_RULE_ADM.CREATE_EVALUATION_CONTEXT_OBJ,
    grantee      => 'support',
    grant_option => FALSE);
END;
```

```
/

/*
```

Create the evalctx Evaluation Context

```
*/


CONNECT support

SET FEEDBACK 1
SET NUMWIDTH 10
SET LINESIZE 80
SET TRIMSPOOL ON
SET TAB OFF
SET PAGESIZE 100
SET SERVEROUTPUT ON
DECLARE
  vt  SYS.RE$VARIABLE_TYPE_LIST;
BEGIN
  vt := SYS.RE$VARIABLE_TYPE_LIST(
        SYS.RE$VARIABLE_TYPE('priority', 'NUMBER', NULL, NULL),
        SYS.RE$VARIABLE_TYPE('problem_type', 'VARCHAR2(30)', NULL, NULL));
  DBMS_RULE_ADM.CREATE_EVALUATION_CONTEXT(
    evaluation_context_name    => 'evalctx',
    variable_types             => vt,
    evaluation_context_comment => 'support problem definition');
end;
/

/*
```

Create the Rules that Correspond to Problem Priority

The following code creates one action context for each rule, and one name-value pair in each action context.

```
*/

DECLARE
  ac  SYS.RE$NV_LIST;
begin
  ac := SYS.RE$NV_LIST(NULL);
  ac.ADD_PAIR('ALERT', ANYDATA.CONVERTVARCHAR2('John Doe'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name      => 'r1',
    condition      => ':priority = 1',
    action_context => ac,
    rule_comment   => 'Urgent problems');
  ac := sys.re$nv_list(NULL);
  ac.ADD_PAIR('TRUE CENTER', ANYDATA.CONVERTVARCHAR2('San Jose'));
  ac.ADD_PAIR('MAYBE CENTER', ANYDATA.CONVERTVARCHAR2('Texas'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name       => 'r2',
    condition       => ':problem_type = ''HARDWARE''',
    action_context  => ac,
    rule_comment    => 'Hardware problems');
  ac := sys.re$nv_list(NULL);
  ac.ADD_PAIR('TRUE CENTER', ANYDATA.CONVERTVARCHAR2('New York'));
  ac.ADD_PAIR('MAYBE CENTER', ANYDATA.CONVERTVARCHAR2('Texas'));
```

```
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name       => 'r3',
    condition       => ':problem_type = ''SOFTWARE''',
    action_context  => ac,
    rule_comment    => 'Software problems');
END;
/

/*
```

Create the rs Rule Set

```
*/


BEGIN
  DBMS_RULE_ADM.CREATE_RULE_SET(
    rule_set_name      => 'rs',
    evaluation_context => 'evalctx',
    rule_set_comment   => 'support rules');
END;
/

/*
```

Add the Rules to the Rule Set

```
*/


BEGIN
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r1',
    rule_set_name => 'rs');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r2',
    rule_set_name => 'rs');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r3',
    rule_set_name => 'rs');
END;
/

/*
```

Query the Data Dictionary

At this point, you can view the evaluation context, rules, and rule set you created in the previous steps.

```
*/

COLUMN EVALUATION_CONTEXT_NAME HEADING 'Eval Context Name' FORMAT A30
COLUMN EVALUATION_CONTEXT_COMMENT HEADING 'Eval Context Comment' FORMAT A40

SELECT EVALUATION_CONTEXT_NAME, EVALUATION_CONTEXT_COMMENT
  FROM USER_EVALUATION_CONTEXTS
  ORDER BY EVALUATION_CONTEXT_NAME;

SET LONGCHUNKSIZE 4000
SET LONG 4000
```

```
COLUMN RULE_NAME HEADING 'Rule|Name' FORMAT A5
COLUMN RULE_CONDITION HEADING 'Rule Condition' FORMAT A35
COLUMN ACTION_CONTEXT_NAME HEADING 'Action|Context|Name' FORMAT A10
COLUMN ACTION_CONTEXT_VALUE HEADING 'Action|Context|Value' FORMAT A10

SELECT RULE_NAME,
       RULE_CONDITION,
       AC.NVN_NAME ACTION_CONTEXT_NAME,
       AC.NVN_VALUE.ACCESSVARCHAR2() ACTION_CONTEXT_VALUE
  FROM USER_RULES R, TABLE(R.RULE_ACTION_CONTEXT.ACTX_LIST) AC
  ORDER BY RULE_NAME;

COLUMN RULE_SET_NAME HEADING 'Rule Set Name' FORMAT A20
COLUMN RULE_SET_EVAL_CONTEXT_OWNER HEADING 'Eval Context|Owner' FORMAT A12
COLUMN RULE_SET_EVAL_CONTEXT_NAME HEADING 'Eval Context Name' FORMAT A25
COLUMN RULE_SET_COMMENT HEADING 'Rule Set|Comment' FORMAT A15

SELECT RULE_SET_NAME,
       RULE_SET_EVAL_CONTEXT_OWNER,
       RULE_SET_EVAL_CONTEXT_NAME,
       RULE_SET_COMMENT
  FROM USER_RULE_SETS
  ORDER BY RULE_SET_NAME;

/*
```

Create the problem_dispatch PL/SQL Procedure

```
*/


CREATE OR REPLACE PROCEDURE problem_dispatch (priority     NUMBER,
                                              problem_type VARCHAR2 := NULL)
IS
    vvl       SYS.RE$VARIABLE_VALUE_LIST;
    truehits  SYS.RE$RULE_HIT_LIST;
    maybehits SYS.RE$RULE_HIT_LIST;
    ac        SYS.RE$NV_LIST;
    namearray SYS.RE$NAME_ARRAY;
    name      VARCHAR2(30);
    cval      VARCHAR2(100);
    rnum      INTEGER;
    i         INTEGER;
    status    PLS_INTEGER;
BEGIN
  IF (problem_type IS NULL) THEN
    vvl  := SYS.RE$VARIABLE_VALUE_LIST(
            SYS.RE$VARIABLE_VALUE('priority',
                                  ANYDATA.CONVERTNUMBER(priority)));
  ELSE
    vvl  := SYS.RE$VARIABLE_VALUE_LIST(
            SYS.RE$VARIABLE_VALUE('priority',
                                  ANYDATA.CONVERTNUMBER(priority)),
            SYS.RE$VARIABLE_VALUE('problem_type',
                                  ANYDATA.CONVERTVARCHAR2(problem_type)));
  END IF;
  truehits := SYS.RE$RULE_HIT_LIST();
  maybehits := SYS.RE$RULE_HIT_LIST();
  DBMS_RULE.EVALUATE(
      rule_set_name        => 'support.rs',
```

```
      evaluation_context   => 'evalctx',
      variable_values      => vvl,
      true_rules           => truehits,
      maybe_rules          => maybehits);
  FOR rnum IN 1..truehits.COUNT LOOP
    DBMS_OUTPUT.PUT_LINE('Using rule '|| truehits(rnum).rule_name);
    ac := truehits(rnum).rule_action_context;
    namearray := ac.GET_ALL_NAMES;
      FOR i IN 1..namearray.count LOOP
        name := namearray(i);
        status := ac.GET_VALUE(name).GETVARCHAR2(cval);
        IF (name = 'TRUE CENTER') then
          DBMS_OUTPUT.PUT_LINE('Assigning problem to ' || cval);
        ELSIF (name = 'ALERT') THEN
          DBMS_OUTPUT.PUT_LINE('Sending alert to: '|| cval);
        END IF;
      END LOOP;
  END LOOP;
  FOR rnum IN 1..maybehits.COUNT LOOP
    DBMS_OUTPUT.PUT_LINE('Using rule '|| maybehits(rnum).rule_name);
    ac := maybehits(rnum).rule_action_context;
    namearray := ac.GET_ALL_NAMES;
      FOR i IN 1..namearray.count loop
        name := namearray(i);
        status := ac.GET_VALUE(name).GETVARCHAR2(cval);
        IF (name = 'MAYBE CENTER') then
          DBMS_OUTPUT.PUT_LINE('Assigning problem to ' || cval);
        END IF;
      END LOOP;
  END LOOP;
END;
/

/*
```

Dispatch Sample Problems

The first problem dispatch in this step uses partial evaluation and takes an action based on the partial evaluation. Specifically, the first problem dispatch specifies that the `priority` is `1` and the `problem_type` is `NULL`. In this case, the rules engine returns a `MAYBE` rule for the event, and the `problem_dispatch` procedure assigns the problem to the Texas center.

The second and third problem dispatches do not use partial evaluation. Each of these problems evaluate to `TRUE` for a rule, and the problem is assigned accordingly by the `problem_dispatch` procedure.

```
*/

EXECUTE problem_dispatch(1, NULL);
EXECUTE problem_dispatch(2, 'HARDWARE');
EXECUTE problem_dispatch(3, 'SOFTWARE');

/*
```

Clean Up the Environment (Optional)

You can clean up the sample environment by dropping the `support` user.

```
*/

CONNECT SYSTEM
```

```
DROP USER support CASCADE;

/*
```

Check the Spool Results
Check the `rules_stored_variables_partial.out` spool file to ensure that all actions completed successfully after this script completes.

```
*/

SET ECHO OFF
SPOOL OFF

/************************** END OF SCRIPT *****************************/
```

6.5 Using Rules on Data Stored in a Table

This example illustrates how to use rules to evaluate data stored in a table. This example is similar to the example described in "Using Rules on Nontable Data Stored in Explicit Variables". In both examples, the application routes customer problems based on priority. However, in this example, the problems are stored in a table instead of variables.

The application uses the `problems` table in the `support` schema, into which customer problems are inserted. This example uses the following rules for handling customer problems:

- Assign all problems with priority greater than 2 to the San Jose Center.
- Assign all problems with priority less than or equal to 2 to the New York Center.
- Send an alert to the vice president of support for a problem with priority equal to 1.

The evaluation context consists of the `problems` table. The relevant row of the table, which corresponds to the problem being routed, is passed to the `DBMS_RULE.EVALUATE` procedure as a table value.

Complete the following steps:

1. Show Output and Spool Results
2. Create the support User
3. Grant the support User the Necessary System Privileges on Rules
4. Create the problems Table
5. Create the evalctx Evaluation Context
6. Create the Rules that Correspond to Problem Priority
7. Create the rs Rule Set
8. Add the Rules to the Rule Set
9. Create the problem_dispatch PL/SQL Procedure
10. Log Problems
11. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect to all of the databases in the environment.

```
/************************ BEGINNING OF SCRIPT ******************************
```

Show Output and Spool Results

Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/

SET ECHO ON
SPOOL rules_table.out

/*
```

Create the support User

```
*/


CONNECT SYSTEM

CREATE TABLESPACE support_tbs1 DATAFILE 'support_tbs1.dbf'
  SIZE 5M REUSE AUTOEXTEND ON MAXSIZE UNLIMITED;

ACCEPT password PROMPT 'Enter password for user: ' HIDE

CREATE USER support
IDENTIFIED BY &password
  DEFAULT TABLESPACE support_tbs1
  QUOTA UNLIMITED ON support_tbs1;

GRANT ALTER SESSION, CREATE CLUSTER, CREATE DATABASE LINK, CREATE SEQUENCE,
  CREATE SESSION, CREATE SYNONYM, CREATE TABLE, CREATE VIEW, CREATE INDEXTYPE,
  CREATE OPERATOR, CREATE PROCEDURE, CREATE TRIGGER, CREATE TYPE
TO support;

/*
```

Grant the support User the Necessary System Privileges on Rules

```
*/


BEGIN
  DBMS_RULE_ADM.GRANT_SYSTEM_PRIVILEGE(
    privilege    => DBMS_RULE_ADM.CREATE_RULE_SET_OBJ,
    grantee      => 'support',
    grant_option => FALSE);
  DBMS_RULE_ADM.GRANT_SYSTEM_PRIVILEGE(
```

```
    privilege    => DBMS_RULE_ADM.CREATE_RULE_OBJ,
    grantee      => 'support',
    grant_option => FALSE);
  DBMS_RULE_ADM.GRANT_SYSTEM_PRIVILEGE(
    privilege    => DBMS_RULE_ADM.CREATE_EVALUATION_CONTEXT_OBJ,
    grantee      => 'support',
    grant_option => FALSE);
END;
/

/*
```

Create the problems Table

```
*/


CONNECT support

SET FEEDBACK 1
SET NUMWIDTH 10
SET LINESIZE 80
SET TRIMSPOOL ON
SET TAB OFF
SET PAGESIZE 100
SET SERVEROUTPUT ON

CREATE TABLE problems(
  probid          NUMBER PRIMARY KEY,
  custid          NUMBER,
  priority        NUMBER,
  description     VARCHAR2(4000),
  center          VARCHAR2(100));

/*
```

Create the evalctx Evaluation Context

```
*/


DECLARE
  ta  SYS.RE$TABLE_ALIAS_LIST;
BEGIN
  ta := SYS.RE$TABLE_ALIAS_LIST(SYS.RE$TABLE_ALIAS('prob', 'problems'));
  DBMS_RULE_ADM.CREATE_EVALUATION_CONTEXT(
    evaluation_context_name    => 'evalctx',
    table_aliases              => ta,
    evaluation_context_comment => 'support problem definition');
END;
/

/*
```

Create the Rules that Correspond to Problem Priority

The following code creates one action context for each rule, and one name-value pair in each action context.

```
*/
```

```
DECLARE
  ac  SYS.RE$NV_LIST;
BEGIN
  ac := SYS.RE$NV_LIST(NULL);
  ac.ADD_PAIR('CENTER', ANYDATA.CONVERTVARCHAR2('San Jose'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name      => 'r1',
    condition      => 'prob.priority > 2',
    action_context => ac,
    rule_comment   => 'Low priority problems');
  ac := SYS.RE$NV_LIST(NULL);
  ac.ADD_PAIR('CENTER', ANYDATA.CONVERTVARCHAR2('New York'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name      => 'r2',
    condition      => 'prob.priority <= 2',
    action_context => ac,
    rule_comment   => 'High priority problems');
  ac := sys.RE$NV_LIST(NULL);
  ac.ADD_PAIR('ALERT', ANYDATA.CONVERTVARCHAR2('John Doe'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name      => 'r3',
    condition      => 'prob.priority = 1',
    action_context => ac,
    rule_comment   => 'Urgent problems');
END;
/

/*
```

Create the rs Rule Set

```
*/


BEGIN
  DBMS_RULE_ADM.CREATE_RULE_SET(
    rule_set_name      => 'rs',
    evaluation_context => 'evalctx',
    rule_set_comment   => 'support rules');
END;
/

/*
```

Add the Rules to the Rule Set

```
*/


BEGIN
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r1',
    rule_set_name => 'rs');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r2',
    rule_set_name => 'rs');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r3',
    rule_set_name => 'rs');
END;
```

```
/

/*
```

Create the problem_dispatch PL/SQL Procedure

```
*/


CREATE OR REPLACE PROCEDURE problem_dispatch
IS
    cursor c IS SELECT probid, rowid FROM problems WHERE center IS NULL;
    tv        SYS.RE$TABLE_VALUE;
    tvl       SYS.RE$TABLE_VALUE_LIST;
    truehits  SYS.RE$RULE_HIT_LIST;
    maybehits SYS.RE$RULE_HIT_LIST;
    ac        SYS.RE$NV_LIST;
    namearray SYS.RE$NAME_ARRAY;
    name      VARCHAR2(30);
    cval      VARCHAR2(100);
    rnum      INTEGER;
    i         INTEGER;
    status    PLS_INTEGER;
BEGIN
  FOR r IN c LOOP
    tv  := SYS.RE$TABLE_VALUE('prob', rowidtochar(r.rowid));
    tvl := SYS.RE$TABLE_VALUE_LIST(tv);
    truehits := SYS.RE$RULE_HIT_LIST();
    maybehits := SYS.RE$RULE_HIT_LIST();
    DBMS_RULE.EVALUATE(
      rule_set_name        => 'support.rs',
      evaluation_context   => 'evalctx',
      table_values         => tvl,
      true_rules           => truehits,
      maybe_rules          => maybehits);
    FOR rnum IN 1..truehits.COUNT LOOP
      DBMS_OUTPUT.PUT_LINE('Using rule '|| truehits(rnum).rule_name);
      ac := truehits(rnum).rule_action_context;
      namearray := ac.GET_ALL_NAMES;
      FOR i IN 1..namearray.COUNT LOOP
        name := namearray(i);
        status := ac.GET_VALUE(name).GETVARCHAR2(cval);
        IF (name = 'CENTER') THEN
          UPDATE PROBLEMS SET center = cval WHERE rowid = r.rowid;
          DBMS_OUTPUT.PUT_LINE('Assigning '|| r.probid || ' to ' || cval);
        ELSIF (name = 'ALERT') THEN
          DBMS_OUTPUT.PUT_LINE('Alert: '|| cval || ' Problem:' || r.probid);
        END IF;
       END LOOP;
    END LOOP;
  END LOOP;
END;
/

/*
```

Log Problems

```
*/
```

```
INSERT INTO problems(probid, custid, priority, description)
  VALUES(10101, 11, 1, 'no dial tone');

INSERT INTO problems(probid, custid, priority, description)
  VALUES(10102, 21, 2, 'noise on local calls');

INSERT INTO problems(probid, custid, priority, description)
  VALUES(10103, 31, 3, 'noise on long distance calls');

COMMIT;

/*
```

Check the Spool Results
Check the `rules_table.out` spool file to ensure that all actions completed successfully after this script completes.

```
*/

SET ECHO OFF
SPOOL OFF

/************************** END OF SCRIPT ****************************/
```

> **See Also:**
>
> "Dispatching Problems and Checking Results for the Table Examples" for the steps to complete to dispatch the problems logged in this example and check the results of the problem dispatch

6.6 Using Rules on Both Explicit Variables and Table Data

This example illustrates how to use rules to evaluate data stored in explicit variables and in a table. The application uses the `problems` table in the `support` schema, into which customer problems are inserted. This example uses the following rules for handling customer problems:

- Assign all problems with priority greater than 2 to the San Jose Center.
- Assign all problems with priority equal to 2 to the New York Center.
- Assign all problems with priority equal to 1 to the Tampa Center from 8 AM to 8 PM.
- Assign all problems with priority equal to 1 to the Bangalore Center from 8 PM to 8 AM.
- Send an alert to the vice president of support for a problem with priority equal to 1.

The evaluation context consists of the `problems` table. The relevant row of the table, which corresponds to the problem being routed, is passed to the `DBMS_RULE.EVALUATE` procedure as a table value.

Some of the rules in this example refer to the current time, which is represented as an explicit variable named `current_time`. The current time is treated as additional data in the evaluation context. It is represented as a variable for the following reasons:

- It is not practical to store the current time in a table because it would have to be updated very often.
- The current time can be accessed by inserting calls to `SYSDATE` in every rule that requires it, but that would cause repeated invocations of the same SQL function `SYSDATE`, which might slow down rule evaluation. Different values of the current time in different rules might lead to incorrect behavior.

Complete the following steps:

1. Show Output and Spool Results
2. Create the support User
3. Grant the support User the Necessary System Privileges on Rules
4. Create the problems Table
5. Create the evalctx Evaluation Context
6. Create the Rules that Correspond to Problem Priority
7. Create the rs Rule Set
8. Add the Rules to the Rule Set
9. Create the problem_dispatch PL/SQL Procedure
10. Log Problems
11. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect to all of the databases in the environment.

```
/************************ BEGINNING OF SCRIPT ****************************
```

Show Output and Spool Results
Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/

SET ECHO ON
SPOOL rules_var_tab.out

/*
```

Create the support User

```
*/


CONNECT SYSTEM
```

```
CREATE TABLESPACE support_tbs2 DATAFILE 'support_tbs2.dbf'
  SIZE 5M REUSE AUTOEXTEND ON MAXSIZE UNLIMITED;

ACCEPT password PROMPT 'Enter password for user: ' HIDE

CREATE USER support
IDENTIFIED BY &password
  DEFAULT TABLESPACE support_tbs2
  QUOTA UNLIMITED ON support_tbs2;

GRANT ALTER SESSION, CREATE CLUSTER, CREATE DATABASE LINK, CREATE SEQUENCE,
  CREATE SESSION, CREATE SYNONYM, CREATE TABLE, CREATE VIEW, CREATE INDEXTYPE,
  CREATE OPERATOR, CREATE PROCEDURE, CREATE TRIGGER, CREATE TYPE
TO support;

/*
```

Grant the support User the Necessary System Privileges on Rules

```
*/


BEGIN
  DBMS_RULE_ADM.GRANT_SYSTEM_PRIVILEGE(
    privilege    => DBMS_RULE_ADM.CREATE_RULE_SET_OBJ,
    grantee      => 'support',
    grant_option => FALSE);
  DBMS_RULE_ADM.GRANT_SYSTEM_PRIVILEGE(
    privilege    => DBMS_RULE_ADM.CREATE_RULE_OBJ,
    grantee      => 'support',
    grant_option => FALSE);
  DBMS_RULE_ADM.GRANT_SYSTEM_PRIVILEGE(
    privilege    => DBMS_RULE_ADM.CREATE_EVALUATION_CONTEXT_OBJ,
    grantee      => 'support',
    grant_option => FALSE);
END;
/

/*
```

Create the problems Table

```
*/


CONNECT support

SET FEEDBACK 1
SET NUMWIDTH 10
SET LINESIZE 80
SET TRIMSPOOL ON
SET TAB OFF
SET PAGESIZE 100
SET SERVEROUTPUT ON

CREATE TABLE problems(
  probid          NUMBER PRIMARY KEY,
  custid          NUMBER,
  priority        NUMBER,
```

```
  description     VARCHAR2(4000),
  center          VARCHAR2(100));

/*
```

Create the evalctx Evaluation Context

```
*/


DECLARE
  ta SYS.RE$TABLE_ALIAS_LIST;
  vt SYS.RE$VARIABLE_TYPE_LIST;
BEGIN
  ta := SYS.RE$TABLE_ALIAS_LIST(SYS.RE$TABLE_ALIAS('prob', 'problems'));
  vt := SYS.RE$VARIABLE_TYPE_LIST(
          SYS.RE$VARIABLE_TYPE('current_time', 'DATE', NULL, NULL));
  DBMS_RULE_ADM.CREATE_EVALUATION_CONTEXT(
    evaluation_context_name    => 'evalctx',
    table_aliases              => ta,
    variable_types             => vt,
    evaluation_context_comment => 'support problem definition');
END;
/

/*
```

Create the Rules that Correspond to Problem Priority

The following code creates one action context for each rule, and one name-value pair in each action context.

```
*/

DECLARE
  ac SYS.RE$NV_LIST;
BEGIN
  ac := SYS.RE$NV_LIST(NULL);
  ac.ADD_PAIR('CENTER', ANYDATA.CONVERTVARCHAR2('San Jose'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name      => 'r1',
    condition      => 'prob.priority > 2',
    action_context => ac,
    rule_comment   => 'Low priority problems');
  ac := SYS.RE$NV_LIST(NULL);
  ac.ADD_PAIR('CENTER', ANYDATA.CONVERTVARCHAR2('New York'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name      => 'r2',
    condition      => 'prob.priority = 2',
    action_context => ac,
    rule_comment   => 'High priority problems');
  ac := SYS.RE$NV_LIST(NULL);
  ac.ADD_PAIR('ALERT', ANYDATA.CONVERTVARCHAR2('John Doe'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name      => 'r3',
    condition      => 'prob.priority = 1',
    action_context => ac,
    rule_comment   => 'Urgent problems');
  ac := SYS.RE$NV_LIST(NULL);
  ac.ADD_PAIR('CENTER', ANYDATA.CONVERTVARCHAR2('Tampa'));
  DBMS_RULE_ADM.CREATE_RULE(
```

```
    rule_name => 'r4',
    condition => '(prob.priority = 1) and ' ||
                 '(TO_NUMBER(TO_CHAR(:current_time, ''HH24'')) >= 8) and ' ||
                 '(TO_NUMBER(TO_CHAR(:current_time, ''HH24'')) <= 20)',
    action_context => ac,
    rule_comment => 'Urgent daytime problems');
  ac := sys.RE$NV_LIST(NULL);
  ac.add_pair('CENTER', ANYDATA.CONVERTVARCHAR2('Bangalore'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name => 'r5',
    condition => '(prob.priority = 1) and ' ||
                 '((TO_NUMBER(TO_CHAR(:current_time, ''HH24'')) < 8) or ' ||
                 ' (TO_NUMBER(TO_CHAR(:current_time, ''HH24'')) > 20))',
    action_context => ac,
    rule_comment => 'Urgent nighttime problems');
END;
/

/*
```

Create the rs Rule Set

```
*/


BEGIN
  DBMS_RULE_ADM.CREATE_RULE_SET(
    rule_set_name      => 'rs',
    evaluation_context => 'evalctx',
    rule_set_comment   => 'support rules');
END;
/

/*
```

Add the Rules to the Rule Set

```
*/


BEGIN
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r1',
    rule_set_name => 'rs');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r2',
    rule_set_name => 'rs');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r3',
    rule_set_name => 'rs');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r4',
    rule_set_name => 'rs');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r5',
    rule_set_name => 'rs');
END;
/

/*
```

Create the problem_dispatch PL/SQL Procedure

```
*/


CREATE OR REPLACE PROCEDURE problem_dispatch
IS
    cursor c  is SELECT probid, rowid FROM PROBLEMS WHERE center IS NULL;
    tv        SYS.RE$TABLE_VALUE;
    tvl       SYS.RE$TABLE_VALUE_LIST;
    vv1       SYS.RE$VARIABLE_VALUE;
    vvl       SYS.RE$VARIABLE_VALUE_LIST;
    truehits  SYS.RE$RULE_HIT_LIST;
    maybehits SYS.RE$RULE_HIT_LIST;
    ac        SYS.RE$NV_LIST;
    namearray SYS.RE$NAME_ARRAY;
    name      VARCHAR2(30);
    cval      VARCHAR2(100);
    rnum      INTEGER;
    i         INTEGER;
    status    PLS_INTEGER;
BEGIN
  FOR r IN c LOOP
    tv  := sYS.RE$TABLE_VALUE('prob', ROWIDTOCHAR(r.rowid));
    tvl := SYS.RE$TABLE_VALUE_LIST(tv);
    vv1 := SYS.RE$VARIABLE_VALUE('current_time',
                                 ANYDATA.CONVERTDATE(SYSDATE));
    vvl := SYS.RE$VARIABLE_VALUE_LIST(vv1);
    truehits := SYS.RE$RULE_HIT_LIST();
    maybehits := SYS.RE$RULE_HIT_LIST();
    DBMS_RULE.EVALUATE(
        rule_set_name        => 'support.rs',
        evaluation_context   => 'evalctx',
        table_values         => tvl,
        variable_values      => vvl,
        true_rules           => truehits,
        maybe_rules          => maybehits);
    FOR rnum IN 1..truehits.COUNT loop
      DBMS_OUTPUT.PUT_LINE('Using rule '|| truehits(rnum).rule_name);
      ac := truehits(rnum).rule_action_context;
      namearray := ac.GET_ALL_NAMES;
      FOR i in 1..namearray.COUNT LOOP
        name := namearray(i);
        status := ac.GET_VALUE(name).GETVARCHAR2(cval);
        IF (name = 'CENTER') THEN
          UPDATE problems SET center = cval
          WHERE rowid = r.rowid;
          DBMS_OUTPUT.PUT_LINE('Assigning '|| r.probid || ' to ' || cval);
        ELSIF (name = 'ALERT') THEN
          DBMS_OUTPUT.PUT_LINE('Alert: '|| cval || ' Problem:' || r.probid);
        END IF;
      END LOOP;
    END LOOP;
  END LOOP;
END;
/

/*
```

Log Problems

```
*/


INSERT INTO problems(probid, custid, priority, description)
  VALUES(10201, 12, 1, 'no dial tone');

INSERT INTO problems(probid, custid, priority, description)
  VALUES(10202, 22, 2, 'noise on local calls');

INSERT INTO PROBLEMS(probid, custid, priority, description)
  VALUES(10203, 32, 3, 'noise on long distance calls');

COMMIT;

/*
```

Check the Spool Results

Check the `rules_var_tab.out` spool file to ensure that all actions completed successfully after this script completes.

```
*/

SET ECHO OFF
SPOOL OFF

/************************** END OF SCRIPT ******************************/
```

> **See Also:**
>
> "Dispatching Problems and Checking Results for the Table Examples" for the steps to complete to dispatch the problems logged in this example and check the results of the problem dispatch

6.7 Using Rules on Implicit Variables and Table Data

This example illustrates how to use rules to evaluate implicit variables and data stored in a table. The application uses the `problems` table in the `support` schema, into which customer problems are inserted. This example uses the following rules for handling customer problems:

- Assign all problems with priority greater than 2 to the San Jose Center.
- Assign all problems with priority equal to 2 to the New York Center.
- Assign all problems with priority equal to 1 to the Tampa Center from 8 AM to 8 PM.
- Assign all problems with priority equal to 1 to the Bangalore Center after 8 PM and before 8 AM.
- Send an alert to the vice president of support for a problem with priority equal to 1.

The evaluation context consists of the `problems` table. The relevant row of the table, which corresponds to the problem being routed, is passed to the `DBMS_RULE.EVALUATE` procedure as a table value.

As in the example illustrated in "Using Rules on Both Explicit Variables and Table Data", the current time is represented as a variable named `current_time`. However, this variable value is not specified during evaluation by the caller. That is, `current_time` is an implicit variable in this example. A PL/SQL function named `timefunc` is specified for `current_time`, and this function is invoked once during evaluation to get its value.

Using implicit variables can be useful in other cases if one of the following conditions is true:

- The caller does not have access to the variable value.
- The variable is referenced infrequently in rules. Because it is implicit, its value can be retrieved only when necessary, and does not need to be passed in for every evaluation.

Complete the following steps:

1. Show Output and Spool Results
2. Create the support User
3. Grant the support User the Necessary System Privileges on Rules
4. Create the problems Table
5. Create the timefunc Function to Return the Value of current_time
6. Create the evalctx Evaluation Context
7. Create the Rules that Correspond to Problem Priority
8. Create the rs Rule Set
9. Add the Rules to the Rule Set
10. Create the problem_dispatch PL/SQL Procedure
11. Log Problems
12. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect to all of the databases in the environment.

```
/************************ BEGINNING OF SCRIPT ****************************
```

Show Output and Spool Results
Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/

SET ECHO ON
SPOOL rules_implicit_var.out
```

```
/*
```

Create the support User

```
*/


CONNECT SYSTEM

CREATE TABLESPACE support_tbs3 DATAFILE 'support_tbs3.dbf'
  SIZE 5M REUSE AUTOEXTEND ON MAXSIZE UNLIMITED;

ACCEPT password PROMPT 'Enter password for user: ' HIDE

CREATE USER support
IDENTIFIED BY &password
  DEFAULT TABLESPACE support_tbs3
  QUOTA UNLIMITED ON support_tbs3;

GRANT ALTER SESSION, CREATE CLUSTER, CREATE DATABASE LINK, CREATE SEQUENCE,
  CREATE SESSION, CREATE SYNONYM, CREATE TABLE, CREATE VIEW, CREATE INDEXTYPE,
  CREATE OPERATOR, CREATE PROCEDURE, CREATE TRIGGER, CREATE TYPE
TO support;

/*
```

Grant the support User the Necessary System Privileges on Rules

```
*/


BEGIN
  DBMS_RULE_ADM.GRANT_SYSTEM_PRIVILEGE(
    privilege    => DBMS_RULE_ADM.CREATE_RULE_SET_OBJ,
    grantee      => 'support',
    grant_option => FALSE);
  DBMS_RULE_ADM.GRANT_SYSTEM_PRIVILEGE(
    privilege    => DBMS_RULE_ADM.CREATE_RULE_OBJ,
    grantee      => 'support',
    grant_option => FALSE);
  DBMS_RULE_ADM.GRANT_SYSTEM_PRIVILEGE(
    privilege    => DBMS_RULE_ADM.CREATE_EVALUATION_CONTEXT_OBJ,
    grantee      => 'support',
    grant_option => FALSE);
END;
/

/*
```

Create the problems Table

```
*/


CONNECT support

SET FEEDBACK 1
SET NUMWIDTH 10
SET LINESIZE 80
```

```
SET TRIMSPOOL ON
SET TAB OFF
SET PAGESIZE 100
SET SERVEROUTPUT ON

CREATE TABLE problems(
  probid          NUMBER PRIMARY KEY,
  custid          NUMBER,
  priority        NUMBER,
  description     VARCHAR2(4000),
  center          VARCHAR2(100));

/*
```

Create the timefunc Function to Return the Value of current_time

```
*/


CREATE OR REPLACE FUNCTION timefunc(
  eco    VARCHAR2,
  ecn    VARCHAR2,
  var    VARCHAR2,
  evctx  SYS.RE$NV_LIST)
RETURN SYS.RE$VARIABLE_VALUE
IS
BEGIN
  IF (var = 'CURRENT_TIME') THEN
    RETURN(SYS.RE$VARIABLE_VALUE('current_time',
                                 ANYDATA.CONVERTDATE(SYSDATE)));
  ELSE
    RETURN(NULL);
  END IF;
END;
/

/*
```

Create the evalctx Evaluation Context

```
*/


DECLARE
  ta SYS.RE$TABLE_ALIAS_LIST;
  vt SYS.RE$VARIABLE_TYPE_LIST;
BEGIN
  ta := SYS.RE$TABLE_ALIAS_LIST(SYS.RE$TABLE_ALIAS('prob', 'problems'));
  vt := SYS.RE$VARIABLE_TYPE_LIST(
          SYS.RE$VARIABLE_TYPE('current_time', 'DATE', 'timefunc', NULL));
  DBMS_RULE_ADM.CREATE_EVALUATION_CONTEXT(
    evaluation_context_name    => 'evalctx',
    table_aliases              => ta,
    variable_types             => vt,
    evaluation_context_comment => 'support problem definition');
END;
/

/*
```

Create the Rules that Correspond to Problem Priority

The following code creates one action context for each rule, and one name-value pair in each action context.

```
*/

DECLARE
  ac SYS.RE$NV_LIST;
BEGIN
  ac := SYS.RE$NV_LIST(NULL);
  ac.ADD_PAIR('CENTER', ANYDATA.CONVERTVARCHAR2('San Jose'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name      => 'r1',
    condition      => 'prob.priority > 2',
    action_context => ac,
    rule_comment   => 'Low priority problems');
  ac := SYS.RE$NV_LIST(NULL);
  ac.ADD_PAIR('CENTER', ANYDATA.CONVERTVARCHAR2('New York'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name      => 'r2',
    condition      => 'prob.priority = 2',
    action_context => ac,
    rule_comment   => 'High priority problems');
  ac := SYS.RE$NV_LIST(NULL);
  ac.ADD_PAIR('ALERT', ANYDATA.CONVERTVARCHAR2('John Doe'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name      => 'r3',
    condition      => 'prob.priority = 1',
    action_context => ac,
    rule_comment   => 'Urgent problems');
  ac := SYS.RE$NV_LIST(NULL);
  ac.ADD_PAIR('CENTER', ANYDATA.CONVERTVARCHAR2('Tampa'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name => 'r4',
    condition => '(prob.priority = 1) and ' ||
                 '(TO_NUMBER(TO_CHAR(:current_time, ''HH24'')) >= 8) and ' ||
                 '(TO_NUMBER(TO_CHAR(:current_time, ''HH24'')) <= 20)',
    action_context => ac,
    rule_comment   => 'Urgent daytime problems');
  ac := SYS.RE$NV_LIST(NULL);
  ac.add_pair('CENTER', ANYDATA.CONVERTVARCHAR2('Bangalore'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name => 'r5',
    condition => '(prob.priority = 1) and ' ||
                 '((TO_NUMBER(TO_CHAR(:current_time, ''HH24'')) < 8) or ' ||
                 ' (TO_NUMBER(TO_CHAR(:current_time, ''HH24'')) > 20))',
    action_context => ac,
    rule_comment => 'Urgent nighttime problems');
END;
/

/*
```

Create the rs Rule Set

```
*/


BEGIN
  DBMS_RULE_ADM.CREATE_RULE_SET(
```

```
    rule_set_name      => 'rs',
    evaluation_context => 'evalctx',
    rule_set_comment   => 'support rules');
END;
/

/*
```

Add the Rules to the Rule Set

```
*/


BEGIN
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r1',
    rule_set_name => 'rs');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r2',
    rule_set_name => 'rs');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r3',
    rule_set_name => 'rs');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r4',
    rule_set_name => 'rs');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r5',
    rule_set_name => 'rs');
END;
/

/*
```

Create the problem_dispatch PL/SQL Procedure

```
*/


CREATE OR REPLACE PROCEDURE problem_dispatch
IS
    cursor c  IS SELECT probid, rowid FROM problems WHERE center IS NULL;
    tv        SYS.RE$TABLE_VALUE;
    tvl       SYS.RE$TABLE_VALUE_LIST;
    truehits  SYS.RE$RULE_HIT_LIST;
    maybehits SYS.RE$RULE_HIT_LIST;
    ac        SYS.RE$NV_LIST;
    namearray SYS.RE$NAME_ARRAY;
    name      VARCHAR2(30);
    cval      VARCHAR2(100);
    rnum      INTEGER;
    i         INTEGER;
    status    PLS_INTEGER;
BEGIN
  FOR r IN c LOOP
    tv  := SYS.RE$TABLE_VALUE('prob', rowidtochar(r.rowid));
    tvl := SYS.RE$TABLE_VALUE_LIST(tv);
    truehits := SYS.RE$RULE_HIT_LIST();
    maybehits := SYS.RE$RULE_HIT_LIST();
    DBMS_RULE.EVALUATE(
```

```
        rule_set_name        => 'support.rs',
        evaluation_context   => 'evalctx',
        table_values         => tvl,
        true_rules           => truehits,
        maybe_rules          => maybehits);
    FOR rnum IN 1..truehits.COUNT LOOP
      DBMS_OUTPUT.PUT_LINE('Using rule '|| truehits(rnum).rule_name);
      ac := truehits(rnum).rule_action_context;
      namearray := ac.GET_ALL_NAMES;
      FOR i IN 1..namearray.COUNT LOOP
        name := namearray(i);
        status := ac.GET_VALUE(name).GETVARCHAR2(cval);
        IF (name = 'CENTER') THEN
          UPDATE problems SET center = cval
            WHERE rowid = r.rowid;
          DBMS_OUTPUT.PUT_LINE('Assigning '|| r.probid || ' to ' || cval);
        ELSIF (name = 'ALERT') THEN
          DBMS_OUTPUT.PUT_LINE('Alert: '|| cval || ' Problem:' || r.probid);
        END IF;
      END LOOP;
    END LOOP;
  END LOOP;
END;
/

/*
```

Log Problems

```
*/


INSERT INTO problems(probid, custid, priority, description)
  VALUES(10301, 13, 1, 'no dial tone');

INSERT INTO problems(probid, custid, priority, description)
  VALUES(10302, 23, 2, 'noise on local calls');

INSERT INTO problems(probid, custid, priority, description)
  VALUES(10303, 33, 3, 'noise on long distance calls');

COMMIT;

/*
```

Check the Spool Results

Check the `rules_implicit_var.out` spool file to ensure that all actions completed successfully after this script completes.

```
*/

SET ECHO OFF
SPOOL OFF

/************************** END OF SCRIPT *****************************/
```

> **See Also:**
>
> "Dispatching Problems and Checking Results for the Table Examples" for the steps to complete to dispatch the problems logged in this example and check the results of the problem dispatch

6.8 Using Event Contexts and Implicit Variables with Rules

An event context is a varray of type `SYS.RE$NV_LIST` that contains name-value pairs that contain information about the event. This optional information is not directly used or interpreted by the rules engine. Instead, it is passed to client callbacks such as an evaluation function, a variable value function (for implicit variables), or a variable method function.

In this example, assume every customer has a primary contact person, and the goal is to assign the problem reported by a customer to the support center to which the customer's primary contact person belongs. The customer name is passed in the event context.

This example illustrates how to use event contexts with rules to evaluate implicit variables. Specifically, when an event is evaluated using the `DBMS_RULE.EVALUATE` procedure, the event context is passed to the variable value function for implicit variables in the evaluation context. The name of the variable value function is `find_contact`, and this PL/SQL function returns the contact person based on the name of the company specified in the event context. The rule set is evaluated based on the contact person name and the priority for an event.

This example uses the following rules for handling customer problems:

- Assign all problems that belong to Jane to the San Jose Center.
- Assign all problems that belong to Fred to the New York Center.
- Assign all problems whose primary contact is unknown to George at the Texas Center.
- Send an alert to the vice president of support for a problem with priority equal to 1.

Complete the following steps:

1. Show Output and Spool Results
2. Create the support User
3. Grant the support User the Necessary System Privileges on Rules
4. Create the find_contact Function to Return a Customer's Contact
5. Create the evalctx Evaluation Context
6. Create the Rules that Correspond to Problem Priority and Contact
7. Create the rs Rule Set
8. Add the Rules to the Rule Set
9. Query the Data Dictionary
10. Create the problem_dispatch PL/SQL Procedure
11. Dispatch Sample Problems

12. Clean Up the Environment (Optional)
13. Check the Spool Results

> **Note:**
>
> If you are viewing this document online, then you can copy the text from the "BEGINNING OF SCRIPT" line after this note to the next "END OF SCRIPT" line into a text editor and then edit the text to create a script for your environment. Run the script with SQL*Plus on a computer that can connect to all of the databases in the environment.

```
/************************ BEGINNING OF SCRIPT ******************************
```

Show Output and Spool Results

Run `SET ECHO ON` and specify the spool file for the script. Check the spool file for errors after you run this script.

```
*/

SET ECHO ON
SPOOL rules_event_context.out

/*
```

Create the support User

```
*/


CONNECT SYSTEM

ACCEPT password PROMPT 'Enter password for user: ' HIDE

GRANT ALTER SESSION, CREATE CLUSTER, CREATE DATABASE LINK, CREATE SEQUENCE,
  CREATE SESSION, CREATE SYNONYM, CREATE TABLE, CREATE VIEW, CREATE INDEXTYPE,
  CREATE OPERATOR, CREATE PROCEDURE, CREATE TRIGGER, CREATE TYPE
TO support IDENTIFIED BY &support;

/*
```

Grant the support User the Necessary System Privileges on Rules

```
*/


BEGIN
  DBMS_RULE_ADM.GRANT_SYSTEM_PRIVILEGE(
    privilege    => DBMS_RULE_ADM.CREATE_RULE_SET_OBJ,
    grantee      => 'support',
    grant_option => FALSE);
  DBMS_RULE_ADM.GRANT_SYSTEM_PRIVILEGE(
    privilege    => DBMS_RULE_ADM.CREATE_RULE_OBJ,
    grantee      => 'support',
    grant_option => FALSE);
  DBMS_RULE_ADM.GRANT_SYSTEM_PRIVILEGE(
```

```
    privilege    => DBMS_RULE_ADM.CREATE_EVALUATION_CONTEXT_OBJ,
    grantee      => 'support',
    grant_option => FALSE);
END;
/

/*
```

Create the find_contact Function to Return a Customer's Contact

```
*/


CONNECT support

SET FEEDBACK 1
SET NUMWIDTH 10
SET LINESIZE 80
SET TRIMSPOOL ON
SET TAB OFF
SET PAGESIZE 100
SET SERVEROUTPUT ON
CREATE OR REPLACE FUNCTION find_contact(
  eco       VARCHAR2,
  ecn       VARCHAR2,
  var       VARCHAR2,
  evctx     SYS.RE$NV_LIST)
RETURN SYS.RE$VARIABLE_VALUE IS
  cust      VARCHAR2(30);
  contact   VARCHAR2(30);
  status    PLS_INTEGER;
BEGIN
  IF (var = 'CUSTOMER_CONTACT') THEN
    status := evctx.GET_VALUE('CUSTOMER').GETVARCHAR2(cust);
    IF (cust = 'COMPANY1') THEN     -- COMPANY1's contact person is Jane
      contact := 'JANE';
    ELSIF (cust = 'COMPANY2') THEN  -- COMPANY2's contact person is Fred
      contact := 'FRED';
    ELSE        -- Assign customers without primary contact person to George
      contact := 'GEORGE';
    END IF;
    RETURN SYS.RE$VARIABLE_VALUE('customer_contact',
                                 ANYDATA.CONVERTVARCHAR2(contact));
  ELSE
    RETURN NULL;
  END IF;
END;
/

/*
```

Create the evalctx Evaluation Context

```
*/


DECLARE
  vt  SYS.RE$VARIABLE_TYPE_LIST;
BEGIN
  vt := SYS.RE$VARIABLE_TYPE_LIST(
```

```
        SYS.RE$VARIABLE_TYPE('priority', 'NUMBER', NULL, NULL),
        SYS.RE$VARIABLE_TYPE('customer_contact', 'VARCHAR2(30)',
                             'find_contact', NULL));
  DBMS_RULE_ADM.CREATE_EVALUATION_CONTEXT(
    evaluation_context_name    => 'evalctx',
    variable_types             => vt,
    evaluation_context_comment => 'support problem definition');
END;
/

/*
```

Create the Rules that Correspond to Problem Priority and Contact

The following code creates one action context for each rule, and one name-value pair in each action context.

```
*/

DECLARE
  ac  SYS.RE$NV_LIST;
BEGIN
  ac := SYS.RE$NV_LIST(NULL);
  ac.ADD_PAIR('CENTER', ANYDATA.CONVERTVARCHAR2('San Jose'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name       => 'r1',
    condition       => ':customer_contact = ''JANE''',
    action_context  => ac,
    rule_comment    => 'Jane''s customer problems');
  ac := sys.re$nv_list(NULL);
  ac.ADD_PAIR('CENTER', ANYDATA.CONVERTVARCHAR2('New York'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name       => 'r2',
    condition       => ':customer_contact = ''FRED''',
    action_context  => ac,
    rule_comment    => 'Fred''s customer problems');
  ac := sys.re$nv_list(NULL);
  ac.ADD_PAIR('CENTER', ANYDATA.CONVERTVARCHAR2('Texas'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name       => 'r3',
    condition       => ':customer_contact = ''GEORGE''',
    action_context  => ac,
    rule_comment    => 'George''s customer problems');
  ac := sys.re$nv_list(NULL);
  ac.ADD_PAIR('ALERT', ANYDATA.CONVERTVARCHAR2('John Doe'));
  DBMS_RULE_ADM.CREATE_RULE(
    rule_name       => 'r4',
    condition       => ':priority=1',
    action_context  => ac,
    rule_comment    => 'Urgent problems');
END;
/

/*
```

Create the rs Rule Set

```
*/


BEGIN
```

```
  DBMS_RULE_ADM.CREATE_RULE_SET(
    rule_set_name      => 'rs',
    evaluation_context => 'evalctx',
    rule_set_comment   => 'support rules');
END;
/

/*
```

Add the Rules to the Rule Set

```
*/


BEGIN
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r1',
    rule_set_name => 'rs');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r2',
    rule_set_name => 'rs');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r3',
    rule_set_name => 'rs');
  DBMS_RULE_ADM.ADD_RULE(
    rule_name     => 'r4',
    rule_set_name => 'rs');
END;
/

/*
```

Query the Data Dictionary

At this point, you can view the evaluation context, rules, and rule set you created in the previous steps.

```
*/

COLUMN EVALUATION_CONTEXT_NAME HEADING 'Eval Context Name' FORMAT A30
COLUMN EVALUATION_CONTEXT_COMMENT HEADING 'Eval Context Comment' FORMAT A40

SELECT EVALUATION_CONTEXT_NAME, EVALUATION_CONTEXT_COMMENT
  FROM USER_EVALUATION_CONTEXTS
  ORDER BY EVALUATION_CONTEXT_NAME;

SET LONGCHUNKSIZE 4000
SET LONG 4000
COLUMN RULE_NAME HEADING 'Rule|Name' FORMAT A5
COLUMN RULE_CONDITION HEADING 'Rule Condition' FORMAT A35
COLUMN ACTION_CONTEXT_NAME HEADING 'Action|Context|Name' FORMAT A10
COLUMN ACTION_CONTEXT_VALUE HEADING 'Action|Context|Value' FORMAT A10

SELECT RULE_NAME,
       RULE_CONDITION,
       AC.NVN_NAME ACTION_CONTEXT_NAME,
       AC.NVN_VALUE.ACCESSVARCHAR2() ACTION_CONTEXT_VALUE
  FROM USER_RULES R, TABLE(R.RULE_ACTION_CONTEXT.ACTX_LIST) AC
  ORDER BY RULE_NAME;

COLUMN RULE_SET_NAME HEADING 'Rule Set Name' FORMAT A20
```

```
COLUMN RULE_SET_EVAL_CONTEXT_OWNER HEADING 'Eval Context|Owner' FORMAT A12
COLUMN RULE_SET_EVAL_CONTEXT_NAME HEADING 'Eval Context Name' FORMAT A25
COLUMN RULE_SET_COMMENT HEADING 'Rule Set|Comment' FORMAT A15

SELECT RULE_SET_NAME,
       RULE_SET_EVAL_CONTEXT_OWNER,
       RULE_SET_EVAL_CONTEXT_NAME,
       RULE_SET_COMMENT
  FROM USER_RULE_SETS
  ORDER BY RULE_SET_NAME;

/*
```

Create the problem_dispatch PL/SQL Procedure

```
*/


CREATE OR REPLACE PROCEDURE problem_dispatch (priority  NUMBER,
                                              customer  VARCHAR2)
IS
    vvl       SYS.RE$VARIABLE_VALUE_LIST;
    truehits  SYS.RE$RULE_HIT_LIST;
    maybehits SYS.RE$RULE_HIT_LIST;
    ac        SYS.RE$NV_LIST;
    namearray SYS.RE$NAME_ARRAY;
    name      VARCHAR2(30);
    cval      VARCHAR2(100);
    rnum      INTEGER;
    i         INTEGER;
    status    PLS_INTEGER;
    evctx     SYS.RE$NV_LIST;
BEGIN
  vvl  := SYS.RE$VARIABLE_VALUE_LIST(
            SYS.RE$VARIABLE_VALUE('priority',
                                  ANYDATA.CONVERTNUMBER(priority)));
  evctx := SYS.RE$NV_LIST(NULL);
  evctx.ADD_PAIR('CUSTOMER', ANYDATA.CONVERTVARCHAR2(customer));
  truehits  := SYS.RE$RULE_HIT_LIST();
  maybehits := SYS.RE$RULE_HIT_LIST();
  DBMS_RULE.EVALUATE(
      rule_set_name        => 'support.rs',
      evaluation_context   => 'evalctx',
      event_context        => evctx,
      variable_values      => vvl,
      true_rules           => truehits,
      maybe_rules          => maybehits);
  FOR rnum IN 1..truehits.COUNT LOOP
    DBMS_OUTPUT.PUT_LINE('Using rule '|| truehits(rnum).rule_name);
    ac := truehits(rnum).rule_action_context;
    namearray := ac.GET_ALL_NAMES;
      FOR i IN 1..namearray.count LOOP
        name := namearray(i);
        status := ac.GET_VALUE(name).GETVARCHAR2(cval);
        IF (name = 'CENTER') THEN
          DBMS_OUTPUT.PUT_LINE('Assigning problem to ' || cval);
        ELSIF (name = 'ALERT') THEN
          DBMS_OUTPUT.PUT_LINE('Sending alert to: '|| cval);
        END IF;
      END LOOP;
```

```
  END LOOP;
END;
/

/*
```

Dispatch Sample Problems

The first problem dispatch in this step uses the event context and the variable value function to determine the contact person for `COMPANY1`. The event context is passed to the `find_contact` variable value function, and this function returns the contact name `JANE`. Therefore, rule `r1` evaluates to `TRUE`. The `problem_dispatch` procedure sends the problem to the San Jose office because `JANE` belongs to that office. In addition, the priority for this event is 1, which causes rule `r4` to evaluate to `TRUE`. As a result, the `problem_dispatch` procedure sends an alert to John Doe.

The second problem dispatch in this step uses the event context and the variable value function to determine the contact person for `COMPANY2`. The event context is passed to the `find_contact` variable value function, and this function returns the contact name `FRED`. Therefore, rule `r2` evaluates to `TRUE`. The `problem_dispatch` procedure sends the problem to the New York office because `FRED` belongs to that office.

The third problem dispatch in this step uses the event context and the variable value function to determine the contact person for `COMPANY3`. This company does not have a dedicated contact person. The event context is passed to the `find_contact` variable value function, and this function returns the contact name `GEORGE`, because `GEORGE` is the default contact when no contact person is found. Therefore, rule `r3` evaluates to `TRUE`. The `problem_dispatch` procedure sends the problem to the Texas office because `GEORGE` belongs to that office.

```
*/

EXECUTE problem_dispatch(1, 'COMPANY1');
EXECUTE problem_dispatch(2, 'COMPANY2');
EXECUTE problem_dispatch(5, 'COMPANY3');

/*
```

Clean Up the Environment (Optional)

You can clean up the sample environment by dropping the `support` user.

```
*/

CONNECT SYSTEM

DROP USER support CASCADE;

/*
```

Check the Spool Results

Check the `rules_event_context.out` spool file to ensure that all actions completed successfully after this script completes.

```
*/

SET ECHO OFF
SPOOL OFF

/************************** END OF SCRIPT ******************************/
```

6.9 Dispatching Problems and Checking Results for the Table Examples

The following sections configure a `problem_dispatch` procedure that updates information in the `problems` table:

- "Using Rules on Data Stored in a Table"
- "Using Rules on Both Explicit Variables and Table Data"
- "Using Rules on Implicit Variables and Table Data"

Complete the following steps to dispatch the problems by running the `problem_dispatch` procedure and display the results in the `problems` table:

1. Query the Data Dictionary
2. List the Problems in the problems Table
3. Dispatch the Problems by Running the problem_dispatch Procedure
4. List the Problems in the problems Table
5. Clean Up the Environment (Optional)

Query the Data Dictionary
View the evaluation context, rules, and rule set you created in the example:

```
CONNECT support
Enter password: password

COLUMN EVALUATION_CONTEXT_NAME HEADING 'Eval Context Name' FORMAT A30
COLUMN EVALUATION_CONTEXT_COMMENT HEADING 'Eval Context Comment' FORMAT A40

SELECT EVALUATION_CONTEXT_NAME, EVALUATION_CONTEXT_COMMENT
  FROM USER_EVALUATION_CONTEXTS
  ORDER BY EVALUATION_CONTEXT_NAME;

SET LONGCHUNKSIZE 4000
SET LONG 4000
COLUMN RULE_NAME HEADING 'Rule|Name' FORMAT A5
COLUMN RULE_CONDITION HEADING 'Rule Condition' FORMAT A35
COLUMN ACTION_CONTEXT_NAME HEADING 'Action|Context|Name' FORMAT A10
COLUMN ACTION_CONTEXT_VALUE HEADING 'Action|Context|Value' FORMAT A10

SELECT RULE_NAME,
       RULE_CONDITION,
       AC.NVN_NAME ACTION_CONTEXT_NAME,
       AC.NVN_VALUE.ACCESSVARCHAR2() ACTION_CONTEXT_VALUE
  FROM USER_RULES R, TABLE(R.RULE_ACTION_CONTEXT.ACTX_LIST) AC
  ORDER BY RULE_NAME;

COLUMN RULE_SET_NAME HEADING 'Rule Set Name' FORMAT A20
COLUMN RULE_SET_EVAL_CONTEXT_OWNER HEADING 'Eval Context|Owner' FORMAT A12
COLUMN RULE_SET_EVAL_CONTEXT_NAME HEADING 'Eval Context Name' FORMAT A25
COLUMN RULE_SET_COMMENT HEADING 'Rule Set|Comment' FORMAT A15

SELECT RULE_SET_NAME,
```

```
      RULE_SET_EVAL_CONTEXT_OWNER,
      RULE_SET_EVAL_CONTEXT_NAME,
      RULE_SET_COMMENT
  FROM USER_RULE_SETS
  ORDER BY RULE_SET_NAME;
```

List the Problems in the problems Table
This `SELECT` statement should show the problems logged previously.

```
COLUMN probid HEADING 'Problem ID' FORMAT 99999
COLUMN custid HEADING 'Customer ID' FORMAT 99
COLUMN priority HEADING 'Priority' FORMAT 9
COLUMN description HEADING 'Problem Description' FORMAT A30
COLUMN center HEADING 'Center' FORMAT A10

SELECT probid, custid, priority, description, center FROM problems
  ORDER BY probid;
```

Your output looks similar to the following:

```
Problem ID Customer ID Priority Problem Description            Center
---------- ----------- -------- ------------------------------ ----------
     10301          13        1 no dial tone
     10302          23        2 noise on local calls
     10303          33        3 noise on long distance calls
```

Notice that the `Center` column is `NULL` for each new row inserted.

Dispatch the Problems by Running the problem_dispatch Procedure
Execute the `problem_dispatch` procedure.

```
SET SERVEROUTPUT ON
EXECUTE problem_dispatch;
```

List the Problems in the problems Table
If the problems were dispatched successfully in Step Dispatch the Problems by Running the problem_dispatch Procedure, then this `SELECT` statement should show the center to which each problem was dispatched in the `Center` column.

```
SELECT probid, custid, priority, description, center FROM problems
  ORDER BY probid;
```

Your output looks similar to the following:

```
Problem ID Customer ID Priority Problem Description            Center
---------- ----------- -------- ------------------------------ ----------
     10201          12        1 no dial tone                   Tampa
     10202          22        2 noise on local calls           New York
     10203          32        3 noise on long distance calls   San Jose
```

> **Note:**
>
> The output will vary depending on which example you used to create the `problem_dispatch` procedure.

Clean Up the Environment (Optional)
You can clean up the sample environment by dropping the `support` user.

```
CONNECT SYSTEM
Enter password: password

DROP USER support CASCADE;
```

Index

N

O

P

Q

R

S

T