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Preface

Welcome to *Oracle Database Real Application Security Administrator's and Developer's Guide*. This guide describes how you may configure Oracle Database Real Application Security.

Audience

This guide is intended for database administrators (DBAs), security administrators, application developers, and others tasked with configuring Oracle Database Real Application Security in an Oracle database.

Documentation Accessibility

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Related Documents

For more information, see these Oracle resources:

- *Oracle Database Real Application Security Java API Reference*
- *Oracle Database Real Application Security Session Service Java API Reference*

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.

Convention	Meaning
`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 Database Real Application Security Administrator's and Developer's Guide

This preface contains:

- Changes in Oracle Database Release 19c Version 19.1
- Changes in Oracle Database Release 18c Version 18.1
- Changes in Oracle Database 12*c* Release 2 (12.2.0.1)

Changes in Oracle Database Release 19c Version 19.1

The following are changes in *Oracle Database Real Application Security Administrator's and Developer's Guide* for Oracle Database release 19c, version 19.1:

- New Features
- Deprecated Features

New Features

There are no new features for this release.

Deprecated Features

There are no deprecated features for this release.

Changes in Oracle Database Release 18c Version 18.1

The following are changes in *Oracle Database Real Application Security Administrator's and Developer's Guide* for Oracle Database release 18c, version 18.1:

- New Features
- Deprecated Features

New Features

There are no new features for this release.

Deprecated Features

There are no deprecated features for this release.

Changes in Oracle Database 12*c* Release 2 (12.2.0.1)

The following are changes in *Oracle Database Real Application Security Administrator's and Developer's Guide* for Oracle Database 12*c* Release 2 (12.2.0.1):

- New Features
- Deprecated Features

New Features

The following features are new in this release:

- Real Application Security includes support for privilege scoping

  Oracle Database 12*c* Release 2 (12.2) extends the Real Application Security model by allowing per principal session privilege grants, through an ACL set on the principal as a native Real Application Security application user, for granting session management privileges. In addition, Oracle Database 12*c* Release 2 (12.2) extends the Real Application Security model by allowing per principal session privilege grants, though an ACL set on the principal as a dynamic role, for granting only the `SET_DYNAMIC_ROLES` privilege. Principal-specific ACL grants take precedence over system-level session privilege grants. It allows for a negative grant to be set on the principal specific ACL. Use of an ACL allows a common set of grants to be enforced on a group of native application users and dynamic roles.

  This feature provides the following new API:

  – SET_ACL Procedure— Sets an ACL on the specified application user or dynamic role.

  This feature enhances the following APIs with the addition of the `acl` parameter:

  – CREATE_USER Procedure

  – CREATE_DYNAMIC_ROLE Procedure

  This feature enhances the following views by displaying the ACLs that are set on the user and or dynamic role or both:

  – DBA_XS_USERS

  – DBA_XS_DYNAMIC_ROLES

  This feature adds the `SET_DYNAMIC_ROLES` privilege, which is defined in the `SESSION_SC` security class to protect enablement and disablement of a dynamic role as part of the attach session and assign user operations.

  See SET_ACL Procedure, CREATE_USER Procedure, CREATE_DYNAMIC_ROLE Procedure, DBA_XS_USERS, DBA_XS_DYNAMIC_ROLES, and the `SESSION_SC` security class in Security Classes for more information.

  See About Real Application Security Session Privilege Scoping Through ACL for more information.

- Real Application Security supports column-level access control on DML statements. This allows users to insert, update, and delete specific column values based on their granted column-level privileges.

Beginning with Oracle Database 12*c* Release 2 (12.2), users with required privileges can do DMLs with Data Security column security. This means:

- To update a row value, an authorized user needs both the row-level `UPDATE` privilege as well as the column privilege on the protected columns to be updated.
- To insert a row, an authorized user needs both the row-level `INSERT` privilege as well as the column privilege on each protected column. If the `INSERT` statement does not insert a value for a protected column, the column privilege is not required, and the default value (or `NULL` if there is no default value) is inserted.
- To delete a row, an authorized user only needs the row-level `DELETE` privilege. The column privilege is not required.
- No data is disclosed for DMLs with Data Security row-level and column-level security. DML statements with `RETURNING INTO` or with the parameter - `sql92_security` enabled require both the row-level `SELECT` privilege as well as the column privileges if the columns appear in the `RETURNING INTO` clause.

- Real Application Security includes support for schema-level security policy administration

  This feature enhances the following APIs:

  - GRANT_SYSTEM_PRIVILEGE Procedure by adding the `schema` parameter
  - REVOKE_SYSTEM_PRIVILEGE Procedure by adding the `schema` parameter

  This feature extends the `ADMIN_SEC_POLICY` privilege to schemas for policy management.

  See XS_ACL Package, XS_DATA_SECURITY Package, and XS_SECURITY_CLASS Package for more information.

  This feature adds the `APPLY_SEC_POLICY` privilege for policy enforcement within granted schemas to achieve policy enforcement within an application.

  The `APPLY_SEC_POLICY` privilege will be checked in the following APIs before enforcing policies: APPLY_OBJECT_POLICY Procedure, REMOVE_OBJECT_POLICY Procedure, ENABLE_OBJECT_POLICY Procedure, and DISABLE_OBJECT_POLICY Procedure.

  This feature adds two audit actions:

  - `AUDIT_GRANT_PRIVILEGE`

    — to audit the `GRANT_SYSTEM_PRIVILEGE` API
  - `AUDIT_REVOKE_PRIVILEGE`

    — to audit the `REVOKE_SYSTEM_PRIVILEGE` API

  This feature adds the following views: ALL_XS_SECURITY_CLASSES, ALL_XS_SECURITY_CLASS_DEP, ALL_XS_PRIVILEGES, ALL_XS_IMPLIED_PRIVILEGES, ALL_XS_ACLS, ALL_XS_ACES, ALL_XS_POLICIES, ALL_XS_REALM_CONSTRAINTS, ALL_XS_INHERITED_REALMS, ALL_XS_ACL_PARAMETERS, ALL_XS_COLUMN_CONSTRAINTS, ALL_XS_APPLIED_POLICIES, and DBA_XS_PRIVILEGE_GRANTS.

  See About Schema Level Real Application Security Policy Administration for more information.

- Oracle Label Security support for the Oracle Database Real Application Security

  For the `user_name` parameter in the `SA_USER_ADMIN.SET_USER_LABELS` procedure and in the `SA_USER_ADMIN.SET_USER_PRIVS` procedure for Oracle Database, the user name can be an Oracle Database Real Application Security user name.

  See the `SA_USER_ADMIN.SET_USER_LABELS` procedure in *Oracle Label Security Administrator's Guide* and the `SA_USER_ADMIN.SET_USER_PRIVS` procedure in *Oracle Label Security Administrator's Guide* for more information.

  Labels or Oracle Label Security privileges assigned to the Real Application Security user are enforced in the Real Application Security user session. Oracle Label Security context is established upon the following Real Application Security session operations (`ATTACH_SESSION`, `SWITCH_USER`, `ASSIGN_USER`) and in Real Application Security direct logon sessions. Based on labels or privileges or both that the current Real Application Security session has, the Oracle Label Security policy is enforced.

  See Attaching an Application Session to a Traditional Database Session, Assigning an Application User to an Anonymous Application Session, Switching a Current Application User to Another Application User in the Current Application Session, and Oracle Label Security Context Is Established in Direct Logon Session for more information.

- Predefined application role `XSCONNECT`
  Allows the user granted this role to connect to the database. In other words, a user not granted this predefined role cannot connect to the database.

  See Regular Application Roles , GRANT_ROLES Procedure, and About Creating a Direct Login Application User Account for more information.

Deprecated Features

The following features are deprecated and will not be supported in future releases:

- For the `CREATE_USER` procedure

  The `PASSWORDEXPIRED` and `LOCKED` values for the parameter `STATUS` are deprecated.

  See "CREATE_USER Procedure" for more information.

- For the `SET_USER_STATUS` procedure

  The `PASSWORDEXPIRED` status value is deprecated.

  See "SET_USER_STATUS Procedure" for more information.

- For the `SET_PASSWORD` procedure

  The password types `XS_MD4` and `XS_O3LOGON` are deprecated.

  See "SET_PASSWORD Procedure" for more information.

- For the `SET_VERIFIER` procedure

  The verifier types `XS_SALTED_MD5`, `XS_SHA1`, `XS_SASL_MD5`, `XS_MD5`, `XS_MD4`, and `XS_O3LOGON` are deprecated.

  See "SET_VERIFIER Procedure" for more information.

1

Introducing Oracle Database Real Application Security

This chapter contains:

- What Is Oracle Database Real Application Security?
- Data Security Concepts Used in Real Application Security
- Application Session Concepts Used in Application Security
- Flow of Design and Development
- Scenario: Security Human Resources (HR) Demonstration of Employee Information
- About Auditing in an Oracle Database Real Application Security Environment
- Support for Pluggable Databases

What Is Oracle Database Real Application Security?

Oracle Database Real Application Security is a database authorization model that:

- Supports declarative security policies
- Enables end-to-end security for multitier applications
- Provides an integrated solution to secure database and application resources
- Advances the security architecture of Oracle Database to meet existing and emerging demands of applications developed for the Internet

Traditional security was designed for client/server systems. These systems had a significantly smaller number of users than newer applications designed for the Internet. When application developers found traditional security inadequate, they often moved it from the database layer to the application layer. To accomplish this, developers frequently built their own tables and defined their own application users. Because security was encoded in the application layer, rather than in the database, application users and application roles were typically known only to the application. In other words, database users were not application-level users, hence the user identity was not known during the access control decision in the database. Furthermore, database operations were limited to DDLs and DMLs that do not represent application-level tasks or operations, hence the operation context was also not known during the access control decision in the database. These practices exposed the database to vulnerability.

Real Application Security is designed to:

- Manage application security for application users rather than database users
- Enable developers to manage security for application level tasks
- Enable application user identity to be known during security enforcement

- Enable developers to return security to the database layer, either incrementally, or all at once

This section discusses traditional security and Real Application Security, indicating how Real Application Security improves upon traditional security.

This section describes these concepts:

- Disadvantages of Traditional Security for Managing Application Users
- Advantages of Real Application Security
- Architecture of Real Application Security

Disadvantages of Traditional Security for Managing Application Users

Using the traditional security model, it was often difficult to manage three-tier applications, especially when performing these security tasks:

- Extending security policies independent of application code
- Enforcing security policies at the database level, where the application user is unknown
- Enforcing least privilege principle as full access is granted to highly privileged two-tier components

Advantages of Real Application Security

Real Application Security enables these security tasks, which improve database security and performance:

- Three-tier and two-tier applications can declaratively define, provide, and enforce access control requirements at the database layer.
- The database can provide a uniform security model across all tiers and support multiple application user stores, including the associated roles, authentication credentials, database attributes, and application-defined attributes. This model enables application users to have a single unique global identity across an Oracle enterprise.
- An Oracle database can natively support the application security context. The database supports integrated policy specification and enforcement for both the application and the database, so the application does not need to do this through application code. Because the database stores the application security context information, this also reduces network traffic.
- Developers can use Real Application Security to control application user access to data in an Oracle database throughout all components of an Oracle enterprise in a common manner.

  See Configuring Data Security for more information about defining data security policies and access control requirements.

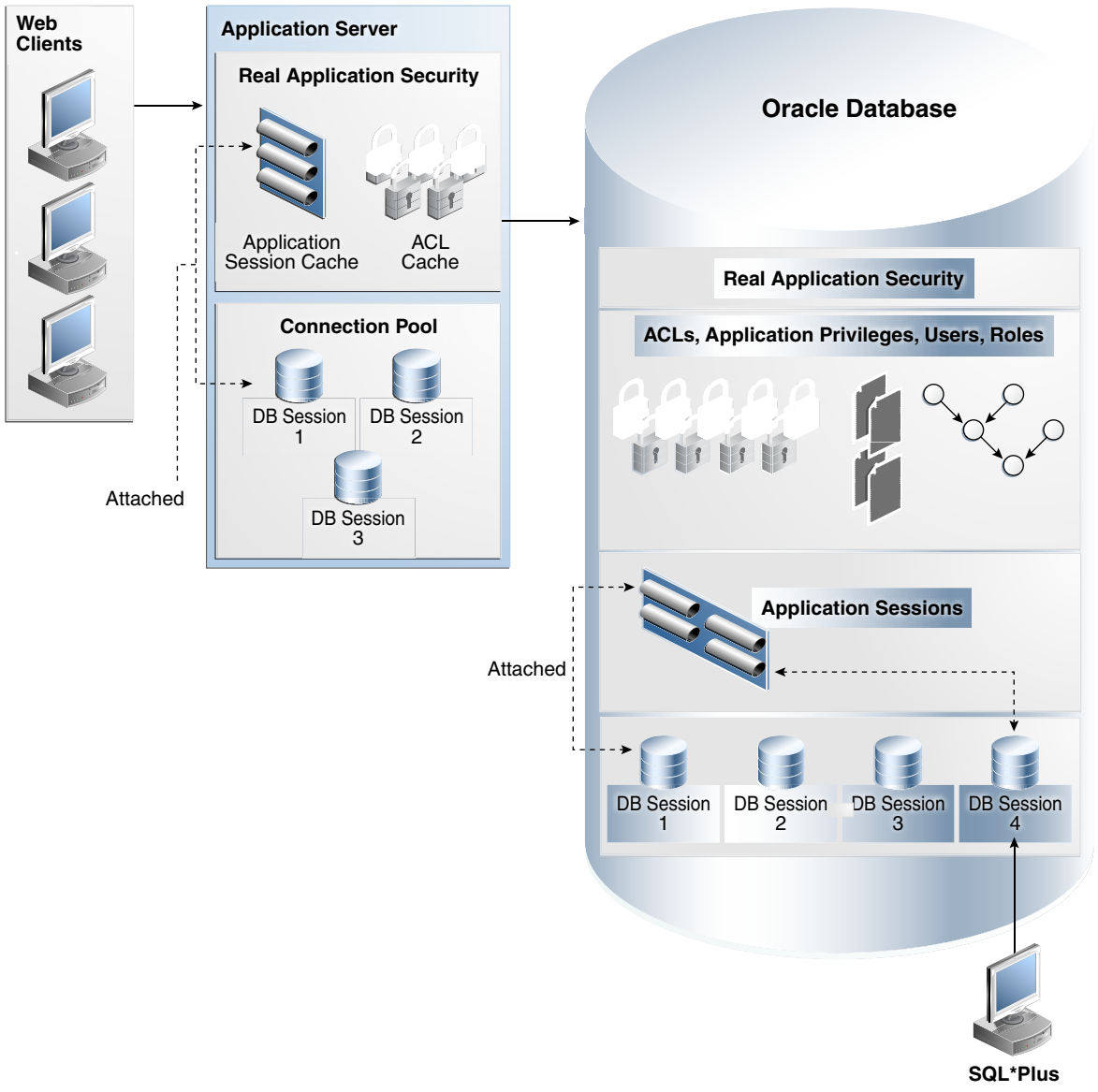
Architecture of Real Application Security

Real Application Security is managed through a collection of PL/SQL and Java APIs. This architecture that enables you to configure its components—application users, application roles, sessions, and other security-related components. With Real

Application Security, you configure application counterparts to the traditional user, role, and session, through the use of entities, which are stored in tables.

Figure 1-1 shows the various components used in Oracle Database Real Application Security. This includes application users, application roles, access control lists, security classes, and application sessions. These components are discussed in the following sections. Figure 1-1 also shows Web applications establishing application sessions to the database.

Figure 1-1 Oracle Database Real Application Security Components



Data Security Concepts Used in Real Application Security

This section describes access control terms and concepts that you need to understand before you can begin to configure Real Application Security. Using the PL/SQL administrative interfaces, you can create and manage the entities described here:

application user, application role, principal, application privilege, security class, *access control list* (ACL), access control entry (ACE), and data realm.

> **Note:**
>
> When a term such as *application user* or *application role* is used here, it applies to Real Application Security; when it is important to distinguish the database type, either no qualifier is used or the qualifier *database* is used.

> **See Also:**
>
> - Configuring Application Users and Application Roles
> - Configuring Application Privileges and Access Control Lists

This section contains:

- About Data Security with Oracle Database Real Application Security
- Principals: Users and Roles
- Application Privileges
- Security Classes in Oracle Database Real Application Security
- Access Control Entry (ACE)
- Access Control List (ACL)
- Data Security Policy

About Data Security with Oracle Database Real Application Security

Effective security requires defining which application users, applications, or functions can have access to which data, to perform which kinds of operations. Thus, effective security has these three dimensions:

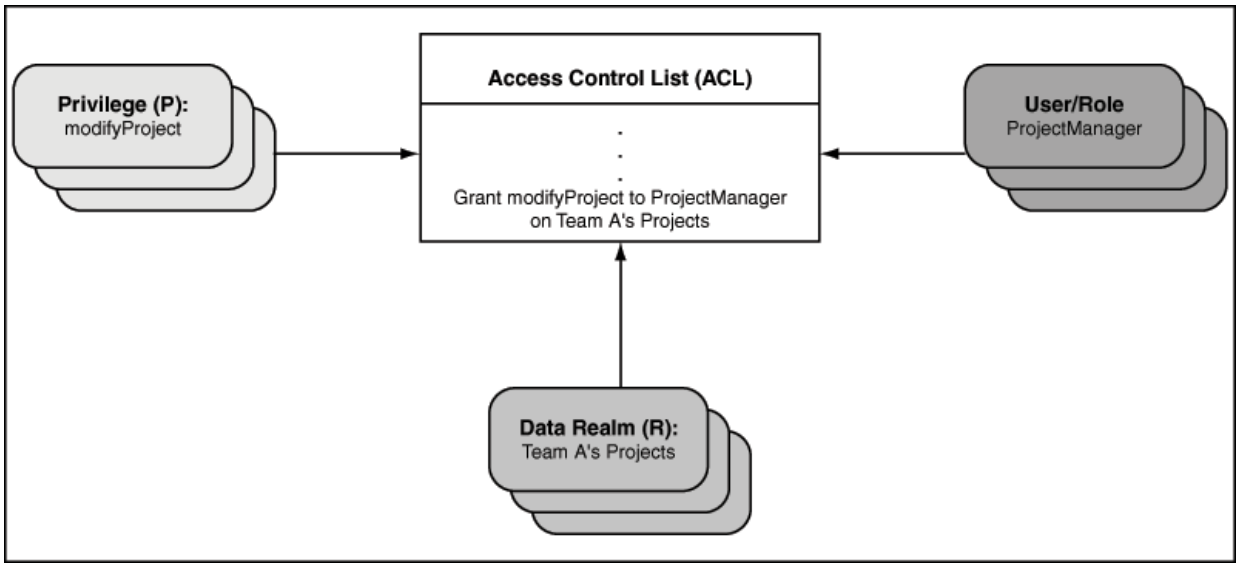
1. *which application users*
2. can perform *which operations*
3. on *which data*

You define (1) principals, (2) application privileges, and (3) objects in relation to these three dimensions, respectively. Principals are users and roles. A role can represent attributes of an application user, system state, or a piece of code.

Principals and application privileges are related in a declarative way by defining ACLs. These ACLs are then related to the data by defining Data Security policy that protects rows and columns of table data. For example, you can protect table data by using PL/SQL procedures to set controlling ACLs.

Figure 1-2 illustrates an example where the user, `ProjectManager` has the `ModifyProject` privilege on a data realm comprised of Team A's projects.

Figure 1-2 Three Dimensions of Data Security



Principals: Users and Roles

When discussing fine-grained database access control, a **principal** is an application user or an application role or a database user or a database role. An **application user** can be a person or an autonomous application process that accesses information in the database. An **application role** is a logical grouping of application privileges required to accomplish a real life task. An application role can contain other application roles, but this recursion cannot be circular. You use application roles to associate application users, both database users and application users with privileges.

Oracle Database supports the following as *principals*:

- **Database users** and **database roles**

  A database user is also sometimes referred to as a database *schema* or a user *account*. When a person or application logs onto the database, it uses a database user (schema) and password.

  A database role corresponds to a set of database privileges that can be granted to database users, applications, or other database roles — see "Understanding the Difference Between Database Roles and Application Roles".

- **Application users** and **Application roles**

  The term *application*, as used by Real Application Security, refers to the creation of an application user, application role, or session that contains only information pertinent to the application that the application user is logging onto. Application users and application roles are defined by an application, and they do not need to be tied to any database schema.

  Application users can also create heavyweight database sessions by connecting to the database directly. These are called direct login application users. See "About Creating a Direct Login Application User Account". When an application user creates a heavyweight database session, the user's default schema is set to a preconfigured value meant solely for name resolution purposes, such as `HR`.

An application role can only be granted to an application user or to another application role. You cannot directly grant database privileges to application users and application roles. See "Granting Database Privileges to Application Users and Application Roles" for further details.

> **See Also:**
>
> – "About Configuring Application Users"
> – "About Configuring Application Roles"

This section includes the following sections:

- Understanding the Difference Between Database Users and Application Users
- Understanding the Difference Between Database Roles and Application Roles
- Granting Database Privileges to Application Users and Application Roles

Understanding the Difference Between Database Users and Application Users

Database users are also referred to as *traditional* users, and have these characteristics:

- They are associated with schemas and passwords.
- They can create heavyweight sessions to schemas with which they are associated.

Application users are defined by an application, and have these characteristics:

- They do not own database schemas.
- They can create application sessions to the database through the middle tier.
- They can create heavyweight database sessions by connecting to the database directly. (See "About Creating a Direct Login Application User Account".)

> **Note:**
>
> In a heavyweight session, the user is associated with a default schema.

Understanding the Difference Between Database Roles and Application Roles

A database role is traditionally thought of as a named set of database privileges.

Database roles have these characteristics:

- They are *granted* privileges, just as database users can be granted privileges.
- They serve as intermediaries for mapping database privileges to database users (and applications) as follows: a role is granted privileges, and the role is then granted to users (giving them the privileges).

  1. **Grant privileges to database role**

2. **Grant database role to database user**

   The database user now has the privileges of the database role.

> **Note:**
>
> In traditional database terminology, a role is considered to be the same thing as the set of privileges that are granted to it.

An application role can be regarded as the set of application-defined privileges that are associated with it using the mechanism of a declarative access control list (ACL), discussed in "Access Control List (ACL)".

Application roles have these characteristics:

- They use an *access control list* (ACL), rather than a database grant, as the intermediary that maps application privileges to users or roles.
- They can be only granted to application users or application roles.
- They cannot be granted to a database role, unlike a database role can be granted to an application role.

> **Note:**
>
> In access control terminology, application roles are classified with application users as principals.

Granting Database Privileges to Application Users and Application Roles

You cannot grant database privileges directly to application users and application roles. Instead, you grant the database privileges to a database role, and then grant the database role to the application role in these steps.

1. Grant **database privileges** to **database role**.
2. Grant **database role** to the **application role**.

The statements in the following code do exactly this, effectively granting the database `SELECT` privilege to the application role, `HRREP`.

```
CREATE ROLE db_hrrep;
GRANT SELECT ON hr.employees TO db_hrrep;
GRANT db_hrrep TO HRREP;
```

Application users already created or subsequently created, with that application role, acquire this application privilege.

Application Privileges

An **application privilege** is a particular right or permission that can be granted or denied to a principal. Application developers define application privileges in a security class.

The set of application privileges granted to a principal controls whether or not this principal can perform a given operation on the data that it protects. For example, if the principal (database user) `HR` wants to perform the `SELECT` operation on a given resource, then `SELECT` privileges must be granted to principal `HR` before the SELECT operation.

Application privileges can also be aggregated. An **aggregate privilege** is an application privilege that implies other application privileges. These implied privileges can be any application privileges defined by the current security class or an inherited privilege. When an aggregate privilege is granted or denied, its implied application privileges are implicitly granted or denied.

Aggregate privileges simplify usability when the number of application privileges grows. For example, instead of granting each application privilege separately, you can group related application privileges into an aggregate privilege. Then, you can use a single grant to enable a principal to access all the application privileges contained in the aggregate privilege.

Security Classes in Oracle Database Real Application Security

A **security class** is a scope for a set of application privileges.

A security class includes application privileges that it inherits from other security classes, and it can include application privileges that it defines.

A security class is typically associated with an access control list (ACL), and the ACL can grant application privileges in the security class to specific principals. See "Access Control List (ACL)".

Example 4-4 shows how to create a security class policy.

Access Control Entry (ACE)

An **access control entry** (**ACE**) either grants or denies application privileges to a particular principal (application user or application role).

An ACE is an element in an array named `ace_list`. The whole array is called by and becomes part of the access control list (ACL).

The ACE does not, itself, specify which data to protect; that is done by associating the ACL with target data, such as a set of rows in an order entry table. You can make this association by creating a **data realm** to restrict the user to modifying only those rows, or by using the PL/SQL procedure `XS_DATA_SECURITY.SET_ACLS`.

Access Control List (ACL)

An **access control list** (**ACL**) is a list of access control entries (ACEs), which permit or deny application privileges to one or more principals.

If the ACL you create relies on a set of custom application privileges that you define in your own security class, then you must explicitly associate that security class with the ACL. See Example 4-15 for an example.

If the only application privileges used in the ACL are defined in the DML security class, then no security class association is needed as that is the default. See a description in "DML Security Class".

Data Security Policy

To protect data within a database table, you must create a data security policy. Database records, both at row and column level, can be protected using the fine-grained access control described in this section.

The data security policy performs the following functions:

- Specifies the data that you want to protect. The data can be indicated by a `WHERE` clause in a data realm of one or more rows that you design. It can also be defined using named notation by using an association operator to associate the parameter to the left of the arrow (=>) with the actual parameter to the right of the arrow. For example, in Example 5-20, each `realm` is defined using association operators.

  The data security policy can contain one or more data realms.

- Associates each data realm with one or more access control lists (ACLs) that specify the application privileges required to access rows and columns of the data realm to form what is called a data realm constraint. A given ACL protects a given data realm and controls access to particular application users or application roles (called principals). (See "Access Control List (ACL)" for more information about ACLs.)

- Optionally applies additional application privileges to protect a particular column to form what is known as column constraints. This is useful in cases where you need to add an extra layer of security for sensitive data.

- Associates additional custom application privileges. For example, an administrator could create an `APPROVE_TRANSACTION` privilege, which controls whether a user can take a particular action on the row. Assuming `SELECT` privilege is granted to all users, all users could see the row, but only some users can perform the transaction approval action.

In summary, the application user who logs in will only be allowed to perform operations including DML on records within the data realm, including individual rows of data, based on the application privileges in its associated ACLs. Thus, the data security policy is composed of data realm constraints and column constraints that protect the data realm by only allowing access to application users who have application privileges in the associated ACLs.

For example, suppose you have a sales table that lists all sales representatives, their regions, the products they are responsible for, product categories, and product prices. When individual sales representatives log on, each representative would see selected data for all other sales representatives, such as sales representatives for particular product categories based on data realm constraints. If you wanted to restrict the display of product prices to sales representatives by region, you could apply additional application privileges to the column listing product prices, in this case using column constraints.

Configuring Data Security describes in detail how to protect database objects.

Application Session Concepts Used in Application Security

Real Application Security introduces the concept of an application session. Within the context of application sessions, there are three types of user identities:

- Application session user: The user associated with the application session.

Application session access to database objects is checked against the permissions granted to this user.

- Traditional (*heavyweight*) session user: The user that established the database session.

  This user can be an application user or a database user, as long as database authentication credentials are available.

- Schema owner: The database schema is the schema associated with the traditional database session and is only used for object name resolution.

Traditional database user sessions have these characteristics:

- They hold their own database resources, such as transactions and cursors.
- They consume many server resources.

Application sessions have these characteristics:

- They contain information that is pertinent only to the application.
- They can be dedicated to each end application user.
- They can persist until the application user logs out of the application or the application terminates unexpectedly.

See Configuring Application Sessions for more information about application sessions.

Flow of Design and Development

You should be familiar with the concepts introduced in this chapter to take full advantage of Real Application Security.

In general, identify all tasks an application performs that require application privileges to control data access. Then, add the appropriate application privileges to a security class so that you can reference them in an ACL and grant them to the application users and application roles. This process involves these tasks:

- Create a default set of meaningful application roles based on the features the application provides.
- Identify the tables that require data security protection based on the application table design and security requirements, and define the data realms, including column protection.
- Define data security policies based on the application requirements and the rules applied on the tables.
- Ensure that ACLs used in the data security policy and functional security grant the appropriate application privileges to application roles.

This section contains:

- Design Phase
- Development Flow Steps

Design Phase

In the design phase, you identify all the tasks an application performs that require application privileges to control data access.

For example, during the design phase, the application policy designer must identify:

1. The set of application-level operations that require access control.
2. The rows and columns of tables and views that can be accessed as part of the application-level operations.
3. The set of actors or principals (users and roles) that can perform these operations.
4. The runtime application session attributes that identity rows of a table or views. These attribute names are used within the predicates that selects the rows to be authorized, and their values are set during the execution of the application.

Development Flow Steps

In the development phase, as the Real Application Security administrator, you use Real Application Security components to develop your data security policies.

Follow these steps to develop your data security policies:

1. Create the corresponding application users and roles. If using an external directory server, create the application users and roles or user groups in the directory server. Follow this procedure to create these principals natively in the database:
   a. Create the application roles and grant application roles to application roles, if needed. See About Configuring Application Roles.
   b. Create the application users and grant application roles to the application users. See About Configuring Application Users.
   c. For configuring the directory server to fetch the users and role, when principals from external stores are used, see the RASADM configuration information in *Oracle Database Real Application Security Administration*.
   d. For users and roles in the external Directory Server, see manage parameter settings for using RASADM with a Directory Serve in *Oracle Database Real Application Security Administration*.
2. Create each privilege class that you plan to use to develop the security policies for your application. Each privilege class consists of one or more appropriate privileges that you define and can reference in an ACL and also grant them to the application users and application roles. Each privilege class authorizes by means of ACLs the required application-level operations of a data security policy. See About Configuring Security Classes and About Configuring Access Control Lists.
3. Create one or more session namespaces that can be used across different application sessions. This consists of defining for a session namespace its set of properties (application attributes) and its associated access control policy or ACL that you can choose from a list or create. See About Manipulating the Application Session State.
4. Create the data security policy by associating each data realm with an ACL, so as to create both data realm authorization and column authorization as needed. See About Data Security.

   This process consists of four parts:

   a. Policy Information - You choose the object to be protected and the privilege class to protect it as well as specify the policy name and select the policy owner. See Understanding the Structure of the Data Security Policy.

b. Column Level Authorization - You choose the name of the column to be protected and select the privilege to be granted to access the column, which is associated with the privilege class you selected in Step 3a. See Applying Additional Application Privileges to a Column.

c. Data Realm Authorization - You create a SQL predicate to represent the data realm to be protected and add each to a data realm grant list. Then you choose or create the ACL to protect the data realm. Next, create privilege grants to be added to a privilege grants list consisting of each principal and whether it is allowed authorization or denied authorization by selecting the appropriate privilege. See About Designing Data Realms.

d. Apply Policy - You can apply, remove, enable, or disable the data security policy you are creating and choose to specify certain apply options, allowing the owner of the table or view to bypass this data security policy, and whether to enforce statement types for this policy. See About Enabling Data Security Policy for a Database Table or View.

See Also:

Scenario: Security Human Resources (HR) Demonstration of Employee Information that describes in detail how the development flow is implemented for an example policy scenario for the security human resources (HR) demonstration of employee information using the concepts and components of Real Application Security.

Scenario: Security Human Resources (HR) Demonstration of Employee Information

This section presents an example policy that provides a high-level overview of Real Application Security. It is a simple scenario aimed at explaining the basic Real Application Security concepts. You should be familiar with the following concepts, introduced in "Data Security Concepts Used in Real Application Security":

- Principals – application users and application roles
- Security classes and application privileges
- Access control lists and entries (ACLs and ACEs)
- Data security policy

This same scenario appears throughout the book, to illustrate different components of Real Application Security. It is also described in detail in Real Application Security HR Demo and Real Application Security HR Demo Files to demonstrate how to use advanced concepts of Real Application Security to handle a more complex policy.

This section includes the following topics:

- Basic Security HR Demo Scenario: Description and Security Requirements
- Basic HR Scenario: Implementation Overview

Basic Security HR Demo Scenario: Description and Security Requirements

Susan Mavris (SMAVRIS) is an employee in the Human Resources department. Her job title is Human Resources Representative. In this capacity, she is in charge of managing the human resources information for all employees, including department 60 (IT). She can view and update all the employee records, including the SALARY column.

David Austin (DAUSTIN) is an employee in the IT department. His job title is Assistant Department Manager. In this capacity, he can view employee records in the IT department, but he cannot view the SALARY column, except for his own salary record.

Secure authorization requires defining which application users and application roles can have access to which data, to perform which kinds of operations. These three security dimensions must be defined: protected data, principals, and application privileges. (see "About Data Security with Oracle Database Real Application Security").

In this basic scenario:

- The data to be protected is employee information and it is protected in three ways:
  - Access to an employee's own record, including the SALARY column.
  - Access to all the records in the IT department, excluding the SALARY column.
  - Access to all employee records, including the SALARY column.
- Users are allowed access to employee data in the following ways:
  - Each user can view their own record, including the SALARY column.
  - Application user DAUSTIN in his role as Assistant Department Manager is allowed to view all the records in the IT department, excluding the SALARY column.
  - Application user SMAVRIS in her role as human-resources representative is allowed to view and update all employee records, including the SALARY column.
- Database role DB_EMP is created and granted SELECT, INSERT, UPDATE, and DELETE privileges on HR.EMPLOYEES.
- Application roles are created as follows:
  - EMPLOYEE role is granted to both application users DAUSTIN and SMAVRIS. Database role DB_EMP is granted to EMPLOYEE role.
  - IT_ENGINEER role is granted to only application user DAUSTIN. Database role DB_EMP is granted to IT_ENGINEER role.
  - HR_REPRESENTATIVE role is granted to only application user SMAVRIS. Database role DB_EMP is granted to HR_REPRESENTATIVE role.
- The VIEW_SALARY application privilege is created to control access to the SALARY column. The HR_PRIVILEGES security class is created in which to scope the VIEW_SALARY application privilege.
- ACLs are created to define the degree of access to employee records in the following ways:

  - EMP_ACL grants the EMPLOYEE role the SELECT database privilege and VIEW_SALARY application privilege to view an employee's own record, including the SALARY column.
  - IT_ACL grants the IT_ENGINEER role only the SELECT database privilege to view the employee records in the IT department, but it does not grant the VIEW_SALARY privilege that is required for access to the SALARY column.
  - HR_ACL grants the HR_REPRESENTATIVE role SELECT, INSERT, UPDATE, and DELETE database privileges to view and update all employee's records, and granting the VIEW_SALARY application privilege to view the SALARY column.
- The HR demo secures the HR.EMPLOYEE table by creating and applying the data security policy, EMPLOYEES_DS, that has the following three data realms and column constraint:
  - An employee's own record realm. The ACL, EMP_ACL controls this realm, which grants application role EMPLOYEE privileges to access the realm, including the SALARY column.
  - All the records in the IT department realm. The ACL, IT_ACL controls this realm, which grants application role IT_ENGINEER privileges to access the realm, but excluding the SALARY column.
  - All the employee records realm. The ACL, HR_ACL controls this realm, which grants application role HR_REPRESENTATIVE privileges to access the realm, including the SALARY column.
  - A column constraint that protects the SALARY column by requiring the VIEW_SALARY privilege to view its sensitive data.

Basic HR Scenario: Implementation Overview

To implement the basic human-resources security scenario, in addition to identifying the protected data, the principals, and the application privileges, you must define the following:

- A database user as the Real Application Security Administrator and then connect as the Real Application Security Administrator to create the components.
- How the principals connect with the database to access the data.
- The access control lists (ACLs) that grant the application privilege and any database privileges to the principals.
- A data security policy that associates the ACLs with the particular data (rows) that the principals need to access.

In this basic scenario, application users SMAVRIS and DAUSTIN connect to the database directly as the principals.

The application user account that is created for application users SMAVRIS and DAUSTIN are principals in this scenario. Each application user account is granted application roles that, ultimately, has the SELECT privilege on the database table that contains the employee information. The application role is a principal in this scenario.

A database role, DB_EMP serves as intermediary between the application role and the database privilege because database privileges can be granted only to database users and roles. That is, the necessary database privileges are granted to a database role, and that role is granted to each application role (the principal).

The database SELECT privilege applies to the entire table. The principal must also be granted an Real Application Security application privilege such as the DML SELECT privilege, which can be restricted to certain rows of the database table. This restriction is implemented using an access control list (ACL) and a data security policy.

The HR scenario requires the following components for the security model:

- **Protected data**: Employee information is stored in the table EMPLOYEES of the sample database schema HR (delivered with Oracle Database).
- **Application role**: Application roles, EMPLOYEE, IT_ENGINEER, and HR_REPRESENTATIVE are created for performing tasks. The application roles are defined with the XS_PRINCIPAL.CREATE_ROLE procedure.
- **Application user**: Application users, SMAVRIS and DAUSTIN, are created and defined. SMAVRIS is granted the application roles EMPLOYEE and HR_REPRESENTATIVE. DAUSTIN is granted the application roles EMPLOYEE and IT_ENGINEER.
- **Database access**: Application users SMAVRIS and DAUSTIN are given a database password for direct database login. In order to grant SELECT, INSERT, UPDATE, and DELETE privileges on table EMPLOYEES to application roles EMPLOYEE, IT_ENGINEER, HR_REPRESENTATIVE a database role, DB_EMP, is created and granted these database privileges. The application roles are then granted this database role.
- **Application Privilege**: A single security class, HR_PRIVILEGES, is created which defines a single custom application privilege, VIEW_SALARY. Through inheritance, the predefined application privilege SELECT is also available in this security class. These application privileges will be used in connection with a data security policy to allow read access to employee information. The security class is created by the XS.SECURITY_CLASS.CREATE_SECURITY_CLASS procedure.
- **ACL**: The SELECT and VIEW_SALARY privileges are granted to application role EMPLOYEE by the access control list (ACL), EMP_ACL that is created by XS_ACL.CREATE_ACL procedure. The SELECT privilege is granted to application role IT_ENGINEER by the ACL, IT_ACL that is created by XS_ACL.CREATE_ACL procedure. The SELECT, INSERT, UPDATE, and DELETE privileges are granted to application role HR_REPRESENTATIVE by the ACL, HR_ACL that is created by XS_ACL.CREATE_ACL procedure to view and update all employee's records, and granting the VIEW_SALARY application privilege to view the SALARY column. .
- **Data Security Policy**: The data security policy is defined and created with the XS_DATA_SECURITY.CREATE_POLICY procedure. This data security policy defines three data realms (an employee's own record realm that can view the realm including the SALARY column, all the records in the IT department realm that can view the IT department excluding the SALARY column, and all the employee records realm that can view the realm including the SALARY column) and a column constraint. The data security policy associates the ACLs EMP_ACL, IT_ACL, and HR_ACL with its respective data realm.

Introducing this example in this chapter provides an overview of the requirements for implementing a policy using Real Application Security. Actual implementation of these tasks requires a systematic understanding of all the Real Application Security concepts introduced in this chapter, and further discussed in subsequent chapters. The complete example, including implementation details, appears in "Real Application Security: Putting It All Together".

About Auditing in an Oracle Database Real Application Security Environment

Another aspect of security is auditing in an Oracle Database Real Application Security environment. Real Application Security administration and run-time actions can be audited by configuring and enabling unified audit policies. For information about unified auditing in an Oracle Database Real Application Security environment, see *Oracle Database Security Guide*.

The following static data dictionary views are defined for auditing policies specifically for Oracle Database Real Application Security:

- `DBA_XS_AUDIT_POLICY_OPTIONS` - describes the auditing options that were defined for Real Application Security unified audit policies. See *Oracle Database Reference* for more information.
- `DBA_XS_AUDIT_TRAIL` - provides detailed information about Real Application Security that were audited. See *Oracle Database Reference* for more information.
- `DBA_XS_ENB_AUDIT_POLICIES` - lists users for whom Real Application Security unified audit polices are enabled. See *Oracle Database Reference* for more information.

Support for Pluggable Databases

The multitenant architecture enables an Oracle database to contain a portable collection of schemas, schema objects, and nonschema objects that appear to an Oracle Real Application Security application user as a separate database. A multitenant container database (CDB) is an Oracle database that includes one or more pluggable databases (PDBs).

Oracle Real Application Security can be used with Oracle Multitenant to provide increased security for consolidation.

Because Oracle Real Application Security entities are scoped within a PDB, each PDB has its own Real Application Security metadata, such as users, roles, privileges, ACLs, data security policies, and so forth. As a result, Real Application Security can prevent privileged user access inside a PDB between and among applications and between the PDB and the common privileged user at the container database.

As `SYS` is the schema owner for Oracle Real Application Security entities, Real Application Security entities created in `root` can only be accessed by the `SYS` user in `root`. The same is true for other operating systems in that the SYS user is the schema owner for Oracle Real Application Security entities and only the SYS user has access to these entities. Similarly, Real Application Security entities created within a local PDB, can only be accessed in the local PDB.

Since Oracle Real Application Security direct login users have a password associated with them, these users can be provisioned within a PDB, using a single `sqlnet.ora` parameter to support them.

Oracle Real Application Security administration involves PDB specific administrative privileges and a schema to qualify the name for Real Application Security entities. The schema name can be common; however, entities created under the naming scope of a common schema are not common.

Oracle Real Application Security auditing is PDB specific.

An Oracle Real Application Security application user can connect to a PDB using a service whose pluggable database property has been set to the relevant PDB.

See Also:

Introduction to the Multitenant Architecture and Overview of the Multitenant Architecture in *Oracle Database Concepts*.

Oracle Database Administrator's Guide for more information about PDBs and for more details about configuring the services to connect to various PDBs

2

Configuring Application Users and Application Roles

This chapter contains:

- About Configuring Application Users
- About Configuring Application Roles
- Effective Dates for Application Users and Application Roles
- About Granting Application Privileges to Principals

> **See Also:**
>
> "XS_PRINCIPAL Package"

About Configuring Application Users

This section contains the following topics:

- About Application User Accounts
- Creating a Simple Application User Account
- About Creating a Direct Login Application User Account
- Resetting the Application User's Password with the SQL*Plus PASSWORD Command
- Configuring an Application User Switch
- Validating an Application User

About Application User Accounts

Traditional database users own database schemas and can create traditional heavyweight database sessions to those schemas.

Application users do not own database schemas, but can create application sessions to the database through the middle tier provided they are granted the role or roles with the appropriate object privileges for accessing tables. Application users can also create heavyweight database sessions by connecting to the database directly through direct login application user accounts provided these accounts are associated with a schema and the `XSCONNECT` application role is granted to these application users. A profile can also be created and assigned to each of these application users.

This section contains: General Procedures for Creating Application User Accounts.

General Procedures for Creating Application User Accounts

The general procedure for creating an application user account is as follows:

1. Create a security manager user, `sec_mgr`, as follows and grant this user `create session` database privilege and Real Application Security `xs_session_admin` database role. Next, execute the `xs_admin_util.grant_system_privilege` call to grant the Real Application Security least system privilege `PROVISION` to `sec_mgr` as a database user. As the security manager, you can now create users and roles, set passwords, and so forth, and administer sessions using the Real Application Security least system privilege.

   ```
   sqlplus /nolog
   SQL> connect sys/password as sysdba
   SQL> grant create session, xs_session_admin to sec_mgr identified by
   password;
   SQL> exec sys.xs_admin_util.grant_system_privilege('provision',
   'sec_mgr', sys.xs_admin_util.ptype_db);
   ```

2. Log in to SQL*Plus as a user who has either the Real Application Security `PROVISION` system privilege or the database `CREATE USER` system privilege.

   ```
   sqlplus sec_mgr
   Enter password: password
   Connected.
   ```

   See "XS_PRINCIPAL Package" for more information about the `XS_PRINCIPAL` package and specifically the "CREATE_USER Procedure".

   You must have the privileges required to create, modify, or drop application users and roles. These privileges are governed by the same system privileges required to create, modify, or drop database users and roles. For more information about these and other SQL statements, see *Oracle Database SQL Language Reference*.

3. Create the application users with the `XS_PRINCIPAL.CREATE_USER` procedure.

   Select the appropriate type, and follow the instructions in these sections:

   - "Creating a Simple Application User Account"
   - "About Creating a Direct Login Application User Account"

Other Tasks

After you create the application user account, you can grant the account a role, which provides privileges for the application users. For more information, see "Granting an Application Role to an Existing Application User".

Creating a Simple Application User Account

> **Note:**
>
> In SQL*Plus, case sensitivity is an issue for lower case characters and special characters, so keep these guidelines in mind.
>
> - An application user whose name contains lower case or special characters must connect to SQL*Plus with the account name in double quotation marks:
>
> For example:
>
>  ```
>  CONNECT "lwuser1"
>  Enter password: password
>  Connected.
>  ```
>
> - The name of an application role that contains lower case or special characters must be entered in SQL*Plus enclosed in double quotation marks.
>
> For example:
>
>  ```
>  GRANT cust_role TO "app_regular_role";
>  ```

When you create a simple application user account, the schema argument specifies the schema name to use to resolve unqualified names. This does not give you any privileges, and it is just used for name resolution purposes. If the schema name is not specified, `XS$NULL`, is used.

To create a simple application user account, do the following:

1. Log in.

   For example, if `sec_mgr` has the `CREATE USER` privilege, log in as follows:

   ```
   sqlplus sec_mgr
   Enter password: password
   Connected.
   ```

2. Create the application user account.

   For example:

   ```
   BEGIN
     SYS.XS_PRINCIPAL.CREATE_USER('lwuser1');
   END;
   /
   ```

   As a user with `DBA` role, you can check the user creation by querying the `DBA_XS_USERS` data dictionary view as follows. See "DBA_XS_USERS" for more information.

   ```
   SELECT NAME FROM DBA_XS_USERS;

   NAME
   -------------------------
   ```

```
XSGUEST
LWUSER1
```

This output displays the existing application user accounts. The `XSGUEST` user account is an already existing or predefined system created user account.

For detailed information about the `XS_PRINCIPAL.CREATE_USER` procedure, see "CREATE_USER Procedure".

You can delete an application user account using the `XS_PRINCIPAL.DELETE_PRINCIPAL` procedure, see "DELETE_PRINCIPAL Procedure".

About Creating a Direct Login Application User Account

This section contains:

- Creating Direct Login Application User Accounts
- Procedure for Creating the Direct Login Application User Account
- Setting a Password Verifier for Direct Application User Accounts
- Oracle Label Security Context Is Established in Direct Logon Session

Creating Direct Login Application User Accounts

You can use an application user account to directly log into the database. This is useful for users who need to perform functions such as logging directly into SQL*Plus without logging in through SSO or a Web interface. The direct login user must have a password.

Procedure for Creating the Direct Login Application User Account

To create a direct login application user account:

1. Log in as described in "General Procedures for Creating Application User Accounts".

   ```
   sqlplus sec_mgr
   Enter password: password
   Connected.
   ```

2. Create the application user account.

   For example, to create an application user account, `lwuser1`, whose default database schema is `HR`:

   ```
   BEGIN
     SYS.XS_PRINCIPAL.CREATE_USER
         (name       => 'lwuser1',
          schema     => 'HR');
   END;/
   ```

> **Note:**
>
> If the schema does not exist, the direct login fails.

When this Real Application user directly connects to the database for name resolution of unqualified database objects in queries, HR schema is used as the default schema. For example:

```
SELECT COUNT(*) FROM EMPLOYEES;
```

3. Create a password for the application user account.

   For example:

   ```
   BEGIN
         SYS.XS_PRINCIPAL.SET_PASSWORD('lwuser1', 'password');
   END;
   /
   ```

   Set the password as described in "SET_PASSWORD Procedure". When you use the SET_PASSWORD procedure, it creates a verifier for you based on the password and the type parameter, and then inserts the verifier and the value of the type parameter into the dictionary table.

   > **Note:**
   >
   > Replace *password* with a secure password. See *Oracle Database Security Guide* for more information about password guidelines.

4. Create a profile named prof and assign this profile to the application user account.

   For example:

   ```
   CREATE PROFILE prof LIMIT PASSWORD_REUSE_TIME 1/1440 PASSWORD_REUSE_MAX 3
   PASSWORD_VERIFY_FUNCTION Verify_Pass;

   BEGIN
     SYS.XS_PRINCIPAL.SET_PROFILE('lwuser1','prof');
   END;
   ```

   The user assigning the profile must have ALTER_USER privilege. See the "SET_PROFILE Procedure" for more information.

5. Grant the role XSCONNECT to the user to allow access to the database.

   For example:

   ```
   BEGIN
         SYS.XS_PRINCIPAL.GRANT_ROLES('lwuser1', 'XSCONNECT');
   END;
   /
   ```

Next, you are ready to assign privileges to the application user account. Go to "About Granting Application Privileges to Principals".

Afterward, the user can connect to the database as follows. For example:

```
CONNECT lwuser1
Password: password
```

Setting a Password Verifier for Direct Application User Accounts

Optionally, you can set a password verifier for this password (a hash transformed password), enabling administrators to migrate users into Real Application Security with knowledge of the verifier and not the password. If you do not set a password verifier, the default hashing algorithm is XS_SHA512. For more information, see the SET_PASSWORD Procedure and the SET_VERIFIER Procedure.

Example 2-1 shows how to use the XS_PRINCIPAL.SET_VERIFIER procedure to set the password verifier to the value as determined from a query of the XS$VERIFIERS dictionary table, using the hashing algorithm XS_SHA512 for the application user account LWUSER1 by following these steps:

1. Query the view DBA_XS_OBJECTS to obtain the ID value for user LWUSER1.
2. Query the XS$VERIFIERS dictionary table for user LWUSER1 whose ID is 2147493730. The value of the verifier includes its type as value “T” followed by a colon (:) to denote that it is a verifier type of XS_SHA512, which is also indicated as being of type# 2.
3. Using the entire verifier value including “T:”, set the verifier for user LWUSER1. The following example shows each of these steps.

Example 2-1 Setting the Password Verifier Using the Hash Algorithm XS_SHA512

```
sqlplus sec_mgr
Enter password: password
Connected.

SQL> column name format A10;
SQL> column owner format A6;
SQL> select NAME, OWNER, ID, TYPE, STATUS from  DBA_XS_OBJECTS where NAME
= 'LWUSER1';

NAME       OWNER          ID TYPE               STATUS
---------- ------ ---------- ------------------ --------
LWUSER1    SYS    2147493730 PRINCIPAL          VALID

SQL> column user# format 9999999999;
SQL> column type# format 99;
SQL> column verifier format A62;
SQL> select USER#, VERIFIER, TYPE# from XS$VERIFIERS where USER# =
'2147493730';

      USER# VERIFIER
TYPE#
----------- --------------------------------------------------------------
-----
 2147493730 T:
9BA95FEF2C2630A2BAACF2E7C5E41B0D50CDC7B0B60C88AD4FE81F8155D0     2
            02F99EEAF9D95477E4749870C67FDE870E154ED17809C359777F979E269010
            823FB981B2A998915EB1439FE3C6C1542A239C
```

```
SQL> BEGIN
SYS.XS_PRINCIPAL.SET_VERIFIER('lwuser1','T:
9BA95FEF2C2630A2BAACF2E7C5E41B0D50CDC7B0B6
0C88AD4FE81F8155D002F99EEAF9D95477E4749870C67FDE870E154ED17809C359777F979E2
69010823FB
981B2A998915EB1439FE3C6C1542A239C', XS_PRINCIPAL.XS_SHA512);
END;
/  2    3    4    5

PL/SQL procedure successfully completed.
```

For this procedure to complete successfully, both the verifier value and its type must match the information in the `VERIFIER` column of the `XS$VERIFIERS` dictionary table for the user whose verifier is being set. Note that when you change the password for an application user, it automatically changes its verifier value with the option of changing its verifier type.

This example set the verifier to its same exact value to show the steps involved. You have the option to set the verifier for a password to any verifier value that displays for an application user when you query the `XS$VERIFIERS` dictionary table as long as the verifier value matches the verifier type that you set. For example, if you wanted to change the verifier value and the verifier type to `XS_SALTED_SHA1`, do the following.

```
SQL> BEGIN
SYS.XS_PRINCIPAL.SET_VERIFIER('lwuser1','S:
14DC0F5ABB72FC869549B1F845C548E0BEF7B863A116DB24DFAE22F0501E',
XS_PRINCIPAL.XS_SALTED_SHA1);
END;
/  2    3    4

PL/SQL procedure successfully completed.
```

Note that this is the same verifier value and verifier type that was set for application user `LWUSER3` as shown in the SET_VERIFIER Procedure.

Oracle Label Security Context Is Established in Direct Logon Session

Describes Oracle Label Security support for Real Application Security users.

Beginning with Oracle Database 12*c* Release 2 (12.2), Oracle Label Security supports Real Application Security users. This means that when a Real Application Security user attaches with Real Application Security user session through direct logon, the user can exercise its own Oracle Label Security authorization. Oracle Label Security context is established during the attach session.

> **See Also:**
>
> - Attaching an Application Session to a Traditional Database Session for more Information about how Oracle Label Security supports Real Application Security users
> - *Oracle Label Security Administrator's Guide* for more Information about Oracle Label Security

Resetting the Application User's Password with the SQL*Plus PASSWORD Command

As the security administrator, `sec_mgr`, you have the `create session` database privilege and Real Application Security`xs_session_admin` database role and in addition, `sec_mgr` is granted the Real Application Security `PROVISION` least system privilege as a database user. As the security manager, you can now create users and roles, set passwords, and so forth, and administer sessions using the Real Application Security least system privilege.Example 2-2 shows how the security administrator can reset the password for user `lwuser2` using the SQL*Plus `PASSWORD` command.

However, if you as user `lwuser2`, perform a self password change using the SQL*Plus `PASSWORD` command invoked from an explicitly attached session (a session attached using the `ATTACH_SESSION` procedure or the `attachSession()` method in Java), the session must have the `ALTER USER` privilege and the user name must be provided with the `PASSWORD` command.

Example 2-3 shows how the application user `lwuser2` explicitly attached to a session, performs a self password change that fails because the users session does not have the `ALTER USER` privilege.

Example 2-4 shows how an application user `lwuser2` explicitly attached to a session having the `ALTER USER` privilege can perform a self password change. The user's self password change is successful.

The `SET_PASSWORD` procedure does not prompt for old password, but requires either Real Application Security `PROVISION` privilege as the least privilege, or database `ALTER USER` privilege. (Note that `SET_PASSWORD` is the Real Application Security PL/SQL procedure, not the SQL*Plus `PASSWORD` command.) If the user's session has the `PROVISION` least privilege or the `ALTER USER` privilege, you can reset the password for any application user from any application user's session (including an explicitly attached and a direct logon session) or the database user session if that session has the `PROVISION` least privilege or the `ALTER USER` privilege. The SQL*Plus `PASSWORD` command never prompts for the old password if you are changing another application user's password.

Example 2-2 DBA Resets the Password with a Password Change Operation for User lwuser2 When Not Explicitly Attached to a Session

```
sqlplus sec_mgr
Enter password: password
Connected.
SQL> BEGIN
  2 SYS.XS_PRINCIPAL.CREATE_USER('lwuser2');
```

```
  3 END;
  4/

PL/SQL orocedure successfully completed.

SQL> PASSWORD lwuser2
Changing password for lwuser2
New password: password
Retype new password: password
Password changed
```

Example 2-3 User lwuser2 Performs a Self Password Change that Fails When Explicitly Attached to a Session Because the Session Lacks the ALTER USER Privilege

```
sqlplus sec_mgr
Enter password: password
Connected.
SQL> DECLARE
  2 SESSIONID RAW(16);
  3 BEGIN
  4 SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser2', sessionid);
  5 SYS.DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid);
  6 END;
  7 /

PL/SQL procedure successfully completed.

SQL> CONNECT lwuser2
Enter password: password
Connected.
SQL> SELECT SYS.XS_SYS_CONTEXT('XS$SESSION','USERNAME') FROM DUAL;

XS_SYS_CONTEXT('XS$SESSION','USERNAME')
--------------------------------------------------------------------------------
LWUSER2

SQL> PASSWORD lwuser2
Changing password for lwuser2

Old password: password
New password: password
Retype new password: password
ERROR:
ORA-01031: insufficient privileges


Password unchanged
```

Example 2-4 A Self Password Change Succeeds When Explicitly Attached to a Session and User lwuser2's Session Has the ALTER USER Privilege

```
sqlplus sec_mgr
Enter password: password
Connected.
SQL> CREATE ROLE pwdchg;

Role created.

SQL> GRANT ALTER USER TO pwdchg;
```

```
Grant succeeded.

SQL> EXEC SYS.XS_PRINCIPAL.CREATE_ROLE(NAME => 'resetpwd_role', ENABLED => TRUE);

PL/SQL procedure successfully completed.

SQL> GRANT pwdchg TO resetpwd_role;

Grant succeeded.

SQL>  EXEC SYS.XS_PRINCIPAL.GRANT_ROLES('lwuser2','resetpwd_role');

PL/SQL procedure successfully completed.

SQL> CONNECT lwuser2
Enter password: password
Connected.

SQL> SELECT SYS.XS_SYS_CONTEXT('XS$SESSION','USERNAME') FROM DUAL;

SYS.XS_SYS_CONTEXT('XS$SESSION','USERNAME')
--------------------------------------------------------------------------------
LWUSER2

SQL> PASSWORD lwuser2
Changing password for lwuser2
Old password: password
New password: password
Retype new password: password
Password changed
SQL>
```

Configuring an Application User Switch

Using the `XS_PRINCIPAL.ADD_PROXY_USER` procedure, you can add an application user to proxy another application user and assume the application roles of that application user. You can use the `DBMS_XS_SESSIONS.SWITCH_USER` procedure to switch application users in a session if the user has been added as a proxy.

Assume `app_user1` has application roles `role1` and `role2`. Example 2-5 allows you to proxy the application roles `role1` and `role2` of `app_user1` to `app_user2`. The call `add_proxy_user('app_user1', 'app_user2', pxy_roles)` allows `app_user2` to switch to `app_user1` and assume `app_user1`'s roles, `role1` and `role2`. It does not grant the roles to `app_user2`.

The query of view `DBA_XS_ROLE_GRANTS` shows that roles, `roles1` and `roles2` are still only granted to `app_user1` and not to `app_user2`, and that `app_user2` only assumed these roles as a proxy user.

The query of view `DBA_XS_PROXY_ROLES` shows that `app_user2` is the proxy user, `app_user1` is the target user, and the target roles are `role1` and `role2`.

The query of view `DBA_XS_SESSIONS` also shows that `app_user2` is the proxy user in this session.

As the application user with DBA role, you can create a session for `app_user2` and switch application user to `app_user1`, as shown in Example 2-6.

This example first creates a session with app_user2 and attaches to it. Then app_user2 switches to app_user1 and assumes app_user1's roles, role1 and role2.

The query of view DBA_XS_ROLE_GRANTS shows that roles, roles1 and roles2 are still only granted to app_user1 and not to app_user2, and that app_user2 only assumed these roles as a proxy user.

The query of view DBA_XS_SESSION_ROLES shows that roles role1 and role2 are associated with the same session ID in which app_user1 was switched with app_user2.

The query of view DBA_XS_SESSIONS also shows that app_user2 is the proxy user in this session.

Example 2-5 Configuring a Proxy Application User

```
sqlplus sec_mgr
Enter password: password
Connected.

SQL> EXEC SYS.XS_PRINCIPAL.CREATE_ROLE('role1',true);
SQL> EXEC SYS.XS_PRINCIPAL.CREATE_ROLE('role2',true);

SQL> EXEC SYS.XS_PRINCIPAL.CREATE_USER('app_user1','HR');
SQL> EXEC SYS.XS_PRINCIPAL.SET_PASSWORD('app_user1', 'password');
SQL> EXEC SYS.XS_PRINCIPAL.CREATE_USER('app_user2','HR');
SQL> EXEC SYS.XS_PRINCIPAL.SET_PASSWORD('app_user2', 'password');

SQL> EXEC SYS.XS_PRINCIPAL.GRANT_ROLES('app_user1', 'role1');
SQL> EXEC SYS.XS_PRINCIPAL.GRANT_ROLES('app_user1', 'role2');

DECLARE
  pxy_roles XS$NAME_LIST;
begin
  pxy_roles := XS$NAME_LIST('role1','role2');
  sys.xs_principal.add_proxy_user(target_user => 'app_user1', proxy_user =>
'app_user2', target_roles => pxy_roles);
end;
/

SQL> SELECT grantee, granted_role FROM DBA_XS_ROLE_GRANTS;

SQL> SELECT proxy_user, target_user, target_role FROM DBA_XS_PROXY_ROLES;

SQL> SELECT user_name, sessionid, proxy_user FROM DBA_XS_SESSIONS;
```

Example 2-6 Creating a Session and Switching an Application User

```
sqlplus sec_mgr
Enter password: password
Connected.
SQL> EXEC SYS.XS_PRINCIPAL.CREATE_USER('app_user1','HR');
SQL> EXEC SYS.XS_PRINCIPAL.SET_PASSWORD('app_user1', 'password');
SQL> EXEC SYS.XS_PRINCIPAL.CREATE_USER('app_user2','HR');
SQL> EXEC SYS.XS_PRINCIPAL.SET_PASSWORD('app_user2', 'password');

SQL> EXEC SYS.XS_PRINCIPAL.CREATE_ROLE('role1',true);
SQL> EXEC SYS.XS_PRINCIPAL.CREATE_ROLE('role2',true);

SQL> EXEC SYS.XS_PRINCIPAL.CREATE_USER('app_user1','HR');
SQL> EXEC SYS.XS_PRINCIPAL.SET_PASSWORD('app_user1', 'password');
```

```
SQL> EXEC SYS.XS_PRINCIPAL.CREATE_USER('app_user2','HR');
SQL> EXEC SYS.XS_PRINCIPAL.SET_PASSWORD('app_user2', 'password');

SQL> EXEC SYS.XS_PRINCIPAL.GRANT_ROLES('app_user1', 'role1');
SQL> EXEC SYS.XS_PRINCIPAL.GRANT_ROLES('app_user1', 'role2');

declare
  sessionid raw(16);
begin
  sys.dbms_xs_sessions.create_session('app_user2', sessionid);
  sys.dbms_xs_sessions.attach_session(sessionid);
  sys.dbms_xs_sessions.switch_user('app_user1');
end;
/

SQL> SELECT grantee, granted_role FROM DBA_XS_ROLE_GRANTS;

SQL> SELECT sessionid, role FROM DBA_XS_SESSION_ROLES;

SQL> SELECT user_name, sessionid, proxy_user FROM DBA_XS_SESSIONS;
```

Validating an Application User

Oracle recommends that you always validate the Real Application Security objects after administrative configuration changes. The `XS_DIAG` package provides a set of validation APIs to help ensure that these changes do not damage the complicated relationships among your Real Application Security objects. To validate an application user account, use the `XS_DIAG.VALIDATE_PRINCIPAL` function. The caller has invoker's rights on this package and must have `ADMIN_ANY_SEC_SECURITY` privilege to run the `XS_DIAG` package.

See the "VALIDATE_PRINCIPAL Function" for more information.

About Configuring Application Roles

This section contains the following topics:

- About Application Roles
- Regular and Dynamic Application Roles
- About Configuring an Application Role
- Predefined Regular Application Roles and Dynamic Application Roles

About Application Roles

An application role is a role that can only be granted to an application user or to another application role. Application roles provide a way to group application users who must have a common application privilege, identified within an ACL, in order to access an application. The `XS_PRINCIPAL.CREATE_ROLE` procedure can create regular application roles. The `XS_PRINCIPAL.CREATE_DYNAMIC_ROLE` procedure can create dynamic application roles (one type of application role).

Application roles are conceptually similar to enterprise roles. An enterprise role can only be granted to an enterprise user and that grant occurs outside the database. Similarly, an application role can only be granted to an application user or application role, and that grant occurs outside of the standard database grant mechanisms.

Dynamic roles cannot be granted to an application user or another application role, but can only be enabled in an application session as a parameter in an attach session call as described in "Dynamic Application Roles".

> **See Also:**
>
> - *Oracle Database SQL Language Reference* for more information about SQL
> - *Oracle Database PL/SQL Language Reference* for more information about PL/SQL APIs

Regular and Dynamic Application Roles

Real Application Security allows regular and dynamic application roles.

This section contains the following topics:

- Regular Application Roles
- Dynamic Application Roles

Regular Application Roles

A regular application role is an application role that you can grant to an application user or another application role (regular or dynamic). You can specify if you want the regular application role to be enabled by default or not.

Dynamic Application Roles

A dynamic application role is an application role that is enabled only under certain situations, for example, when a user has logged on using SSL, or during a specific period of time, and so on. Dynamic application roles might be used, for example, if there is some application privilege granted to all application users connecting during weekdays. If that criterion is met, then the application enables those application roles.

The application determines the criteria for enabling a dynamic application role, however the criteria can be evaluated by the application or by the database at the request of the application.

- When the Application Evaluates the Criteria

  If the application evaluates the criteria and the application role meets it, then the application, if it is attached to an application session, can enable dynamic application roles for application users. When the application detaches from the application session, the dynamic application role is automatically disabled.

  For security reasons, you cannot disable dynamic application roles during the session. This is especially important because they may infer negative application privileges.

- When the Database Evaluates the Criteria

  If the database evaluates the criteria and the application role meets it, then the database can enable application roles for the application user. The database can disable dynamic application roles based on two types of time-outs: one from the

last time the session was accessed, and one from the last time the session was authenticated. Oracle Database checks these time-outs when the session is first attached.

You do not need to grant the dynamic application role formally to a user beforehand. There is no way to enable or disable a dynamic application role through the standard enable and disable APIs. You cannot grant dynamic application roles to other application roles, but you can grant other application roles to dynamic roles.

> **See Also:**
>
> "Predefined Regular Application Roles and Dynamic Application Roles"

About Configuring an Application Role

This section contains the following topics:

- Creating a Regular Application Role
- Creating a Dynamic Application Role
- Validating an Application Role

Creating a Regular Application Role

To create a regular application role, log into SQL*Plus as user `sec_mgr` with the `CREATE ROLE` system privilege, and then use the `XS_PRINCIPAL.CREATE_ROLE` procedure.

Example 2-7 shows how to create a regular application role called `app_regular_role`. The `start_date` and `end_date` parameters specify the active start and end times for this application role. The `enable` parameter is set to `TRUE`.

After you create the regular application role, you are ready to grant it to one or more application users or application roles. See the following section:

"About Granting an Application Role to an Application User"

Example 2-7 Creating a Regular Application Role

```
sqlplus sec_mgr
Enter password: password
Connected.

DECLARE
  st_date TIMESTAMP WITH TIME ZONE;
  ed_date TIMESTAMP WITH TIME ZONE;
BEGIN
  st_date := SYSTIMESTAMP;
  ed_date := TO_TIMESTAMP_TZ('2013-06-18 11:00:00 -5:00','YYYY-MM-DD HH:MI:SS');
  SYS.XS_PRINCIPAL.CREATE_ROLE
      (name        => 'app_regular_role',
      enabled      =>  TRUE,
      start_date   =>  st_date,
      end_date     =>  ed_date);
END;
/
```

Creating a Dynamic Application Role

To create a dynamic application role, log into SQL*Plus as user `sec_mgr` with the `CREATE ROLE` system privilege and then use the `XS_PRINCIPAL.CREATE_DYNAMIC_ROLE` procedure.

Example 2-8 shows how to create a dynamic application role called `app_dynamic_role`. The optional `duration` parameter specifies the period of time (in minutes) the application role is active. The `scope` parameter specifies the scope for this role, which can be either `SESSION_SCOPE` (the default value) or `REQUEST_SCOPE`. `SESSION_SCOPE` means the enabled dynamic role is still enabled when you detach the session and attach to the session again, unless you explicitly specify that it be disabled in the session reattach. `REQUEST_SCOPE` means that the role is disabled after the session is detached.

In this example, the dynamic application role is active for 40 minutes, and the scope is set to `SESSION_SCOPE` for the current application session. So the dynamic application role is active even when you detach the session and attach to the session again as long as the time limit has not exceeded 40 minutes after having created the dynamic application role.

Example 2-8 Creating a Dynamic Application Role

```
sqlplus sec_mgr
Enter password: password
Connected.

BEGIN
  SYS.XS_PRINCIPAL.CREATE_DYNAMIC_ROLE
      (name         => 'app_dynamic_role',
      duration      => 40,
      scope         => XS_PRINCIPAL.SESSION_SCOPE);
END;
/
```

Validating an Application Role

Oracle recommends that you should always validate Real Application Security objects after administrative configuration changes. The `XS_DIAG` package provides a set of validation APIs to help ensure that these changes do not damage the complicated relationships among your Real Application Security objects. To validate an application role, use the `XS_DIAG.VALIDATE_PRINCIPAL` function. See the "VALIDATE_PRINCIPAL Function" for more information.

See Troubleshooting Oracle Database Real Application Security for troubleshooting advice.

Predefined Regular Application Roles and Dynamic Application Roles

Using predefined dynamic application roles in a Real Application Security session, application users can acquire application privileges based on their run-time states. These application roles cannot be acquired by grants.

As an example, an application role may be enabled for application users connecting from within the corporate firewall, which grants application users more application privileges than connecting from outside the firewall.

See "Roles" for a description of Real Application Security predefined regular application roles, dynamic application roles, and database roles.

Regular application roles can be granted to an application user, but dynamic application roles cannot. Dynamic application roles are enabled based on user state.

See "Regular and Dynamic Application Roles" for descriptions.

Effective Dates for Application Users and Application Roles

You can specify effective dates for application users, application roles, and role grants. The application user or application role is available only within the period defined by the effective start and end date. Example 2-9 shows how effective dates are specified for an application user.

Sometimes the effective date restriction does not need to be an attribute of an application user or application role. Instead, it is only needed to restrict the effective dates on a per role grant basis. In this case, you can specify beginning and ending effective dates for an application role grant. This only constrains that particular application role grant and allows for implementing fine-grained access control policy. Example 2-10 shows how effective dates are specified for an application role.

These are the most direct consequences of effective date restrictions:

- If an application user is not currently effective (that is, within the period defined by its start and end date), the session for the particular application user cannot be created.
- If an application role is not currently effective, the application role (and any descendants) is not be available to the application user in the session.
- For application roles that are shared children of multiple application roles, the child application roles are available as long as there is at least one parent that is effective.
- If the application role grant of an application role is not currently effective, the application role (and any descendants) is not available to the application user or application role to which it is granted.

> **Note:**
>
> The effective dates should be used in the policy after a careful consideration of the nature of the restrictions that they impose on the use of application users and application roles.

Example 2-9 Setting Effective Dates for an Application User

```
sqlplus sec_mgr
Enter password: password
Connected.

DECLARE
 startDate TIMESTAMP := TO_TIMESTAMP (
      '2012-01-01 11:00:00','YYYY-MM-DD HH:MI:SS');
 endDate TIMESTAMP := TO_TIMESTAMP (
      '2013-01-01 11:00:00','YYYY-MM-DD HH:MI:SS');
```

```
BEGIN
  SYS.XS_PRINCIPAL.CREATE_USER
      (name        => 'lwuser1',
      start_date   => startDate,
      end_date     => endDate);
END;
/
```

Example 2-10 Setting Effective Dates for an Application Role of an Application User

```
sqlplus sec_mgr
Enter password: password
Connected.

DECLARE
 startDate TIMESTAMP := TO_TIMESTAMP ('2012-01-01 11:00:00','YYYY-MM-DD
 HH:MI:SS');
 endDate TIMESTAMP := TO_TIMESTAMP ('2013-01-01 11:00:00','YYYY-MM-DD
 HH:MI:SS');
BEGIN
  SYS.XS_PRINCIPAL.GRANT_ROLES
    (grantee      => 'lwuser1',
     role         => 'app_regular_role',
     start_date   => startDate,
     end_date     => endDate);
END;
/
```

About Granting Application Privileges to Principals

This section contains the following topics:

- About Granting an Application Role to an Application User
- Granting an Application Role to Another Application Role
- Granting a Database Role to an Application Role

About Granting an Application Role to an Application User

This section contains the following topics:

Creating a New Application User and Granting This User an Application Role

Example 2-11 shows how to grant an application role, `appl1_regular_role`, to an application user, `lwuser1`, when the application user account is created.

To find a listing of existing application roles, query the `DBA_XS_ROLES` data dictionary view.

Example 2-11 Creating a New Application User and Granting This User an Application Role

```
sqlplus sec_mgr
Enter password: password
Connected.
```

```
BEGIN
  SYS.XS_PRINCIPAL.CREATE_USER('lwuser1');
  SYS.XS_PRINCIPAL.GRANT_ROLES('lwuser1', 'appl1_regular_role');
END;
/
```

Granting an Application Role to an Existing Application User

Example 2-12 shows how to grant an application role, `appl1_regular_role`, to an existing application user, `lwuser1`. You cannot grant dynamic application roles to an existing application user.

You can find a listing of existing application user accounts by querying the `DBA_XS_USERS` view.

Example 2-12 Granting an Application Role to an Existing Application User

```
sqlplus sec_mgr
Enter password: password
Connected.

BEGIN
  SYS.XS_PRINCIPAL.GRANT_ROLES('lwuser1', 'appl1_regular_role');
END;
/
```

Granting an Application Role to Another Application Role

Example 2-13 shows how to grant a regular application role to another regular application role. You cannot grant dynamic application roles to other regular application roles, but you can grant other regular application roles to dynamic application roles. To find a listing of existing application roles, query the `DBA_XS_ROLES` view (see "DBA_XS_ROLES").

Example 2-13 Granting a Regular Application Role to Another Regular Application Role

```
sqlplus sec_mgr
Enter password: password
Connected.

BEGIN
  SYS.XS_PRINCIPAL.GRANT_ROLES(grantee => 'app_regular_role', role =>
'appl1_regular_role');
END;
/
```

Granting a Database Role to an Application Role

To grant a database role to an application role, use the SQL `GRANT` statement. You can find a listing of existing database roles by querying the `DBA_ROLES` data dictionary view.

Example 2-14 shows how to grant the database role, `cust_role`, to the application role `app_regular_role`.

Example 2-14 Granting a Database Role to an Application Role

```
sqlplus sec_mgr
Enter password: password
Connected.

GRANT cust_role TO app_regular_role;
```

3
Configuring Application Sessions

This chapter contains:

- About Application Sessions
- About Creating and Maintaining Application Sessions
- About Manipulating the Application Session State
- About Administrative APIs for External Users and Roles
- About Real Application Security Session Privilege Scoping Through ACL

About Application Sessions

An application session contains information relevant to the application and its user. An application session stores application session state as a collection of attribute-value pairs. These attribute value pairs are divided into namespaces. Unlike traditional *heavyweight* database sessions, an application session does not hold its own database resources, such as transactions and cursors. Because application sessions consume far fewer server resources than heavyweight sessions, an application session can be dedicated to each end application user. An application session can persist in the database and resume later with minimal cost.

To configure an application session, you work in two phases:

1. You create and maintain the application session.
2. You can manipulate the session state during the life of the session.

You can use either PL/SQL APIs or Java APIs to configure application sessions. This chapter describes the programmatic creation, use, and maintenance of application sessions in PL/SQL, and includes specific links to comparable Java information.

> **See Also:**
>
> - Oracle Database Real Application Security SQL Functions and Oracle Database Real Application Security PL/SQL Packages for information about PL/SQL API syntax
> - *Oracle Database Real Application Security Java API Reference* for information about Java API syntax (in Javadoc format)
> - Using Real Application Security in Java Applications for information about performing tasks with Java APIs

This section contains:

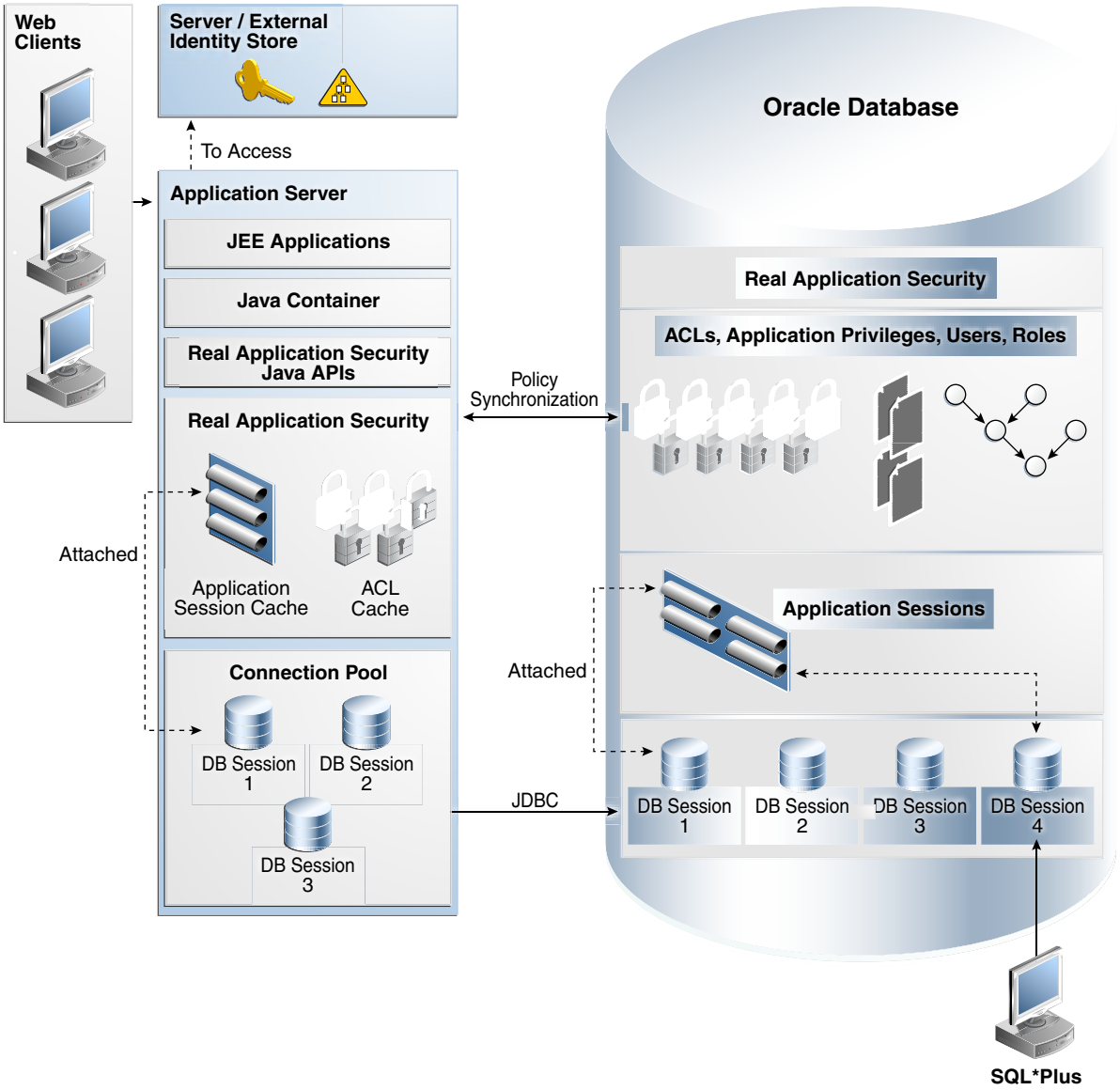
- About Application Sessions in Real Application Security
- Advantages of Application Sessions

About Application Sessions in Real Application Security

Figure 3-1 shows a Real Application Security architecture diagram and indicates how application sessions fit into it. The figure shows applications creating application sessions in the database. Some of these application sessions are associated with traditional database (DB) sessions.

Figure 3-1 also shows other components of Real Application Security such as ACLs, application privileges, application users, and application roles.

Figure 3-1 Real Application Security Architecture



Advantages of Application Sessions

Application sessions have functional advantages over traditional database sessions. For example, traditional database sessions are typically unaware of the end user identities or the security policies for those end users. On the contrary:

- Application sessions encapsulate end user's security context. They enable applications to use database authorization mechanisms for access control based on the end user identity.
- An application session can be associated with multiple database sessions simultaneously.
- They are accessible by all nodes in an Oracle Real Application Clusters (Oracle RAC) environment.

Application sessions have these performance advantages over traditional database sessions:

- They can be created with less overhead than traditional database sessions.
- They can persist in the database and resume later with minimal cost.
- Real Application Security can collect session attribute changes and session states on the client, using caches. Then, these changes are appended to the database until the next database roundtrip, reducing the number of database roundtrips.

About Creating and Maintaining Application Sessions

This section contains:

- Creating an Application Session
- Creating an Anonymous Application Session
- Attaching an Application Session to a Traditional Database Session
- Setting a Cookie for an Application Session
- Assigning an Application User to an Anonymous Application Session
- Switching a Current Application User to Another Application User in the Current Application Session
- About Creating a Global Callback Event Handler Procedure
- Configuring Global Callback Event Handlers for an Application Session
- Saving an Application Session
- Detaching an Application Session from a Traditional Database Session
- Destroying an Application Session

Creating an Application Session

You can create an application session using the `DBMS_XS_SESSIONS.CREATE_SESSION` procedure in PL/SQL or using the `createSession` method of the `XSSessionManager` class in Java. To create an application session, the invoking user needs `CREATE_SESSION` application privilege. This privilege can be obtained through `XS_SESSION_ADMIN` Database role or by `XS_ADMIN_UTIL.GRANT_SYSTEM_PRIVILEGE` API

call (see "GRANT_SYSTEM_PRIVILEGE Procedure" for more information). `CREATE_SESSION` procedure populates the unique identifier of the newly created session in `sessionid` out parameter. This unique identifier can be used to refer to the session in future calls. The `DBA_XS_SESSIONS` data dictionary view displays all the application sessions in the database.

You can also specify a list of namespaces to be created when the session is created. If you specify namespaces during creation of the session, the caller must have application privileges `MODIFY_NAMESPACE` or `MODIFY_ATTRIBUTE` on the namespaces, or the `ADMIN_NAMESPACE` system privilege.

Example 3-1 shows how to create an application session with `lwuser1`.

Example 3-1 Creating an Application Session

```
DECLARE
  sessionid RAW(16);
BEGIN
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
END;
```

See Also:

- CREATE_SESSION Procedure for information about the syntax of this PL/SQL procedure
- *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `createSession` method (in Javadoc format)
- Example 6-2 for information about a Java example of this task

Creating an Anonymous Application Session

You can also create an anonymous application session using the `DBMS_XS_SESSIONS.CREATE_SESSION` procedure in PL/SQL or using the `createAnonymousSession` method of the `XSSessionManager` class in Java. To create an anonymous session through the PL/SQL API, you must specify the predefined user name `XSGUEST`.

Example 3-2 shows how to create an anonymous session with the predefined user `XSGUEST`.

After creating an anonymous application session, you can assign a named user to the session.

Example 3-2 Creating an Anonymous Application Session

```
DECLARE
  sessionid RAW(16);
BEGIN
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('XSGUEST', sessionid);
END;
```

See Also:

- CREATE_SESSION Procedure for information about the syntax of this PL/SQL procedure
- *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `createAnonymousSession` method (in Javadoc format)
- Example 6-2 for information about a Java example of this task

Attaching an Application Session to a Traditional Database Session

To use an application session, it must be associated with a database session. This operation is called `attach`. You can attach an application session to a traditional database session using the `DBMS_XS_SESSIONS.ATTACH_SESSION` procedure in PL/SQL or the `attachSession` method of the `XSSessionManager` class in Java. A database session can only attach one application session at a time. The `DBA_XS_ACTIVE_SESSIONS` dynamic data dictionary view displays all attached application sessions in the database.

To execute this procedure, the traditional session user must have the `ATTACH_SESSION` application privilege. This privilege can be obtained through the `XS_SESSION_ADMIN` Database role or by the `XS_ADMIN_UTIL.GRANT_SYSTEM_PRIVILEGE` API call. If you specify namespaces, then the user is required to have the application privileges `MODIFY_NAMESPACE` or `MODIFY_ATTRIBUTE` on the namespaces, or `ADMIN_NAMESPACE` system privilege.

Example 3-3 shows how to attach an application session to a database session.

Beginning with Oracle Database 12*c* Release 2 (12.2), Oracle Label Security supports Real Application Security users. This means that Oracle Label Security context is established in the Real Application Security session during the attach operation, so that Oracle Label Security authorization can be exercised in the Real Application Security user session. Oracle Label Security provides the ability to define data labels, assign user labels and protect sensitive application data within the Oracle database.

For example, using Oracle Label Security data labels allows each row of a table to be labeled based on its level of confidentiality. Data labels consist of 3 components: levels, compartments, and groups. So a given data label should have one level, zero or more compartments and zero or more groups associated with it. Compartments allow defining finer granularity within a level – all data belonging to a particular project can be labeled with the same compartment. Groups are hierarchical and a group can thus be associated with a parent group.

In addition, using Oracle Label Security user labels, each user can be assigned labels that constrain access to labeled data. Each user is assigned a range of levels, compartments, and groups, and each session can operate within that authorized range to access labeled data within that range.

Furthermore, using privileges, Oracle Label Security privileges are policy specific and used to provide users specific rights to perform special operations or to access data beyond their label authorizations. The list of all policy specific privileges is: `FULL`, `READ`, `COMPACCESS`, `PROFILE_ACCESS`, `WRITEUP`, `WRITEDOWN`, and `WRITEACROSS`.

Using Oracle Label Security, trusted stored programs can be used. A trusted stored program unit is a stored procedure, function, or package that has been granted one or more label security privileges. Trusted stored program units are used to let users perform privileged operations in a controlled manner, or update data at several labels. By granting privileges to a program unit, the privileges required for users can be effectively reduced.

Using Oracle Label Security, a policy is applied to a table or an entire schema after defining data labels or user labels or both and assigning appropriate privileges to users. When a policy is applied on a table, label security creates a policy specific NUMBER column on the table to store numeric equivalent of the data labels defined before for the policy. The column can be created as a user visible column or as a hidden column. The user can specify various enforcement options when the policy is applied on the table. The `READ_CONTROL` enforcement option for example protects the table from queries and `WRITE_CONTROL` protects it from DML operations.

Establishing Oracle Label Security context in a Real Application Security session therefore lets `SELECT` and DML operations return results authorized for the Real Application Security user.

To attach a session with dynamic roles, a list of dynamic roles can be passed in the PL/SQL `ATTACH_SESSION` procedure.

> **Note:**
>
> When developing the application, ensure that all application end user actions are captured within an `ATTACH_SESSION` ... `DETACH_SESSION` programming block. (For more information, see "Detaching an Application Session from a Traditional Database Session").

Example 3-3 Attaching an Application Session

```
DECLARE
  sessionid raw(16);
BEGIN
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
  SYS.DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid);
END;
```

> **See Also:**
>
> - ATTACH_SESSION Procedure for information about the syntax of this PL/SQL procedure
> - *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `attachSession` method (in Javadoc format)
> - Example 6-3 for information about a Java example of this task
> - *Oracle Label Security Administrator's Guide* for information about Oracle Label Security

Setting a Cookie for an Application Session

You can associate a specific cookie with an application session using the `DBMS_XS_SESSIONS.SET_SESSION_COOKIE` procedure in PL/SQL or the `setCookie` method of the `XSSessionManager` class in Java. The cookie can also be associated at the time of creation of the session through the `CREATE_SESSION` PL/SQL API. A cookie is a token embedded in a user's session by a web site during an application session. So the next time the same user requests something from that web site, it sends the cookie to the application session, which allows the server to associate the session with that user.

To execute this procedure, the user must be granted the `MODIFY_SESSION` application privilege. This privilege can be obtained through the `XS_SESSION_ADMIN` Database role or by the `XS_ADMIN_UTIL.GRANT_SYSTEM_PRIVILEGE` API call.

Example 3-4 shows how to set a cookie for an application session.

Example 3-4 Setting a Cookie for an Application Session

```
DECLARE
  sessionid raw(16);
BEGIN
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
  SYS.DBMS_XS_SESSIONS.SET_SESSION_COOKIE('Cookie1', sessionid);
END;
```

See Also:

- SET_SESSION_COOKIE Procedure for information about the syntax of this PL/SQL procedure
- *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `setCookie` method (in Javadoc format)
- Example 6-20 for information about a Java example of this task

Assigning an Application User to an Anonymous Application Session

You can assign a named application user to a currently attached anonymous application session using the `DBMS_XS_SESSIONS.ASSIGN_USER` procedure in PL/SQL or the `assignUser` method of the `XSSessionManager` class in Java. Assigning a user changes the user session from anonymous to a named user.

To execute this procedure, the dispatcher or connection user must have the `ASSIGN_USER` application privilege. This privilege can be obtained through the `XS_SESSION_ADMIN` Database role or by the `XS_ADMIN_UTIL.GRANT_SYSTEM_PRIVILEGE` API call. If you specify namespaces, then the user is required to be granted application privileges `MODIFY_NAMESPACE` or `MODIFY_ATTRIBUTE` on the namespaces, or `ADMIN_NAMESPACE` system privilege. A list of dynamic roles can also be enabled using the `DBMS_XS_SESSIONS.ASSIGN_USER` procedure.

Beginning with Oracle Database 12*c* Release 2 (12.2), Oracle Label Security supports Real Application Security users. If the Real Application Security user is authorized in any Oracle Label Security policy then, during an `assign_user` call, the corresponding label security authorization is established for the named Real Application Security user session. Establishing Oracle Label Security context in a Real Application Security session therefore lets `SELECT` and DML operations return results authorized for the Real Application Security user.

Example 3-5 shows how to assign the application user `lwuser1` to an application session.

Example 3-5 Assigning an Application User to an Application Session

```
DECLARE
  sessionid raw(16);
BEGIN
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('XSGUEST', sessionid);
  SYS.DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid);
  SYS.DBMS_XS_SESSIONS.ASSIGN_USER('lwuser1');
END;
```

See Also:

- ASSIGN_USER Procedure for information about the syntax of this PL/SQL procedure
- *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `assignUser` method (in Javadoc format)
- Example 6-5 for information about a Java example of this task
- Attaching an Application Session to a Traditional Database Session for information about how Oracle Label Security supports Real Application Security users
- *Oracle Label Security Administrator's Guide* for information about Oracle Label Security

Switching a Current Application User to Another Application User in the Current Application Session

You can switch or proxy the security context of the current application session to a newly initialized security context for a specified application user using the `DBMS_XS_SESSIONS.SWITCH_USER` procedure in PL/SQL or the `switchUser` method of the `Session` interface in Java. To proxy another application user, the current application session user must be set up as a proxy user for the target user before performing the switch operation. This is performed through the `XS_PRINCIPAL.ADD_PROXY_USER` PL/SQL API.

Switching a user changes the user session between two named users.

If the target application user of the proxy operation has a list of filtering roles (proxy roles) set up for the proxy user, they are enabled in the session.

Beginning with Oracle Database 12*c* Release 2 (12.2), Oracle Label Security supports Real Application Security users. This means that Oracle Label Security context of the `target_user` will be established on switching from the `proxy_user` session to the `target_user` session.

You can either retain or clear the application namespace and attributes after a switch operation. When the `keep_state` parameter is set to `TRUE`, all application namespaces and attributes are retained; otherwise, all previous state in the session is cleared.

If you specify namespaces, then the user is required to be granted application privileges `MODIFY_NAMESPACE` or `MODIFY_ATTRIBUTE` on the namespaces, or the `ADMIN_NAMESPACE` system privilege.

Example 3-6 shows how to switch the application user `lwuser1` to application user `lwuser2` in the current application session. Note that namespace templates `ns1` and `ns2` should have already have been created by `SYSDBA`.

Example 3-6 Switching an Application User to Another Application User in the Current Application Session

```
DECLARE
  sessionid RAW(16);
  nsList DBMS_XS_NSATTRLIST;
BEGIN
  nsList := DBMS_XS_NSATTRLIST(DBMS_XS_NSATTR('ns1'),DBMS_XS_NSATTR('ns2'));
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
  SYS.DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid);
  SYS.DBMS_XS_SESSIONS.SWITCH_USER(username => 'lwuser2',
                                   keep_state => TRUE,
                                   namespaces => nsList);
END;
```

See Also:

- SWITCH_USER Procedure for information about the syntax of this PL/SQL procedure
- *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `assignUser` method (in Javadoc format)
- Example 6-6 for information about a Java example of this task
- Attaching an Application Session to a Traditional Database Session for information about how Oracle Label Security supports Real Application Security users
- *Oracle Label Security Administrator's Guide* for information about Oracle Label Security

About Creating a Global Callback Event Handler Procedure

The callback event handler procedure must adhere to the prototype, which includes a specified set of arguments.

For example, the following `callback_procedure` specifies an existing PL/SQL procedure, which is the event handler and shows its two possible forms.

```
PROCEDURE callback_procedure (sessionid in raw, error out pls_integer)
```

This first form includes two parameters, the `sessionid` in `RAW` and the out parameter `error`, which is used for the purpose of setting the error. The `sessionid` contains the session ID of the session in which the event was triggered. The out `error` parameter can be used in the event handler code to display the error.

```
PROCEDURE callback_procedure (sessionid in raw, user in varchar2, error
out pls_integer)
```

This second form includes an additional parameter `user` in `VARCHAR2` to specify the user who triggered this event.

> **Note:**
>
> The error value must be explicitly set to a value in the PL/SQL body or in the exception block as follows, `error:= 0;`.
>
> Otherwise, the following error is raised, `ORA-46071: Error occured in event handler <name-of-event-handler>` followed by another error, `ORA-1405: fetched column value is NULL`, indicating that the error value is `NULL`.

The following example shows the explicit setting of the error value using the second form of the callback procedure.

```
CREATE OR REPLACE PACKAGE CALLBACK_PACKAGE AS
PROCEDURE CALLBACK_PROCEDURE (sessionid in RAW, user in VARCHAR2, error
out PLS_INTEGER);
END CALLBACK_PACKAGE;
/

CREATE OR REPLACE PACKAGE BODY CALLBACK_PACKAGE AS
PROCEDURE CALLBACK_PROCEDURE (sessionid in RAW, user in VARCHAR2, error
out PLS_INTEGER) IS
BEGIN
  error := 0;
  dbms_output.put_line('Inside callback procedure');
EXCEPTION
WHEN OTHERS THEN
        error:=0;
        dbms_output.put_line('Error');
END CALLBACK_PROCEDURE;
END CALLBACK_PACKAGE;
```

> **See Also:**
>
> - Configuring Global Callback Event Handlers for an Application Session

Configuring Global Callback Event Handlers for an Application Session

A global callback event handler is a predefined PL/SQL procedure that can be invoked to inspect, log, and modify the session state when certain session events of interest occur. You can add multiple global callback event handlers on a session event. After you create the PL/SQL procedure, you can register or deregister, or enable or disable it using these procedures, respectively:

- `DBMS_XS_SESSIONS.ADD_GLOBAL_CALLBACK`

  Use this procedure to register a callback event handler.

- `DBMS_XS_SESSIONS.DELETE_GLOBAL_CALLBACK`

  Use this procedure to deregister a global callback.

- `DBMS_XS_SESSIONS.ENABLE_GLOBAL_CALLBACK`

  Use this procedure to enable or disable a global callback procedure by specifying a value of `TRUE` for enable or `FALSE` for disable.

To execute these APIs the user must have the `CALLBACK` application privilege. This can be obtained through the `XSPROVISIONER` application role or by calling the `XS_ADMIN_UTIL.GRANT_SYSTEM_PRIVILEGE` API. You can configure one or more global callback event handlers for use in an application session. If you configure multiple callback event handlers, Oracle Database executes the handlers in the order in which they were created.

Optionally, you can follow these steps to change the execution order:

1. Run the `DBMS_XS_SESSIONS.DELETE_GLOBAL_CALLBACK` procedure to deregister any existing callback.
2. Run the `DBMS_XS_SESSIONS.ADD_GLOBAL_CALLBACK` procedure to register the callback.

Example 3-7 Registering a Global Callback in an Application Session

```
BEGIN
  SYS.DBMS_XS_SESSIONS.ADD_GLOBAL_CALLBACK
   (DBMS_XS_SESSIONS.CREATE_SESSION_EVENT,
   'CALLBACK_SCHM','CALLBACK_PKG','CALLBACK_PROC');
END;
/
```

Table 3-1 lists session events that can use callback event handlers.

Table 3-1 Session Events That Can Use Callback Event Handlers

Session Event	When the Callback Will Be Executed
Creating a new application session	After the session is created.
Attaching to an existing application session	After the session is attached.
Enabling a dynamic application role	After a dynamic application role is enabled.
Disabling a dynamic application role	After a dynamic application role is disabled.
Direct login of an application session	After the session is attached (if the session attach is called as part of the direct logon of an application session).
Assigning a named application user to an anonymous application session	After the named user is assigned to the anonymous application session.
Proxying from one named application user to another named application user	After the application user is switched (if the application user is not proxying back to the original application user).
Proxying back from a named application user to the original application user	After the application user is switched (if the application user is proxying back to the original application user).
Enabling a regular application role	After the application role is enabled.
Disabling a regular application role	After the application role is disabled.
Detaching from an existing application session or database session	Before the session is detached.
Terminating an existing application session or database session	Before the session is destroyed.
Direct logoff of an application session or database session	Before the session is detached (if the session detach is called as part of the direct logoff of an application session).

Suppose you want to initialize certain application-specific states after creating a session. Example 3-7 shows how to register a global callback that sets up the state `CALLBACK_PROC`, which is defined in the package `CALLBACK_PKG` and owned by the schema `CALLBACK_SCHM`.

The state `CALLBACK_PROC` is registered as a global callback for the event `CREATE_SESSION_EVENT`.

For more examples, and for details about the syntax of these procedures, see the following:

- "ADD_GLOBAL_CALLBACK Procedure"
- "DELETE_GLOBAL_CALLBACK Procedure"
- "ENABLE_GLOBAL_CALLBACK Procedure"

Saving an Application Session

You can save the current user application session using the `DBMS_XS_SESSIONS.SAVE_SESSION` procedure in PL/SQL or the `saveSession` method of the `XSSessionManager` class in Java. Use the save operation when session changes need to be propagated immediately to other sessions using the same session as this one. If the save operation is not used, then the session changes would be reflected in other sessions only after this session is detached.

The calling user requires no privileges to perform this operation.

Example 3-8 shows how to save the current user application session.

Example 3-8 Saving the Current User Application Session

```
BEGIN
 SYS.DBMS_XS_SESSIONS.SAVE_SESSION;
END;
```

> **See Also:**
>
> - SAVE_SESSION Procedure for information about the syntax of these PL/SQL procedures
> - *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `detachSession` method (in Javadoc format)
> - Example 7-4 for information about a Java example of this task

Detaching an Application Session from a Traditional Database Session

You can detach an application session from the traditional database session using either of these procedures:

- `DBMS_XS_SESSIONS.DETACH_SESSION(abort => FALSE)`

  Use this procedure to detach the session and commit any changes that were made since the last time session changes were saved. When you specify the `abort` parameter as `FALSE` (the default value), all changes performed in the current session are persisted. The currently attached user can perform this operation without any additional privileges.

  `DETACH_SESSION` is always performed on the currently attached session.

- `DBMS_XS_SESSIONS.DETACH_SESSION(abort => TRUE)`

  Use this procedure to detach the session without saving the changes. When you specify the `abort` parameter as `TRUE`, it rolls back the changes performed in the current session. The role and namespace changes made to the session since the attach are discarded.

Example 3-9 shows how to detach an application session from a database session and commit the changes. Note that you can call `DETACH_SESSION` anywhere to detach the currently attached session.

You can use the `detachSession` method of the `XSSessionManager` class in Java.

Example 3-10 shows how to detach a database session from an application session without saving any changes.

> **Note:**
>
> When developing the application, ensure that all application end user actions are captured within an `ATTACH_SESSION` ... `DETACH_SESSION` programming block. (For more information, see "Attaching an Application Session to a Traditional Database Session")

Example 3-9 Detaching and Committing an Application Session

```
DECLARE
  sessionid RAW(16);
BEGIN
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
  SYS.DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid);
...
  SYS.DBMS_XS_SESSIONS.DETACH_SESSION;
...
END;
```

Example 3-10 Detaching and Not Committing an Application Session

```
DECLARE
  sessionid RAW(16);
BEGIN
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
  SYS.DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid);
...
  SYS.DBMS_XS_SESSIONS.DETACH_SESSION(TRUE);
END;
```

> **See Also:**
>
> - DETACH_SESSION Procedure for information about the syntax of these PL/SQL procedures
> - *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `detachSession` method (in Javadoc format)
> - Example 6-21 for information about a Java example of this task

Destroying an Application Session

You can terminate an application session using the `DBMS_XS_SESSIONS.DESTROY_SESSION` procedure in PL/SQL or using the `destroySession` method of the `XSSessionManager` class in Java. This procedure also detaches all traditional sessions from the application session.

To execute this procedure, the invoking user must have the `TERMINATE_SESSION` application privilege. This privilege can be obtained through the `XS_SESSION_ADMIN` Database role or by the `XS_ADMIN_UTIL.GRANT_SYSTEM_PRIVILEGE` API call.

Example 3-11 shows how to destroy an application session.

Example 3-11 Destroying an Application Session

```
DECLARE
  sessionid RAW(16);
BEGIN
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
  SYS.DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid);
  SYS.DBMS_XS_SESSIONS.DETACH_SESSION;
  SYS.DBMS_XS_SESSIONS.DESTROY_SESSION(sessionid);
END;
```

See Also:

- DESTROY_SESSION Procedure for information about the syntax of this PL/SQL procedure
- *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `destroySession` method (in Javadoc format)
- Example 6-22 for information about a Java example of this task

About Manipulating the Application Session State

This section contains:

- About Using Namespace Templates to Create Namespaces
- Initializing a Namespace in an Application Session
- Setting Session Attributes in an Application Session
- Getting Session Attributes in an Application Session
- Creating Custom Attributes in an Application Session
- Deleting a Namespace in an Application Session
- Enabling Application Roles for a Session
- Disabling Application Roles for a Session

About Using Namespace Templates to Create Namespaces

An application uses a namespace to store application defined attribute-value pairs. Often, an application needs to use the same namespace across different application sessions. A namespace template provides a way to define and initialize a namespace.

A namespace template defines the namespace and its properties. It is used to initialize the namespace in an application session. The namespace name must be the same as the template that defines it.

This section contains:

- Components of a Namespace Template
- About Namespace Views
- Creating a Namespace Template for an Application Session

Components of a Namespace Template

A namespace template includes the following:

- Name of the namespace

  The name of the application namespace uniquely identifies the namespace. This name is used when creating the namespace in an application session.

- Namespace handler

  The namespace handler is called when an attribute value is set or retrieved. Specifying a handler is optional.

  Namespaces can be associated with an event handling function. The server invokes this function whenever an operation on an attribute registered for event handling is performed. The event handling function is provided with the attribute name, attribute value, and the event code as arguments. For example:

```
FUNCTION event_handling_function_name(
         session_id IN RAW,
         namespace  IN VARCHAR2,
         attribute  IN VARCHAR2,
         old_value  IN VARCHAR2,
         new_value  IN VARCHAR2,
         event_code IN PLS_INTEGER)
RETURNS PLS_INTEGER;
```

- Attribute List

  The attribute list includes the attributes defined for the namespace. These attributes are created in the session when the namespace is created.

  You can specify the following optional data for attributes:

  – The default value

    The attribute is initialized with the default value when the namespace is created in the application session. The default value and the event types `FIRSTREAD_EVENT` and `FIRSTREAD_PLUS_UPDATE_EVENT` cannot exist at the same time.

  – Event types

You can specify the following event types for an attribute:

* `FIRSTREAD_EVENT`

  Specify this event type to call the namespace handler when an attribute whose value has not been set is read for the first time. You can specify this event type only if a default value has not been set for the attribute.

* `UPDATE_EVENT`

  Specify this event type to call the namespace handler when the attribute value is updated.

* `FIRSTREAD_PLUS_UPDATE_EVENT`

  Specify this event type to call the namespace handler when an attribute whose value has not been set is read for the first time, or when its value is updated. You can specify this event type only if a default value has not been set for the attribute.

- Namespace ACL

  The privilege model for namespace operations. Namespace operations are protected by the ACL set on the template. By default, `NS_UNRESTRICTED_ACL` is set on a template, which allows unrestricted operation on namespaces created from the templates.

About Namespace Views

You can find information about namespace templates, namespace template attributes, and namespace attributes in current and all application sessions by querying these data dictionary views:

- "DBA_XS_NS_TEMPLATES"
- "DBA_XS_NS_TEMPLATE_ATTRIBUTES"
- "DBA_XS_SESSION_NS_ATTRIBUTES"
- "V$XS_SESSION_NS_ATTRIBUTES"

Creating a Namespace Template for an Application Session

You can create a namespace template using the `XS_NAMESPACE.CREATE_TEMPLATE` procedure in PL/SQL or the `createNamespace` method of the `Session` interface in Java.

Example 3-12 shows how to create the namespace template `ns1` for an application session. It defines the attributes for this namespace using the list of attributes `attrs`. Because this namespace template has `NS_UNRESTRICTED_ACL` set on the template, this allows unrestricted operation on namespaces created from the template.

The calling user must have the `ADMIN_ANY_SEC_POLICY` application privilege, which allows it to administer namespace templates and attributes.

Example 3-12 Creating a Namespace Template

```
DECLARE
  attrs XS$NS_ATTRIBUTE_LIST;
BEGIN
  attrs := XS$NS_ATTRIBUTE_LIST();
  attrs.extend(3);

  attrs(1) := XS$NS_ATTRIBUTE('attr1','value1',
```

```
    XS_NAMESPACE.UPDATE_EVENT);
  attrs(2) := XS$NS_ATTRIBUTE('attr2',null,
    XS_NAMESPACE.FIRSTREAD_PLUS_UPDATE_EVENT);
  attrs(3) := XS$NS_ATTRIBUTE('attr3','value3');

  SYS.XS_NAMESPACE.CREATE_TEMPLATE(name=>'ns1',
                                   description=>'namespace template 1',
                                   attr_list=>attrs,
                                   schema=>'SCOTT',
                                   package=>'PKG1',
                                   function=>'FN1',
                                   acl=>'SYS.NS_UNRESTRICTED_ACL');
END;
/
```

See Also:

- CREATE_TEMPLATE Procedure for information about the syntax of this PL/SQL procedure
- *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `createNamespace` method (in Javadoc format)
- Example 6-10 for information about a Java example of this task

Initializing a Namespace in an Application Session

A namespace can be initialized, using a namespace template, during any of the following events, as described in this section:

This section contains:

- Initializing a Namespace When the Session Is Created
- Initializing a Namespace When the Session Is Attached
- Initializing a Namespace When a Named Application User Is Assigned to an Anonymous Application Session
- Initializing a Namespace When the Application User Is Switched in an Application Session
- Initializing a Namespace Explicitly

Initializing a Namespace When the Session Is Created

When you create an application session using the `DBMS_XS_SESSIONS.CREATE_SESSION` procedure in PL/SQL or the `createSession` method of the `XSSessionManager` class in Java, you can specify a list of namespaces to initialize.

Example 3-13 shows how to initialize two namespaces, `ns1` and `ns2`, while creating an application session.

If you specify namespaces during creation of the session, the caller is required to be granted application privileges `MODIFY_NAMESPACE` or `MODIFY_ATTRIBUTE` on the namespaces, or be granted the `ADMIN_NAMESPACE` system privilege.

> **Note:**
>
> The namespaces used in Example 3-13 must already have corresponding namespace templates defined.

Example 3-13 Initializing Namespaces When Creating an Application Session

```
DECLARE
  nsList DBMS_XS_NSATTRLIST;
  sessionid RAW(16);
BEGIN
    nsList := DBMS_XS_NSATTRLIST(DBMS_XS_NSATTR('ns1'),DBMS_XS_NSATTR('ns2'));
    SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid, FALSE, FALSE, nsList);
END;
/
```

> **See Also:**
>
> - CREATE_SESSION Procedure for information about the syntax of this PL/SQL procedure
> - *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `createSession` method (in Javadoc format)
> - Example 6-2 for information about a Java example of this task

Initializing a Namespace When the Session Is Attached

When you attach the session using the `DBMS_XS_SESSIONS.ATTACH_SESSION` procedure in PL/SQL or using the `attachSession` method of the `XSSessionManager` class in Java, you can specify a list of namespaces to initialize.

Example 3-14 shows how to initialize two namespaces, `ns1` and `ns2`, while attaching an application session.

If you specify namespaces, then the user is required to be granted application privileges `MODIFY_NAMESPACE` or `MODIFY_ATTRIBUTE` on the namespaces, or the `ADMIN_NAMESPACE` system privilege.

> **Note:**
>
> The namespaces used in Example 3-14 must already have corresponding namespace templates defined.

Example 3-14 Initializing Namespaces When Attaching an Application Session

```
DECLARE
  nsList DBMS_XS_NSATTRLIST;
  sessionid RAW(16);
```

```
BEGIN
    nsList := DBMS_XS_NSATTRLIST(DBMS_XS_NSATTR('ns1'),DBMS_XS_NSATTR('ns2'));
    SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
    SYS.DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid, NULL, NULL, NULL, NULL, nsList);
END;
/
```

> **See Also:**
>
> - ATTACH_SESSION Procedure for information about the syntax of this PL/SQL procedure
> - *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `attachSession` method (in Javadoc format)
> - Example 6-3 for information about a Java example of this task

Initializing a Namespace When a Named Application User Is Assigned to an Anonymous Application Session

When you assign an application user to an application session using the `DBMS_XS_SESSIONS.ASSIGN_USER` procedure in PL/SQL or the `assignUser` method of the `XSSessionManager` class in Java, you can specify a list of namespaces to initialize.

If you specify namespaces, then the user is required to be granted application privileges `MODIFY_NAMESPACE` or `MODIFY_ATTRIBUTE` on the namespaces, or `ADMIN_NAMESPACE` system privilege.

Example 3-15 shows how to initialize two namespaces, `ns1` and `ns2`, while assigning an application user to an application session.

> **Note:**
>
> The namespaces used in Example 3-15 must already have corresponding namespace templates defined.

Example 3-15 Initializing Namespaces When Assigning an Application User to an Application Session

```
DECLARE
  sessionid RAW(30);
  nsList DBMS_XS_NSATTRLIST;
BEGIN
  nsList := DBMS_XS_NSATTRLIST(DBMS_XS_NSATTR('ns1'),DBMS_XS_NSATTR('ns2'));
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('XSGUEST', sessionid);
  SYS.DBMS_XS_SESSIONS.ASSIGN_USER(username => 'lwuser2',
                                   sessionid => sessionid,
                                   namespaces => nsList);
END;
/
```

> **See Also:**
>
> - ASSIGN_USER Procedure for information about the syntax of this PL/SQL procedure
> - *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `assignUser` method (in Javadoc format)
> - Example 6-5 for information about a Java example of this task

Initializing a Namespace When the Application User Is Switched in an Application Session

When you switch an application user in an application session using the `DBMS_XS_SESSIONS.SWITCH_USER` procedure in PL/SQL or using the `switchUser` method of the `Session` interface in Java, you can specify a list of namespaces to initialize.

If you specify namespaces, then the user is required to be granted application privileges `MODIFY_NAMESPACE` or `MODIFY_ATTRIBUTE` on the namespaces, or the `ADMIN_NAMESPACE` system privilege.

> **Note:**
>
> To enable the switch from `lwuser1` to `lwuser2` after attaching the session, you must first define `lwuser2` as the target user for `lwuser1`, as follows:
>
> ```
> exec XS_PRINCIPAL.ADD_PROXY_USER('lwuser2', 'lwuser1');
> ```

Example 3-16 shows how to initialize two namespaces, `ns1` and `ns2`, while switching an application user in an application session.

> **Note:**
>
> The namespaces used in Example 3-16 must already have corresponding namespace templates defined.

Example 3-16 Initializing Namespaces When Switching an Application User in an Application Session

```
DECLARE
  sessionid RAW(30);
  nsList DBMS_XS_NSATTRLIST;
BEGIN
  nsList := DBMS_XS_NSATTRLIST(DBMS_XS_NSATTR('ns1'),DBMS_XS_NSATTR('ns2'));
 SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
 SYS. DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid);
```

```
  SYS.DBMS_XS_SESSIONS.SWITCH_USER(username => 'lwuser2',
                                   namespaces => nsList);
END;
/
```

> **See Also:**
>
> - SWITCH_USER Procedure for information about the syntax of this PL/SQL procedure
> - *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `switchUser` method (in Javadoc format)
> - Example 6-6 for information about a Java example of this task

Initializing a Namespace Explicitly

You can explicitly initialize a namespace in an application session using the `DBMS_XS_SESSIONS.CREATE_NAMESPACE` procedure in PL/SQL or the `createNamespace` method of the `Session` interface in Java.

To execute the `DBMS_XS_SESSIONS.CREATE_NAMESPACE` procedure, the calling user must have the `MODIFY_NAMESPACE` application privilege on the namespace or the `ADMIN_NAMESPACE` system privilege.

Example 3-17 shows how to explicitly initialize a namespace, `ns1`, in an application session.

> **Note:**
>
> The namespace used in Example 3-17 must already have a corresponding namespace template defined.

Example 3-17 Initializing a Namespace Explicitly in an Application Session

```
DECLARE
  sessionid RAW(30);
BEGIN
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
  SYS.DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid);
  SYS.DBMS_XS_SESSIONS.CREATE_NAMESPACE('ns1');
END;
/
```

> **See Also:**
>
> - CREATE_NAMESPACE Procedure for information about the syntax of this PL/SQL procedure
> - *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `createNamespace` method (in Javadoc format)
> - Example 6-10 for information about a Java example of this task

Setting Session Attributes in an Application Session

You can set the value of a specific session attribute using the `DBMS_XS_SESSIONS.SET_ATTRIBUTE` procedure in PL/SQL or the `setAttribute` method of the `SessionNamespace` interface method in Java.

The calling user is required to be granted the `MODIFY_ATTRIBUTE` application privilege on the namespace or the `ADMIN_NAMESPACE` system privilege.

> **Note:**
>
> An attribute can store a string value up to 4000 characters long.

Example 3-18 shows how to set a value, `val1`, for an attribute, `attr1`, of the application session.

Example 3-18 Setting a Namespace Attribute for an Application Session

```
DECLARE
  sessionid RAW(16);
BEGIN
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
  SYS.DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid);
  SYS.DBS_XS_SESSIONS.CREATE_NAMESPACE('ns1');
  SYS.DBMS_XS_SESSIONS.SET_ATTRIBUTE('ns1', 'attr1', 'val1');
  SYS.DBMS_XS_SESSIONS.DETACH_SESSION;
  SYS.DBMS_XS_SESSIONS.DESTROY_SESSION(sessionid);
END;
/
```

> **See Also:**
>
> - SET_ATTRIBUTE Procedure for more information about the syntax of this PL/SQL procedure
> - *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `setAttribute` method (in Javadoc format)
> - About Setting a Session Namespace Attribute for information about this task in Java

Getting Session Attributes in an Application Session

You can retrieve the value of a specific session attribute using the `DBMS_XS_SESSIONS.GET_ATTRIBUTE` procedure in PL/SQL or using the `getAttribute` method of the `SessionNamespace` interface method in Java.

The calling user is not required to be granted any privileges to get attributes using the `DBMS_XS_SESSIONS.GET_ATTRIBUTE` procedure.

> **Note:**
>
> If an attribute value has not been set, and the `FIRSTREAD_EVENT` has been specified for the attribute, then an attempt to read the the attribute value triggers a call to the namespace event handler. The namespace event handler procedure typically sets a value for the attribute, and performs other application-specific processing tasks.

Example 3-19 shows how to retrieve an attribute, `attr1`, of the application session.

Example 3-19 Getting a Namespace Attribute for an Application Session

```
DECLARE
  sessionid RAW(16);
  attrib_out_val VARCHAR2(4000);
BEGIN
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
  SYS.DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid);
  SYS.DBMS_XS_SESSIONS.CREATE_NAMESPACE('ns1');
  SYS.DBMS_XS_SESSIONS.SET_ATTRIBUTE('ns1', 'attr1', 'val1');
  SYS.DBMS_XS_SESSIONS.GET_ATTRIBUTE('ns1', 'attr1', attrib_out_val);
  SYS.DBMS_XS_SESSIONS.DETACH_SESSION;
  SYS.DBMS_XS_SESSIONS.DESTROY_SESSION(sessionid);
END;
/
```

> **See Also:**
>
> - GET_ATTRIBUTE Procedure for information about the syntax of this PL/SQL procedure
> - *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `getAttribute` method (in Javadoc format)
> - Getting a Session Namespace Attribute for information about this task in Java

Creating Custom Attributes in an Application Session

You can create custom attributes in a namespace using the `DBMS_XS_SESSIONS.CREATE_ATTRIBUTE` procedure in PL/SQL or the `createAttribute` method of the `SessionNamespace` interface method in Java.

Custom attributes differ from template attributes. Template attributes are part of the namespace template, and are automatically created in the session when the namespace is created. Custom attributes are programmatically created in a namespace, using the `CREATE_ATTRIBUTE` procedure.

The calling application is required to be granted the `MODIFY_ATTRIBUTE` application privilege on the namespace or the `ADMIN_NAMESPACE` system privilege.

Example 3-20 shows how to create a custom attribute, `customattr`, in a namespace of the application session.

Example 3-20 Creating a Custom Namespace Attribute for an Application Session

```
DECLARE
  sessionid RAW(16);
  attrib_out_val VARCHAR2(4000);
BEGIN
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
  SYS.DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid);
  SYS.DBMS_XS_SESSIONS.CREATE_NAMESPACE('ns1');
  SYS.DBMS_XS_SESSIONS.CREATE_ATTRIBUTE('ns1','customattr','default_value_custom',NUL
L);
  SYS.DBMS_XS_SESSIONS.SET_ATTRIBUTE('ns1','customattr','newvalue');
  SYS.DBMS_XS_SESSIONS.GET_ATTRIBUTE('ns1', 'customattr', attrib_out_val);
  SYS.DBMS_XS_SESSIONS.DETACH_SESSION;
  SYS.DBMS_XS_SESSIONS.DESTROY_SESSION(sessionid);
END;
/
```

> **See Also:**
>
> - CREATE_ATTRIBUTE Procedure for information about the syntax of this PL/SQL procedure
> - *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `createAttribute` method (in Javadoc format)
> - Example 6-13 for information about a Java example of this task

Deleting a Namespace in an Application Session

You can delete a namespace and all attributes identified by it from an application session using the `DBMS_XS_SESSIONS.DELETE_NAMESPACE` procedure in PL/SQL or the `deleteAttribute` method of the `SessionNamespace` interface method in Java.

The calling user must have the `MODIFY_NAMESPACE` application privilege on the namespace or the `ADMIN_NAMESPACE` system privilege.

Example 3-21 shows how to delete a namespace `ns1` from an application session.

Example 3-21 Deleting a Namespace in an Application Session

```
DECLARE
  sessionid RAW(16);
  out_value VARCHAR2(4000);
BEGIN
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
  SYS.DBS_XS_SESSIONS.ATTACH_SESSION(sessionid);
  SYS.DBMS_XS_SESSIONS.CREATE_NAMESPACE('ns1');
  SYS.DBMS_XS_SESSIONS.SET_ATTRIBUTE('ns1', 'attr1', 'val1');
  SYS.DBMS_XS_SESSIONS.GET_ATTRIBUTE('ns1', 'attr1', out_value);
  SYS.DBMS_XS_SESSIONS.DELETE_NAMESPACE('ns1');
  SYS.DBMS_XS_SESSIONS.DETACH_SESSION;
  SYS.DBMS_XS_SESSIONS.DESTROY_SESSION(sessionid);
END;
/
```

> **See Also:**
>
> - DELETE_NAMESPACE Procedure for information about the syntax of this PL/SQL procedure
> - *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `deleteNamespace` method (in Javadoc format)
> - Example 6-11 for information about a Java example of this task

Enabling Application Roles for a Session

You can enable only directly granted regular application roles of an application session user using the `DBMS_XS_SESSIONS.ENABLE_ROLE` procedure in PL/SQL or the `enableRole` method of the `Session` interface in Java.

The `DBA_XS_SESSION_ROLES` dynamic data dictionary view lists application roles enabled in all application sessions. The `V$XS_SESSION_ROLES` dynamic data dictionary view lists application roles enabled in the currently attached application session.

Example 3-22 shows how to enable a role in an application session.

Example 3-22 Enabling a Role in an Application Session

```
DECLARE
  sessionid RAW(16);
BEGIN
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
  SYS.DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid);
  SYS.DBMS_XS_SESSIONS.ENABLE_ROLE('auth1_role');
  SYS.DBMS_XS_SESSIONS.DETACH_SESSION;
  SYS.DBMS_XS_SESSIONS.DESTROY_SESSION(sessionid);
END;
/
```

See Also:

- ENABLE_ROLE Procedure for information about the syntax of this PL/SQL procedure
- *Oracle Database Real Application Security Java API Reference* for information about the syntax of the Java `enableRole` method (in Javadoc format)
- Example 6-7 for information about a Java example of this task

Disabling Application Roles for a Session

You can disable application roles for a specific session using the `DBMS_XS_SESSIONS.DISABLE_ROLE` procedure in PL/SQL or the `disableRole` method of the `Session` interface in Java.

Example 3-23 shows how to disable a role in an application session.

Example 3-23 Disabling a Role in an Application Session

```
DECLARE
  sessionid RAW(16);
BEGIN
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
  SYS.DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid);
  SYS.DBMS_XS_SESSIONS.ENABLE_ROLE('auth1_role');
  SYS.DBMS_XS_SESSIONS.DISABLE_ROLE('auth1_role');
  SYS.DBMS_XS_SESSIONS.DETACH_SESSION;
  SYS.DBMS_XS_SESSIONS.DESTROY_SESSION(sessionid);
```

```
END;
/
```

> **See Also:**
>
> - DISABLE_ROLE Procedure for information about the syntax of this PL/SQL procedure
> - *Oracle Database Real Application Security Java API Reference* for information about t he syntax of the Java `disableRole` method (in Javadoc format)
> - Example 6-8 for information about a Java example of this task

About Administrative APIs for External Users and Roles

This section describes the following administrative APIs that are required for external users and roles:

- CREATE_SESSION Procedure
- ATTACH_SESSION Procedure
- ASSIGN_USER Procedure
- SAVE_SESSION Procedure

About Real Application Security Session Privilege Scoping Through ACL

Describes session privilege scoping through an ACL allowing per principal session privilege grants through an ACL set on the principal, where the principal can be either an application user or a dynamic role.

In Oracle Database 12*c* Release 1 (12.1), Real Application Security session privileges are granted through `GRANT_SYSTEM_PRIVILEGE` procedure or revoked through `REVOKE_SYSTEM_PRIVILEGE` procedure in the `XS_ADMIN_UTIL` package. These grants are applicable system wide and allow the grantee to exercise the grants for session operations on any Real Application Security principal. This is implemented using a seeded system ACL – `SESSIONACL`. All session privilege checks are done in this ACL. For a database running multiple applications with multiple user communities this approach becomes cumbersome to administer Real Application Security session administration appropriately.

Session privilege scoping addresses two issues. The first issue is who can create, attach, detach, or destroy a user's session. The second issue is who can enable a dynamic role for a user session. Because a dynamic role can never be granted and can only be dynamically enabled, session privilege scoping through an ACL is needed. Because regular roles are granted to application users, an ACL is not needed on them.

Beginning with Oracle Database 12*c* Release 2 (12.2), Real Application Security supports session privilege scoping through an ACL. This feature allows per principal session privilege grants through an ACL set on the principal. The ACL containing the

session privilege grant can be set on a regular Real Application Security application user or a dynamic role, but it cannot be set on a regular Real Application Security role or external principal. Because Real Application Security session scoping can be enforced per the ACL set on the application user or dynamic role involved in a session operation, you can more finely restrict session operations to specific user communities. For example, you can set up a session operation for a separate user community that can be managed by separate session managers (dispatchers), so users belonging to the same user community will have the same ACL set on them. In addition, enabling and disabling of a dynamic role can be restricted to appropriate dispatchers with the addition of a new privilege `ENABLE_DYNAMIC_ROLE` to restrict enablement and disablement of dynamic roles. This privilege is enforced even for enabling existing session scope dynamic roles from previous attach. With these features, the Real Application Security session administrator can provide a scoping for session privileges that allows a user to create or attach or modify sessions for one Real Application Security user community or a group of Real Application Security user communities for which it has been granted privilege.

The ACL can be set on the principal at creation time using the Real Application Security least system privilege `PROVISION`, which can create, modify, or drop application users and application roles. In addition, you can also use the `CREATE_USER` procedure and `CREATE_DYNAMIC_ROLE` procedure and this requires the caller to have `ALTER USER` or `ALTER ROLE` privilege depending on the principal being created; or the ACL can be created after principal creation using the `SET_ACL` procedure, which requires the caller to have the same privilege as previously mentioned depending on whether the principal is an application user or dynamic role. Both the application user or dynamic role and ACL must already exist before setting the ACL using the `SET_ACL` procedure and the ACL must have been created in the `SYS` schema.

Session operations require either specific session privileges to be granted to the session manager depending on the session operation by either a system-wide ACL or an ACL attached to the affected user or role. The `ADMINISTER_SESSION` privilege aggregates all specific session privileges. Like all session privileges, this privilege can be granted to the session manager by either a system-wide ACL or principal specific ACL. The use of new privileges is audited like other system privileges. An ACL set on a user or dynamic role overrides the system-wide ACL.

The `DBA_XS_USERS` and `DBA_XS_DYNAMIC_ROLES` views are enhanced to show an additional column for the ACL that is set on the Real Application Security application user or dynamic role.

System level session privilege grants can coexist with the principal specific ACL, but the principal specific ACL grants have precedence. This precedence is important as Real Application Security principal specific ACLs can have negative grants. Note that the negative grant can only appear in principal specific ACLs not for the system ACL.

The following table describes the behavior of a session privilege check comparing the principal specific ACL (column 1) with the System ACL (column 2) and showing the result of the session privilege check (column 3) as being either True or False. For example, when the checked privilege is neither granted or denied in a principal specific ACL, then the System ACL is checked for the privilege.

Table 3-2 Session Privilege Checking

Principal Specific ACL	System ACL	Session Privilege Check Result
Grant	Deny, grant, or not specified	True
Deny	Deny, grant, or not specified	False
Not specified or ACL does not exist	Grant	True
Not specified or ACL does not exist	Not specified.	False

Enforcing Session Privilege According to the ACL Set on the Principal

Session privilege is enforced according to the ACL set on the Real Application Security application user in the session operation. A privilege to enable a dynamic role is enforced according to the ACL set on the dynamic role. For example, a create session operation requires the caller to have the `CREATE_SESSION` privilege in the ACL set on the Real Application Security application user. Similarly, the attach operation with dynamic role requires the `ENABLE_DYNAMIC_ROLES` privilege in the ACLs set on the dynamic roles. Any existing system level session privilege grants as mentioned previously can still coexist, but the principal specific ACL grants gets precedence.

Privilege check is first done in the ACL associated with the principal (if at all there are such settings). If the ACL check succeeds the operation will go through. If the check finds deny, the operation fails with insufficient privilege error. If neither grant nor deny is found, the check is done in system ACL associated with SESSION_SC security class and operation fails or succeeds based on this privilege check result.

The following table lists Real Application Security session operations and the required session privileges to perform that operation. This information is useful for creating ACLs on principals for specific session operations. Note that the `ADMINISTER_SESSION` privilege aggregates all session privileges listed in this table.

Table 3-3 Session Privilege Operations and the Required Privileges to Perform Them

Session Operations	Required Session Privilege
Create Session	`CREATE_SESSION` privilege in the ACL set on the Real Application Security application user (that is used for creating the session) or in the System ACL. If there is a negative grant in the principal specific ACL, the operation fails.
Attach Session	`ATTACH_SESSION` privilege in the ACL set on the Real Application Security application user (that is used for creating the session) or in the System ACL. `ENABLE_DYNAMIC_ROLE` privilege in the ACL set on the dynamic roles (that is used for creating the session) or in the System ACL. If there is a negative grant in the principal specific ACL, the operation fails.

Table 3-3 (Cont.) Session Privilege Operations and the Required Privileges to Perform Them

Session Operations	Required Session Privilege
Assign User	`ASSIGN_SESSION` privilege in the ACL set on the named Real Application Security application user to be assigned or in the System ACL. `ENABLE_DYNAMIC_ROLE` privilege in the ACL set on the dynamic roles (that is used for creating the session) or in the System ACL. So if there are dynamic roles enabled, these privileges are checked. If there is a negative grant in the principal specific ACL, the operation fails.
Switch User	No session privilege check, as per proxy configuration.
Enable Role	No session privilege check.
Disable Role	No session privilege check.
Namespace Operation (Create Namespace, delete namespace, create attribute, set attribute, reset attribute, delete attribute)	No session privilege check, only namespace privilege checks.
Save Session, Detach Session	No session privilege check.
Destroy Session	`TERMINATE_SESSION` privilege in the ACL set on the Real Application Security application user (that is used for creating the session) or in the System ACL.
Set Session Cookie	`MODIFY_SESSION` privilege in the ACL set on the Real Application Security application user (that is used for creating the session) or in the System ACL.
Set Inactivity Timeout	`MODIFY_SESSION` privilege in the ACL set on the Real Application Security application user (that is used for creating the session) or in the System ACL.
Reauthorize Session	`MODIFY_SESSION` privilege in the ACL set on the Real Application Security application user (that is used for creating the session) or in the System ACL.
Get SID from Cookie	No session privilege check.
Global Callback Configuration (Add global callback, delete global callback, enable global callback)	No session privilege check, only callback privilege checks.

See Also:

- GRANT_SYSTEM_PRIVILEGE Procedure and REVOKE_SYSTEM_PRIVILEGE Procedure
- Security Classes
- CREATE_USER Procedure, CREATE_DYNAMIC_ROLE Procedure, and SET_ACL Procedure
- DBA_XS_USERS and DBA_XS_DYNAMIC_ROLES

Granting Session Privileges on a Principal Using an ACL

Describes how to grant session privileges on a principal using an ACL while creating the user and after the user is already created.

The following examples show how to grant session privileges to principals through an ACL, `USER_ACL` while creating the user and after the user is already created.

First, create the ACL `USER_ACL` and grant the privilege `ADMINISTER_SESSION` to user `lwuser3` and grant the privileges `CREATE_SESSION`, `MODIFY_SESSION`, and `ATTACH_SESSION` to user `lwuser4` and grant the privileges `CREATE_SESSION` and `MODIFY_SESSION` to user `lwuser5`.

```
sqlplus /nolog
SQL> CONNECT SYS/password as SYSDBA
SQL> GRANT CREATE SESSION, XS_SESSION_ADMIN TO SEC_MGR IDENTIFIED BY
password;
SQL> EXEC SYS.XS_ADMIN_UTIL.GRANT_SYSTEM_PRIVILEGE('PROVISION', 'sec_mgr',
SYS.XS_ADMIN_UTIL.PTYPE_DB);


CONNECT SEC_MGR
Enter password: password
Connected.


DECLARE
ace_list  XS$ACE_LIST;

BEGIN

ace_list := XS$ACE_LIST(
    XS$ACE_TYPE(privilege_list=>XS$NAME_LIST('"ADMINISTER_SESSION"'),
                granted=>true,
                principal_name=>'lwuser3'),

XS$ACE_TYPE(privilege_list=>XS$NAME_LIST('"CREATE_SESSION"','"MODIFY_SESSIO
N"','"ATTACH_SESSION"'),
                granted=>true,
                principal_name=>'lwuser4'),

XS$ACE_TYPE(privilege_list=>XS$NAME_LIST('"CREATE_SESSION"','"MODIFY_SESSIO
```

```
N"'),
                granted=>true,
                principal_name=>'lwuser5'));

sys.xs_acl.create_acl(name=>'USER_ACL',
                    ace_list=>ace_list,
                    sec_class=>'SESSIONPRIVS',
                    description=>'Session management');
END;
/
```

Next, create users `lwuser3` and `lwuser4` and grant these users the ACL, `USER_ACL`.

```
BEGIN
 SYS.XS_PRINCIPAL.CREATE_USER(name=>'lwuser3',
                              schema=>'HR',
                              acl=>'USER_ACL';
END;
/
EXEC  SYS.XS_PRINCIPAL.SET_PASSWORD('lwuser3', 'password');


BEGIN
 SYS.XS_PRINCIPAL.CREATE_USER(name=>'lwuser4',
                              schema=>'HR',
                              acl=>'USER_ACL';
END;
/
EXEC  SYS.XS_PRINCIPAL.SET_PASSWORD('lwuser4', 'password');
```

Next, create user `lwuser5` and set the ACL, `USER_ACL`, for this user using the `SET_ACL` procedure.

```
sqlplus SEC_MGR
Enter password: password
Connected.


BEGIN
 SYS.XS_PRINCIPAL.CREATE_USER(name=>'lwuser5',
                              schema=>'HR');
END;
/
EXEC SYS.XS_PRINCIPAL.SET_ACL('lwuser5','USER_ACL');
```

See Also:

- GRANT_SYSTEM_PRIVILEGE Procedure and REVOKE_SYSTEM_PRIVILEGE Procedure
- Security Classes
- CREATE_USER Procedure, CREATE_DYNAMIC_ROLE Procedure, and SET_ACL Procedure
- DBA_XS_USERS and DBA_XS_DYNAMIC_ROLES

4

Configuring Application Privileges and Access Control Lists

This chapter describes how to configure application privileges and access control lists (ACLs) in Oracle Database Real Application Security. It includes information on how to create, set, and modify ACLs, and describes how ACL security interacts with other Oracle Database security mechanisms.

This chapter contains the following sections:

- About Application Privileges
- About Configuring Security Classes
- About Configuring Access Control Lists
- Data Security
- ACL Binding

About Application Privileges

The database has predefined system privileges, such as `CREATE TABLE`, and object privileges, such as `UPDATE`. A large number of custom privileges that must be defined for enterprise applications are often called application-defined privileges. Real Application Security introduces the definition of these privileges, termed application privileges, in the database. For application developers, these custom application privileges are used for access control on application-level operations. These application-level operations allow fine-grained access on data at a granular level of columns, rows, or cells.

When an application privilege is explicitly bound to a resource, for example, rows and columns of a table, an application privilege can be used to protect an application-level operation on a database object. Alternatively, it may be used in the same manner as a system privilege when binding to a resource is not required.

> **See Also:**
>
> About Checking ACLs for a Privilege

This section contains the following topic: Aggregate Privilege.

Aggregate Privilege

A Real Application Security **aggregate privilege** implies a set of other application privileges. The implied application privileges of an aggregate privilege can be any application privilege defined by the current security class or an inherited application privilege (see "About Configuring Security Classes" for more information). When an

aggregate privilege is granted or denied, its implied application privileges are implicitly granted or denied.

When an aggregate privilege `AG` implies the application privileges `p1` and `p2`, granting the application privilege, `AG`, implies that both `p1` and `p2` are granted. However, granting both the `p1` and `p2` does not imply that `AG` is granted.

Aggregate privileges are useful for the following purposes:

- Enabling grouping and granting a set of application privileges as a single grant, simplifying application privilege administration. A group name or an alias for a set of application privileges, where the group name itself is not an application privilege, makes checking for the set simpler as it checks for each application privilege in the group.
- Providing an efficient way to check a set of application privileges based on a single application privilege check.

Example 4-1 adds an aggregate privilege called `UPDATE_INFO` to the `HRPRIVS` security class. The aggregate privilege contains the implied privileges `UPDATE`, `DELETE`, and `INSERT`.

When the group name itself is a first class privilege, there may be several possible semantics for the aggregate privilege based on its relationship to its members. When defining a semantic to represent an aggregate privilege, you must consider various relations between the aggregate privilege and its members, such as *imply* and *include*. For example, consider the *imply* relation in Java Security; selecting this semantic when granting an aggregate privilege implies granting all its member application privileges individually, but not the aggregate privilege. Therefore, granting all the member application privileges of an aggregate does not imply granting the aggregate privilege.

Example 4-2 adds a list of implied application privileges for the aggregate privilege `UPDATE_INFO`.

An aggregate privilege is not an application role. An application role itself is not an application privilege that protects a resource. Application roles are used to activate and deactivate application privileges available to an application user to enforce role-based access control constraints.

Also, an aggregate privilege is not a security class. A security class is not an application privilege that can be granted to a user. A security class lists a set of application privileges including aggregate privileges that may be either granted or denied in an ACL. Within a security class, many aggregate privileges may be defined based on the application privileges available in the security class.

An aggregate privilege can have other aggregate privileges as its members. Note that the member privileges of an aggregate privilege must be defined in the same security class (or in an ancestor security class) as the aggregate privilege. An aggregate privilege definition cannot create a cycle.

Example 4-1 Adding an Aggregate Privilege to a Security Class

```
BEGIN
  SYS.XS_SECURITY_CLASS.ADD_PRIVILEGES(sec_class=>'HRPRIVS',
                                       priv=>'UPDATE_INFO',
                                       implied_priv_list=>XS$NAME_LIST('"UPDATE"',
                                              '"DELETE"', '"INSERT"'));
END;
```

Example 4-2 Adding Implied Privileges to an Aggregate Privilege

```
BEGIN
  SYS.XS_SECURITY_CLASS.ADD_IMPLIED_PRIVILEGES(sec_class =>'HRPRIVS',
(priv=>'UPDATE_INFO',
implied_priv_list=>XS$NAME_LIST('"UPDATE"', '"DELETE"', '"INSERT"'));
END;
```

This section contains: ALL Privilege.

ALL Privilege

The ALL privilege is a predefined aggregate privilege. Every security class has the ALL privilege, and it contains all the application privileges of that security class. ALL is not explicitly defined in every security class, but it is internally understood by the system based on the security class associated with the ACL. The cardinality of an ALL for a security class changes whenever an application privilege is added or removed from the security class.

Use of the ALL construct enables Real Application Security to express access control policy such as "grant all the application privileges to the application user u1 defined for an application except the specific privilege p1". Example 4-3 shows an ACL in the security class, AppSecurityClass, which has all the application privileges for the application. The ordered evaluation of ACEs ensures that the ALL except p1 is granted to the application user u1.

Example 4-3 Using ALL Grant

```
select NAME, SECURITY_CLASS, PARENT_ACL from DBA_XS_ACLS;

NAME         SECURITY_CLASS     PARENT_ACL
----------   ----------------   ---------------
sampleACL    AppSecurityClass


select ACL, ACE_ORDER, GRANT_TYPE, PRINCIPAL, PRIVILEGE from DBA_XS_ACES;

ACL          ACE_ORDER   GRANT_TYPE   PRINCIPAL      PRIVILEGE
---------    ---------   ----------   ------------   ----------
sampleACL    1           DENY         U1             p1
sampleACL    2           GRANT        U1             ALL
```

About Configuring Security Classes

This section contains the following topics:

- About Security Classes
- Security Class Inheritance
- Security Class as Privilege Scope
- DML Security Class
- About Validating Security Classes
- Manipulating Security Classes

About Security Classes

A **security class** is a scope for a set of application privileges. The same application privilege can be defined in multiple security classes. A security class restricts the set of application privileges that may be granted or denied within an ACL. A security class is both a place to define a collection of relevant application privileges and a way to associate an ACL with one security class.

Real Application Security supports a set of predefined application privileges and security classes and also allows applications to define their own custom application privileges using security classes. Each class of object being protected is associated with a security class that indicates the set of operations that may be performed on its objects. There are predefined security classes that define built-in application privileges.

Security classes simplify the task of managing a large number of application privileges. Each ACL is associated with one security class. This security class defines the scope of application privileges that may be granted within the ACL.

Each object type can support a large number of application privileges, and many different object types may share a common set of operations. To simplify these types of specifications, security classes support inheritance.

Security Class Inheritance

A security class can inherit application privileges from parent security classes. A child security class implicitly contains all the application privileges defined in the parent security classes. The application privileges available in a security class are the combination of the application privileges defined in the security class and the application privileges inherited from parent security classes.

A security class can specify a list of parent security classes. The application privileges available in these parent classes become available in the child class. When the same application privilege name is defined in a child and its parent security class, the application privilege in the child replaces or overrides the application privilege in the parent.

Example 4-4 shows security class inheritance by creating a security class called `HRPRIVS`. The `HRPRIVS` security class defines two application privileges, `VIEW_SENSITIVE_INFO` and `UPDATE_INFO`. `UPDATE_INFO`, which is an aggregate privilege that implies three other privileges: `UPDATE`, `DELETE`, and `INSERT`. The security class `HRPRIVS` inherits application privileges from `DML` security class as specified by the `parent_list` parameter.

Example 4-4 Showing Security Class Inheritance

```
 DECLARE
  pr_list  XS$PRIVILEGE_LIST;
BEGIN
  pr_list :=XS$PRIVILEGE_LIST(
     XS$PRIVILEGE(name=>'VIEW_SENSITIVE_INFO'),
     XS$PRIVILEGE(name=>'UPDATE_INFO',
                  implied_priv_list=>XS$NAME_LIST
                    ('"UPDATE"', '"DELETE"', '"INSERT"')));

  sys.xs_security_class.create_security_class(
```

```
    name=>'HRPRIVS',
    parent_list=>XS$NAME_LIST('DML'),
    priv_list=>pr_list);
END;
/
```

Security Class as Privilege Scope

An ACL has a single security class as its **scope**. An ACL grants application privileges to principals to control access to protected data or functionality; it can grant only the application privileges that are defined in its security class. The `security_class` parameter is used to specify the security class in an ACL. When checking an application privilege against an ACL, the security class of the application privilege is resolved based on the security class of the ACL, as the ACL always has an associated security class. If no security class is specified, then the DML Security Class is used as the default security class. Different ACLs can have as their scope the same security class.

DML Security Class

The `DML` security class is predefined or created during installation. The `DML` security class contains common application privileges for object manipulation: `SELECT`, `INSERT`, `UPDATE`, and `DELETE`. If an ACL does not specify its security class, `DML` is the default security class for the ACL.

Real Application Security DML application privileges are the same as database object privileges and inherently enforced by database object-level operations. However, Real Application Security DML application privileges are effective only when Real Application Security Data Security is enabled for database tables.

About Validating Security Classes

Oracle recommends that you always validate the Real Application Security objects after administrative configuration changes. The `XS_DIAG` package provides a set of validation APIs to help ensure that these changes do not damage the complicated relationships among your Real Application Security objects.

See "VALIDATE_SECURITY_CLASS Function" for more information about validating a security class.

Manipulating Security Classes

To manipulate security classes, use the procedures in PL/SQL package `XS_SECURITY_CLASS`; it includes procedures to create, manage, and delete security classes and their application privileges. This package also includes procedures for managing security class inheritance; see "XS_SECURITY_CLASS Package".

Example 4-5 invokes `ADD_PARENTS` to add the parent security class `GENPRIVS` to the `HRPRIVS` security class.

Example 4-6 invokes `REMOVE_PARENTS` to remove the parent security class `GENPRIVS` from the `HRPRIVS` security class.

Example 4-7 invokes `ADD_PRIVILEGES` to add an aggregate privilege called `UPDATE_INFO` to the `HRPRIVS` security class. The aggregate privilege contains the

implied privileges UPDATE, DELETE, and INSERT. Note that ADD_PRIVILEGES may be used to add several application privileges to a security class. See "Aggregate Privilege" for more information.

Example 4-8 invokes REMOVE_PRIVILEGES to remove the UPDATE_INFO application privilege from the HRPRIVS security class.

Example 4-9 invokes REMOVE_PRIVILEGES to remove all application privileges from the HRPRIVS security class.

Example 4-10 invokes ADD_IMPLIED_PRIVILEGES to add a list of implied application privileges for the aggregate privilege UPDATE_INFO.

Example 4-11 invokes REMOVE_IMPLIED_PRIVILEGES to remove the implicit privilege DELETE from the aggregate privilege UPDATE_INFO.

Example 4-12 invokes REMOVE_IMPLIED_PRIVILEGES to remove all implicit application privileges from the aggregate privilege UPDATE_INFO.

The procedure sets a description string for the specified security class. Example 4-13 invokes SET_DESCRIPTION to set a description string for the HRPRIVS security class.

Example 4-14 invokes DELETE_SECURITY_CLASS to delete the HRACL ACL using the default delete option DEFAULT_OPTION. Note that this option is defined in "XS_ADMIN_UTIL Package".

Example 4-5 Adding Parent Security Classes for a Specified Security Class

```
BEGIN
  SYS.XS_SECURITY_CLASS.ADD_PARENTS('HRPRIVS','GENPRIVS');
END;
```

Example 4-6 Removing One or More Parent Classes for a Specified Security Class

```
BEGIN
  SYS.XS_SECURITY_CLASS.REMOVE_PARENTS('HRPRIVS','GENPRIVS');
END;
```

Example 4-7 Adding One or More Application Privileges to a Security Class

```
BEGIN
  SYS.XS_SECURITY_CLASS.ADD_PRIVILEGES(sec_class=>'HRPRIVS',
                                priv=>'UPDATE_INFO',
                                implied_priv_list=>XS$NAME_LIST('"UPDATE"',
                                                '"DELETE"', '"INSERT"'));
END;
```

Example 4-8 Removing One or More Application Privileges from a Specified Security Class

```
BEGIN
  SYS.XS_SECURITY_CLASS.REMOVE_PRIVILEGES('HRPRIVS','UPDATE_INFO');
END;
```

Example 4-9 Removing all Application Privileges for a Specified Security Class

```
BEGIN
  SYS.XS_SECURITY_CLASS.REMOVE_PRIVILEGES('HRPRIVS');
END;
```

Example 4-10 Adding One or More Implied Application Privileges to an Aggregate Privilege

```
BEGIN
  SYS.XS_SECURITY_CLASS.ADD_IMPLIED_PRIVILEGES(priv=>'UPDATE_INFO',

implied_priv_list=>XS$NAME_LIST('"UPDATE"', '"DELETE"', '"INSERT"'));
END;
```

Example 4-11 Removing a Specified Implied Application Privileges from an Aggregate Privilege

```
BEGIN
  SYS.XS_SECURITY_CLASS.REMOVE_IMPLIED_PRIVILEGES('UPDATE_INFO','"DELETE"');
END;
```

Example 4-12 Removing all Implied Application Privileges from an Aggregate Privilege

```
BEGIN
  SYS.XS_SECURITY_CLASS.REMOVE_IMPLIED_PRIVILEGES('UPDATE_INFO');
END;
```

Example 4-13 Setting a Description String for a Specified Security Class

```
BEGIN
  SYS.XS_SECURITY_CLASS.SET_DESCRIPTION(
    'HRPRIVS','Contains privileges required to manage HR data');
END;
```

Example 4-14 Deleting a Specified Security Class

```
BEGIN

SYS.XS_SECURITY_CLASS.DELETE_SECURITY_CLASS('HRPRIVS',XS_ADMIN_UTIL.DEFAULT_OPTION);
END;
```

About Configuring Access Control Lists

This section contains the following topics:

- About ACLs and ACEs
- Creating ACLs and ACEs
- About Validating Access Control Lists
- Updating Access Control Lists
- About Checking ACLs for a Privilege
- About Using Multilevel Authentication
- Principal Types
- Access Resolution Results
- ACE Evaluation Order
- ACL Inheritance
- About ACL Catalog Views
- About Security Class Catalog Views

About ACLs and ACEs

Real Application Security encompasses access control lists (ACLs) and supports grants, denials, and various conflict resolution methods. ACLs are extended to support application-defined privileges, enabling applications to control privileges that are meaningful to it. Authorization queries are of the form: "Is the application user authorized for privilege *p* in ACL *a*?" Application-defined privileges are implemented through APIs supported both in the middle tier and in the database. These APIs enable the application to protect sensitive operations, such as approval of purchase orders.

Before performing a sensitive operation, the application must determine the required application privileges. For example, if the application requires the `approvePO` application privilege, it must locate the ACL associated with the desired purchase order, `a1`, and issue a query to determine if the Real Application Security session is authorized for application privilege `approvePO` in `a1`. Note that the application must be trusted to properly carry out authorization. Data security improves this by providing a declarative method of associating ACLs with rows in a table; a data security policy allows an administrator or developer to identify a set of rows in a table using an SQL predicate and associates the set with the ACL that is used to control access to its member rows.

The data security system provides a SQL operator that returns the ACLs associated with a row. This SQL operator performs an authorization check using the ACL references associated with the row. By default, a query returns all rows the user is allowed to view; these ACL references may be used in the middle tier to determine appropriate access for a particular row, as arguments in a `WHERE` clause that limits the result set. Thus, the result set may be further restricted to display only those rows for some specific operations, such as `approvePO`, based on the user's authorization.

The Real Application Security system provides native enforcement for SQL operations in the database, limiting the scope for damage due to security errors in the application. Thus, a SQL injection attack in one part of the application will not provide access to tables outside of that component.

An ACL protects a resource by specifying application privileges of the principals on the resource. An ACL is a list of access control entries (ACEs) where each ACE maintains the mapping from a principal to a granted or denied application privileges for the resource. A principal may be a database user or Real Application Security application user or application role.

Access Control Entry or ACE

An **access control entry**, or **ACE**, represents an application privilege grant, and an ACL represents a set of application privilege grants that are bound to a resource. Here, the resource can be a database table, a column in a table, or a set of rows in a table selected using a SQL predicate. Hence when a resource is accessed, only the ACLs associated with the resource are checked for the access right.

An ACE either grants or denies access to some application function or other database data for a particular principal. The ACE does not, itself, specify which data to protect; that is done outside the ACE and the ACL, by associating the ACL with target data.

`XS$ACE_TYPE` type is provided to construct each ACE entry for the ACL. An `XS$ACE_LIST` object consists of a list of privileges and the principal to whom the

privileges are granted or denied. ACEs related information can be accessed through DBA_XS_ACES view.

Creating ACLs and ACEs

Example 4-15 creates an ACL called HRACL. This ACL includes ACEs contained in ace_list. The application privileges used in ace_list are available in the HRPRIVS security class. The st_date and en_date parameters specify the active start and end times for this ACL; note that only the SELECT and VIEW_SENSITIVE_INFO application privileges are temporary.

Example 4-15 Creating an Access Control List

```
DECLARE
  st_date TIMESTAMP WITH TIME ZONE;
  en_date TIMESTAMP WITH TIME ZONE;
  ace_list XS$ACE_LIST;
BEGIN
  st_date := SYSTIMESTAMP;
  en_date := TO_TIMESTAMP_TZ('2019-06-18 11:00:00 -5:00',
                          'YYYY-MM-DD HH:MI:SS  TZH:TZM');
  ace_list := XS$ACE_LIST(
      XS$ACE_TYPE(privilege_list=>XS$NAME_LIST('"SELECT"','VIEW_SENSITIVE_INFO'),
                  granted=>true,
                  principal_name=>'HRREP',
                  start_date=>st_date,
                  end_date=>en_date),
      XS$ACE_TYPE(privilege_list=>XS$NAME_LIST('UPDATE_INFO'),
                  granted=>true,
                  principal_name=>'HRMGR'),
      XS$ACE_TYPE(privilege_list=>XS$NAME_LIST('"SELECT"'),
                  granted=>true,
                  principal_name=>'DB_HR', principal_type=>XS_ACL.PTYPE_DB));

  sys.xs_acl.create_acl(name=>'HRACL',
                    ace_list=>ace_list,
                    sec_class=>'HRPRIVS',
                    description=>'HR Representative Access');
END;
/
```

Each ACE includes a principal that is the target of the grant and a list of application privileges. The grant is subject to the following attributes described in these topics:

- Deny
- Invert
- ACE Start-Date and End-Date

Deny

When a grant is negated, the application privileges are denied. Example 4-16 sets the value of the attribute granted to FALSE to deny application privileges to the principal. The default value is TRUE.

Real Application Security ACL supports only the ordered evaluation of ACEs. The first ACE that grants or denies the requested application privilege contributes toward the final grant or deny. See section "DBA_XS_ACES".

Example 4-16 Denying a Privilege

```
XS$ACE_LIST(
            XS$ACE_TYPE(privilege_list=>XS$NAME_LIST('UPDATE_INFO'),
            granted=>FALSE,
            principal_name=>'HRREP'
            );
```

Invert

When the specified application privileges are given to all principals except one, that principal is inverted; the `inverted` attribute is set to `TRUE`. The default value of the attribute `inverted` is `FALSE`. In Example 4-17, a grant made to the inverted role `HRGUEST` provides the application privileges to any user that does not have the role enabled.

Example 4-17 Inverting an Application Privilege

```
XS$ACE_LIST(
            XS$ACE_TYPE(privilege_list=>XS$NAME_LIST('UPDATE_INFO'),
            inverted=>TRUE,
            principal_name=>'HRGUEST'
            );
```

ACE Start-Date and End-Date

Each ACE can have a time constraint based on a start-date and an end-date, specifying the time when the ACE is in effect.

In Example 4-18, the optional attributes `start_date` and `end_date` (of datatype `TIMESTAMP WITH TIME ZONE`) define the time period over which an ACE is valid. The `end_date` value must be greater than the `start_date` value.

Example 4-18 Setting ACE Start-Date and End-Date

```
XS$ACE_TYPE(privilege_list=>XS$NAME_LIST('"SELECT"','VIEW_SENSITIVE_INFO'),
            granted=>true,
            principal_name=>'HRREP',
            start_date=>st_date,
            end_date=>en_date))
```

About Validating Access Control Lists

Oracle recommends that you always validate the Real Application Security objects after administrative configuration changes. The `XS_DIAG` package provides a set of validation APIs to help ensure that these changes do not damage the complicated relationships among your Real Application Security objects.

See "VALIDATE_ACL Function" for more information about validating an ACL.

Updating Access Control Lists

To manipulate ACLs, use the procedures in PL/SQL package `XS_ACL`; it contains procedures that create and manage ACLs. See "XS_ACL Package".

Example 4-19 invokes `APPEND_ACES` to add an ACE, `ace_entry`, to the `HRACL` ACL. The ACE grants the `SELECT` privilege to the `DB_HR` database user.

Example 4-20 invokes REMOVE_ACES to remove all ACEs from the ACL called HRACL.

The procedure sets or modifies the security class for an ACL. Example 4-21 invokes SET_SECURITY_CLASS procedure to associate the HRPRIVS security class with ACL HRACL.

Example 4-22 invokes SET_PARENT_ACL to set the AllDepACL ACL as the parent ACL for the HRACL ACL. The inheritance type is set to EXTEND.

Example 4-23 invokes REMOVE_ACL_PARAMETERS to remove all ACL parameters for ACL1.

Example 4-24 invokes REMOVE_ACL_PARAMETERS to remove the REGION parameter for ACL1.

Example 4-25 invokes SET_DESCRIPTION to set a description for ACL HRACL.

Example 4-26 invokes DELETE_ACL to delete ACL HRACL using the default delete option.

Example 4-19 Appending an ACE to an Access Control List

```
DECLARE
  ace_entry XS$ACE_TYPE;
BEGIN
  ace_entry := XS$ACE_TYPE(privilege_list=>XS$NAME_LIST('"SELECT"'),
                           granted=>true,
                           principal_name=>'DB_HR',
                           principal_type=>XS_ACL.PTYPE_DB);
  SYS.XS_ACL.APPEND_ACES('HRACL',ace_entry);
END;
```

Example 4-20 Removing all ACEs from an ACL

```
BEGIN
  SYS.XS_ACL.REMOVE_ACES('HRACL');
END;
```

Example 4-21 Modifying the Security Class for an ACL

```
BEGIN
  SYS.XS_ACL.SET_SECURITY_CLASS('HRACL','HRPRIVS');
END;
```

Example 4-22 Setting or Modifying the Parent ACL

```
BEGIN
  SYS.XS_ACL.SET_PARENT_ACL('HRACL','AllDepACL',XS_ACL.EXTENDED);
END;
```

Example 4-23 Removing all ACL Parameters for an ACL

```
BEGIN
  SYS.XS_ACL.REMOVE_ACL_PARAMETERS('ACL1');
END;
```

Example 4-24 Removing the Specified ACL Parameter for an ACL

```
BEGIN
  SYS.XS_ACL.REMOVE_ACL_PARAMETERS('ACL1','REGION');
END;
```

Example 4-25 Setting a Description String for an ACL

```
BEGIN
  SYS.XS_ACL.SET_DESCRIPTION('HRACL',
                         'Grants privileges to HR representatives and managers.');
END;
```

Example 4-26 Deleting an ACL

```
BEGIN
  SYS.XS_ACL.DELETE_ACL('HRACL');
END;
```

About Checking ACLs for a Privilege

There are two forms of enforcement; the system enforces DML privileges on data security protected objects, and the SQL operator added by the user enforces all other application privileges.

To check an ACL for an application privilege, call the SQL operator `ORA_CHECK_ACL`:

```
ORA_CHECK_ACL (acls, privilege [,privilege] ... )
```

The `ORA_CHECK_ACL` SQL operator evaluates the list of application privileges with respect to an ordered list of ACLs. The evaluation process proceeds until any one of the following three events occurs:

- A grant is encountered for every application privilege specified before any potential denials of the same application privilege. The outcome is that the application privileges are granted.
- One of the application privileges specified is denied before any potential grants. The outcome is that at least one of the application privileges is denied.
- The list of ACEs is fully traversed. The outcome is that not all of the application privileges are granted.

To evaluate the application privilege, Oracle checks the ACEs (which are kept in order), and the evaluation stops when it finds an ACE that grants or denies the requested application privileges.

To find the ACLs associated with rows of a table or view, call the SQL operator `ORA_GET_ACLIDS`: `ORA_GET_ACLIDS(table, ...)`. For example, to enforce an application privilege, `priv`, on a table, `tab`, the user query adds the following check:

```
ORA_CHECK_ACL(ORA_GET_ACLIDS(tab), priv)
```

This function answers the question whether application privileges were granted, denied, or neither. A corresponding Java API is also available.

About Using Multilevel Authentication

Multilevel authentication enables the user to specify, through system-constraining ACLs, application privileges based on levels of authentication. A **system-constraining ACL** specifies a minimum application-wide set of application privileges on objects, based on dynamic roles that reflect an application user's level of authentication. When attempting to access an object, an application user may be either strongly or weakly authenticated, either inside or outside the firewall, with the following four possible levels of authentication:

- Strongly authenticated, inside firewall
- Strongly authenticated, outside firewall
- Weakly authenticated, inside firewall
- Weakly authenticated, outside firewall

A system-constraining ACL can specify application privileges that apply to application users at each level of authentication in an application. Based on application requirements, the administrator may grant additional application privileges to specific users based on any necessary criteria; such additional application privileges are independent of any system-constraining ACL. Example 4-28 and Example 4-29 implement a system-constraining ACL.

Principal Types

In addition to Real Application Security principals, application users and application roles, Real Application Security supports grants based on database users and roles. When the system evaluates an ACL in a context of a Real Application Security session, it ignores grants that are based on a database schema, but honors grants that are based on database role because they are part of Real Application Security user's role list. Within an ACL, multiple ACEs can grant privileges to a principal.

Access Resolution Results

Requests for access can have two possible results: `true` or `false`.

- A result of `true` means that the requested application privilege is granted
- A result of `false` means that the requested application privilege is either not granted or denied.

ACE Evaluation Order

ACEs are evaluated in the order they appear in the ACL. The outcome of evaluating a particular ACE may be one of the following:

- The application privilege is granted.
- The application privilege is denied.
- The application privilege is neither granted nor denied.

Note that if an ACE grants an application privilege that a previous ACE denies, the result is a deny because the ACEs are evaluated in order.

ACL Inheritance

ACLs can explicitly inherit from a single parent ACL, enabling the application to share policies across multiple objects. When the request for an application privilege involves two ACLs, the final result of the access-resolution algorithm may be based on semantics of individual access-resolution results of the ACLs. Real Application Security supports two types of inheritance semantics: extending ACL inheritance (`OR` with ordered evaluation), and constraining ACL inheritance (`AND`).

This section contains:

- Extending ACL Inheritance

- Constraining ACL Inheritance

Extending ACL Inheritance

Extending ACL inheritance (`OR` with ordered evaluation) dictates that the ACEs are evaluated from the bottom of the inheritance tree to its top, from child to parent. In extending ACL inheritance, an application privilege is granted if either child or parent ACL grants the privilege, and denied if either the child or parent ACL denies the privilege. In fact, the first ACL that explicitly grants or denies the requested application privilege determines the final result. After the first grant or deny, further evaluations of the remaining ACLs are not attempted. Note that this evaluation rule is the same as the ordered evaluation of ACEs within an ACL.

The following example sets the `AllDepACL` ACL as the parent ACL for the `HRACL` ACL. The inheritance type is set to `EXTENDED`.

Example 4-27 Extending ACL Inheritance

```
BEGIN
  SYS.XS_ACL.SET_PARENT_ACL('HRACL','AllDepACL',XS_ACL.EXTENDED);
END;
```

Constraining ACL Inheritance

Constraining ACL inheritance (`AND`) requires that both the child and the parent ACL grant the application privilege so that the ACL check evaluates to `true`.

Application-wide security policies can be enforced if all the ACLs for an application are constrained by the same parent ACL. For example, imagine a sample policy where users who are authenticated as being inside the corporate firewall can have application privileges in addition to the `SELECT` privilege. Example 4-28 shows the constraining ACL for this policy (inheritance type is set to `CONSTRAINED`), where all application users with `XSPUBLIC` application role are granted the `SELECT` privilege. Note that only the application users who are inside the corporate firewall have the dynamic application role `FIREWALL` enabled. Therefore, application users inside the firewall are granted all the application privileges in `HRPRIVS` security class. As this ACL constrains all the ACLs, such as `guestACL`, Example 4-29 shows that the application privilege grants of these ACLs are constrained by `FIREWALL_ACL`.

Example 4-28 Constraining ACL Inheritance: Firewall-Specific Authentication Privilege

```
DECLARE
  ace_list XS$ACE_LIST;
BEGIN
  ace_list := XS$ACE_LIST(
                XS$ACE_TYPE(privilege_list=>XS$NAME_LIST('"SELECT"'),
                            granted=>true,
                            principal_name=>'XSPUBLIC'),
                XS$ACE_TYPE(privilege_list=>XS$NAME_LIST('ALL'),
                            granted=>true,
                            principal_name=>'FIREWALL'));
  sys.xs_acl.create_acl(name=>'FIREWALL_ACL',
                   ace_list=>ace_list,
                   sec_class=>'HRPRIVS',
                   description=>'Only select privilege if not inside firewall');
END;
/
```

```
BEGIN
SYS.XS_ACL.SET_PARENT_ACL('GuestACL', 'FIREWALL_ACL',XS_ACL.CONSTRAINED);
END;
```

Example 4-29 Using a Constraining Application Privilege

```
SQL> select ACE_ORDER, GRANT_TYPE, PRINCIPAL, PRIVILEGE
     from DBA_XS_ACES
     where ACL='FIREWALL_ACL';

ACE_ORDER    GRANT_TYPE    PRINCIPAL    PRIVILEGE
----------   ----------    ---------    ----------
1            GRANT         XSPUBLIC     SELECT
2            GRANT         FIREWALL     ALL
```

About ACL Catalog Views

ACLs have the following catalog views:

- `DBA_XS_ACLS` catalog view, described in section "DBA_XS_ACLS"
- `DBA_XS_ACES` catalog view, described in section "DBA_XS_ACES"

About Security Class Catalog Views

Security classes have the following catalog views:

- `DBA_XS_SECURITY_CLASSES`, described in section "DBA_XS_SECURITY_CLASSES"
- `DBA_XS_SECURITY_CLASS_DEP`, described in "DBA_XS_SECURITY_CLASS_DEP"
- `DBA_XS_PRIVILEGES`, described in "DBA_XS_PRIVILEGES"

Data Security

Data security associates ACLs with a logical group of rows, known as a data realm.

This enables applications to define and enforce application-specific privileges at the database layer, through policies that define data realms and their access. These data realms include both a SQL predicate that identifies a set of rows and an ACL that protects the identified rows. The ACL evaluation is based on the application user, not the schema owner.

This section includes the following topics:

- Data Realms
- Parameterized ACL

Data Realms

Real Application Security's Data Security policy **data realms** associate ACLs with rows in a table. A data realm has two parts:

1. A rule expressed as a SQL predicate, which selects a set of rows.
2. A set of ACLs, which specify access policies on the rows.

Data Security manages DML Real Application Security application privileges granted by the associated ACLs. The `DataSecurity` module does not inherently enforce other (non-DML) Real Application Security application privileges. Such application privilege may be enforced programmatically as part of a DML operation, when invoking the `CHECK_PRIVILEGE` operator inside either the SQL operator or data realm predicate.

Parameterized ACL

Because each data realm defines a rule that uses a set of parameters, different values for these parameters select different rows. These sets of rows may require different ACLs. Therefore, association between an ACL and a set of rows depends on the data realm rule and its parameter names and values.

ACL Binding

In the database, a privilege may be bound to a resource in the following manner:

- It can be explicitly bound as part of a privilege grant. For example, database object privileges are bound to a resource as part of a privilege grant, such as `GRANT` *`user_N`* `update ON` *`table_M`*.
- It may also be globally bound as part of the privilege definition, such as a system privileges `ALTER SYSTEM` or `CREATE ANY TABLE`, which do not require the resource name as part of their grant statement.

Similarly, a Real Application Security application privilege can be one of these types:

- Explicitly bound through an ACL and data realms as part of Data Security policies; see Configuring Data Security
- Globally bound to a resource as part of its definition

5

Configuring Data Security

This chapter contains:

- About Data Security
- About Validating the Data Security Policy
- Understanding the Structure of the Data Security Policy
- About Designing Data Realms
- Applying Additional Application Privileges to a Column
- About Enabling Data Security Policy for a Database Table or View
- About Creating Real Application Security Policies on Master-Detail Related Tables
- About Managing Application Privileges for Data Security Policies
- Using BEQUEATH CURRENT_USER Views
- Real Application Security: Putting It All Together
- About Schema Level Real Application Security Policy Administration

About Data Security

Data security refers to the ability to control application user access to data in an Oracle database throughout all components of an Oracle Enterprise, using a uniform methodology. In Oracle Database Real Application Security, to secure a database table or view, you must specify the rows that you want to secure by creating a data realm (see also, data realm).

To restrict access to the data realm, you associate one or more access control lists (ACLs) that list the application users or application roles and their application privileges for each data realm. A data realm together with its associated ACL is known as a data realm constraint.

You can further restrict access to specific columns by applying one or more application privileges to each column. This is useful in situations where you want only privileged application users to see the data in that column.

Data security is an extension of Oracle Virtual Private Database (VPD). VPD adds a `WHERE` predicate to restrict data access each time an application user selects or modifies a database table. For more information about VPD, see *Oracle Database Security Guide*. Oracle Database Real Application Security extends VPD concepts further by implementing an authorization model that can further restrict access at both the row and column by means of associating ACLs to these objects. In addition, the application session and session context (through user roles and session namespace) are made more secure. Furthermore Real Application Security provides its own data dictionaries.

To configure data security in Oracle Database Real Application Security, you must follow these steps:

1. **Create a data security policy.** The data security policy defines one or more data realms and associates ACLs for each data realm to create data realm constraints. The data security policy can also contain column-specific attributes to further control data access. Multiple tables or views can share the same data security policy. This lets you create a uniform security strategy that can be used across a set of tables and views.

   Example 5-1Example 5-1 shows the structure a data security policy.

2. **Associate the data security policy with the table or view you want to secure.**

   You can run the `XS_DATA_SECURITY.APPLY_OBJECT_POLICY` PL/SQL procedure to enable the data security policy for the table or view that contains the data realms and columns that you want to secure.

   Note that if your application security requires that you update table rows and also restrict read access to certain columns in the same table, you must use two `APPLY_OBJECT_POLICY` procedures to enforce both data security policies. For example, one `APPLY_OBJECT_POLICY` procedure would enforce the DML `statement_types` required for updating table rows (for example, `INSERT`, `UPDATE`, `DELETE`), while the other `APPLY_OBJECT_POLICY` procedure would enforce only the `statement_types` of `SELECT` for the column constraint.

   Example 5-5Example 5-5 shows how to use the APPLY_OBJECT_POLICY procedure. See "APPLY_OBJECT_POLICY Procedure" for more information.

3. **Validate the data security policy.** See "About Validating the Data Security Policy" for more information.

About Validating the Data Security Policy

Oracle recommends that you should always validate the Real Application Security objects after administrative configuration changes. The `XS_DIAG` package provides a set of validation APIs to help ensure that the complicated relationships among your Real Application Security objects are not damaged unintentionally by these changes.

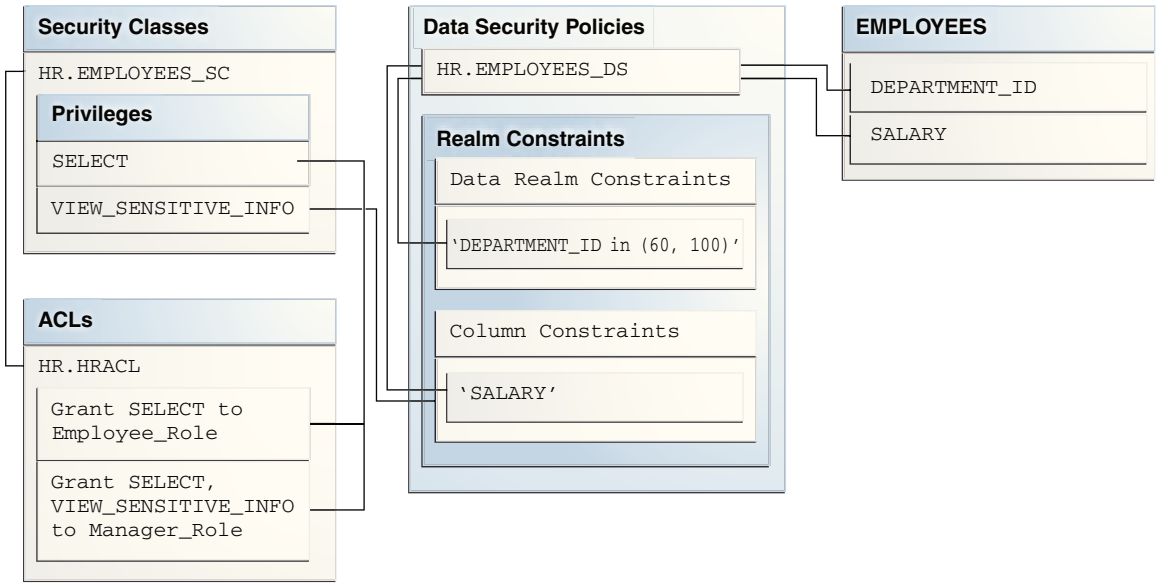
See "VALIDATE_DATA_SECURITY Function" for more information about validating a data security policy.

Understanding the Structure of the Data Security Policy

You can create a data security policy using the `XS_DATA_SECURITY.CREATE_POLICY` PL/SQL procedure.

Figure 5-1 shows the structure of a Real Application Security data security policy named `HR.EMPLOYEES_DS` that is created from a data realm constraint and a column constraint, both of which are to be applied to the `EMPLOYEES` table. The data realm constraint defines the rows (`DEPARTMENT_ID` with a value of 60 or 100) on which the data security policy applies and the ACL (`HRACL`) that is associated with these rows. The column constraint defines a constraint for the sensitive column data in the `SALARY` column of the `EMPLOYEES` table by using the `VIEW_SENSITIVE_INFO` privilege that is required to view this sensitive data.

Figure 5-1 Real Application Security Data Security Policy Created on the EMPLOYEES Table



Example 5-1 creates the data security policy shown in Figure 5-1.

> **See Also:**
>
> "CREATE_POLICY Procedure"

You should validate the data security policy after you create it. See "VALIDATE_DATA_SECURITY Function" for more information.

The main parameters of a data security policy are as follows:

- **Policy Name:** This defines the name of the data security policy.

  Example 5-1 uses the name `EMPLOYEES_DS` for the data security policy that it creates.

- **Data Realm Constraints:** The data realm constraints define the data realms, or the rows, on which the data security policy applies, together with the ACLs to be associated with these data realms.

  Example 5-1 uses the `realm_cons` list to define the data realm constraint for the `EMPLOYEES_DS` policy. `realm_cons` comprises of rows that have a `DEPARTMENT_ID` value of `60` or `100`. These rows are associated with the `HRACL` access control list.

- **Column Constraint:** Column constraint defines additional constraint for sensitive column data in the data realm constraint.

  Example 5-1 associates the column_cons column constraint with the `EMPLOYEES_DS` policy. `column_cons` protects the `SALARY` column with the `VIEW_SENSITIVE_INFO` privilege.

Example 5-1 Structure of a Data Security Policy

```
-- Create the ACL HRACL.
DECLARE
ace_list XS$ACE_LIST;
BEGIN
ace_list := XS$ACE_LIST(
XS$ACE_TYPE(privilege_list => XS$NAME_LIST('SELECT'),
granted => true,principal_name => 'Employee_Role'),
XS$ACE_TYPE(privilege_list => XS$NAME_LIST('SELECT', 'VIEW_SENSITIVE_INFO'), granted
=> true, principal_name => 'Manager_Role'));

sys.xs_acl.create_acl(name => 'HRACL',ace_list => ace_list, sec_class =>
'HR.EMPOLYEES_SC');
END;

-- Create variables to store the data realm constraints and the column constraint.
DECLARE
  realm_cons XS$REALM_CONSTRAINT_LIST;
BEGIN

-- Create a data realm constraint comprising of a data realm (rule) and
-- an associated ACL.
  realm_cons :=
    XS$REALM_CONSTRAINT_LIST(
      XS$REALM_CONSTRAINT_TYPE(realm=> 'DEPARTMENT_ID in (60, 100)',
                               acl_list=> XS$NAME_LIST('HRACL')));

-- Create the column constraint.
  column_cons :=
    XS$COLUMN_CONSTRAINT_LIST(
      XS$COLUMN_CONSTRAINT_TYPE(column_list=> XS$LIST('SALARY'),
                           privilege=> 'VIEW_SENSITIVE_INFO'));

 -- Create the data security policy.
  SYS.XS_DATA_SECURITY.CREATE_POLICY(
          name=>'HR.EMPLOYEES_DS',
          realm_constraint_list=>realm_cons,
          column_constraint_list=>column_cons);

-- Enforce the data security policy to protect READ access of the EMPLOYEES table
-- and restrict access to the SALARY column using the VIEW_SENSITIVE_INFO
-- privilege.
  sys.xs_data_security.apply_object_policy(
           policy => 'HR.EMPLOYEES_DS',
           schema => 'HR',
           object => 'EMPLOYEES',
           statement_types => 'SELECT',
           owner_bypass => true);

END;
```

About Designing Data Realms

This section includes the following topics:

- About Understanding the Structure of a Data Realm
- About Using Static Data Realms
- Using Trace Files to Check for Policy Predicate Errors

About Understanding the Structure of a Data Realm

A data realm is a collection of one or more object instances. An object instance is associated with a single row in a table or view and is identified by the primary key value of the row in the storage table of the object. A table can have both static and dynamic data realms defined for it at the same time. As described earlier, an ACL defines the application privilege grants for the data realm.

A data realm constraint is used to associate a data realm with an ACL. Example 5-2 creates a data realm constraint called `realm_cons`. The data realm constraint includes a membership rule to create a data realm. The data realm includes rows where `DEPARTMENT_ID` is 60 or 100. `realm_cons` also declares an ACL, called `HRACL`, to associate with the data realm.

The membership of the object instances within a data realm is determined by a rule in the form of a SQL predicate, which must be applicable to the `WHERE` clause of a single-table query against the storage table of the object. The SQL predicate in Example 5-2 is `DEPARTMENT_ID in (60, 100)`.

If the SQL you write causes errors, such as `ORA-28113: policy predicate has error`, then you can use trace files to find cause of the error. See "Using Trace Files to Check for Policy Predicate Errors" for more information.

Example 5-2 uses a single ACL called `HRACL`. A data realm can be associated with multiple ACLs, and the same ACL can be used across multiple data realms.

Consider the following columns from the `ORDERS` purchase order table in the `OE` sample schema:

ORDER_ID	CUSTOMER_ID	ORDER_STATUS	SALES_REP_ID	ORDER_TOTAL
2354	104	0	155	46257
2355	104	8	NULL	94513.5
2356	105	5	NULL	29473.8
2357	108	5	158	59872.4
2358	105	2	155	7826

Each row in the `ORDERS` table is an object instance in the purchase order object. The number listed in the `ORDER_ID` column is the primary key used to uniquely identify a particular purchase order object instance. For example:

- A data realm comprised of one object instance, that is, one row. For example, you could use the `WHERE` predicate of `ORDER_ID=2354`.
- A data realm comprised of multiple object instances. For example, you could have multiple rows using the `WHERE` predicate of `CUSTOMER_ID=104`.
- A data realm comprised of the entire contents of the table, defined by the `WHERE` predicate of `1=1`.

Examples of ways to define data realms are as follows:

- **Use valid SQL attributes such as columns in a table.**

  In this case, you are using `WHERE` predicates such as the following:

```
CUSTOMER_ID=104
```

Changes made to the data in the rows and columns are automatically reflected in the data collected by the data realm.

- **Use parameters in the WHERE predicate.**

  You can parameterize an data realm, for example:

  ```
  CUSTOMER_ID=&PARAM
  ```

  This example assumes that the parameter `PARAM` has been associated with different customer IDs. When you grant permissions in this situation, you need to grant the permission to the specific parameter value. You must specify the values of the parameters in the ACL associated with the data realm that contains this type of `WHERE` predicate. This enables you to create the grant based on customer IDs without having to create many customer ID-specific data realms.

- **Use a membership rule based on runtime application session variables or subqueries.**

  An example of this type of membership rule is:

  ```
  CUSTOMER_ID=XS_SYS_CONTEXT('order', 'cust_id')
  ```

  However, be careful about creating membership rules that are based on session variables or subqueries. For example, suppose you wanted to use the session variable `USER`, which reflects the current application user, in the membership rule `col=USER`. Oracle Database cannot pre-compute the resultant row set because the result is not deterministic. Application user `SCOTT` and application user `JSMITH` may have a different result for the same row. However, the membership rule `col='SCOTT'` works because the rule is always evaluated to the same result for any given row.

  See "About Using Static Data Realms" for more information about creating data realms. See also "XS_SYS_CONTEXT Function" for more information about `XS_SYS_CONTEXT`.

Example 5-2 Components of a Data Realm Constraint

```
realm_cons := XS$REALM_CONSTRAINT_TYPE(realm=> 'DEPARTMENT_ID in (60, 100)',
                                       acl_list=> XS$NAME_LIST('HRACL'));
```

About Using Static Data Realms

In a static data realm, Oracle Database evaluates changes to data affected by a data realm when the data is updated. You can use static data realms with tables, but not with views.

To set an data realm to be static, set its `is_static` attribute to `true`. The following example creates a static data realm:

```
realm_cons := XS$REALM_CONSTRAINT_TYPE(realm=> 'DEPARTMENT_ID in (60, 100)',
                                       acl_list=> XS$NAME_LIST('HRACL'),
                                       is_static=> TRUE);
```

Materialized Views (MVs) will be used to maintain the binding between rows in the protected table and the ACLs that protect them. They will be generated automatically whenever static data realms are included in the data security policy. These MVs will

support complete refresh only and will allow up to 125 ACLs to be associated with any single row.

The MV that is generated will be of the form `mv(TABLEROWID, ACLIDLIST)` where `TABLEROWID` refers to a row in the table being protected and ACLIDLIST is a list of ACLID values stored in a `RAW` type column. The individual 16-byte values will be concatenated to form the list.

Oracle Database evaluates dynamic data realms each time the application user performs a query on the data realm data. You can use dynamic data realms to protect rows for both tables and views. A dynamic data realm has the most flexibility, because it is not bound by the requirements needed for static data realms. Be aware that an overly complex rule within the dynamic data realm definition may affect performance.

If the base table update is infrequent or the data realm member evaluation rule is complex, then you should consider using static data realms to protect the base table. A frequently updated base table may be constantly out of sync with the ACLIDS storage MV, unless the MV is refreshed accordingly. The administrator should make the decision based on the base table statistics and performance requirements of the system.

To set a data realm constraint to be dynamic, set its `is_static` attribute to `FALSE`, or omit the `is_static` attribute. The following example creates a dynamic data realm:

```
realm_cons := XS$REALM_CONSTRAINT_TYPE(realm=> 'DEPARTMENT_ID in (60, 100)',
                                       acl_list=> XS$NAME_LIST('HRACL'),
                                       is_static=> FALSE);
```

Using Trace Files to Check for Policy Predicate Errors

If the SQL defined in the `realm` element causes an `ORA-28113: policy predicate has error` or similar message, then you can use trace files to find the cause of the error. The trace file shows the actual error, along with the VPD view showing the reason for the problem. Often, the syntax of the view has a trivial error, which you can solve by analyzing the SQL text of the view.

To enable tracing, log into SQL*Plus as a user who has the `ALTER SESSION` privilege.

If you want to dump all the data realm constraint rules (with their parameter values resolved) into the trace file, enter the following statement:

```
ALTER SESSION SET EVENTS 'TRACE[XSXDS] disk=high';
```

If you want to dump the VPD views of the XDS-enabled table during the initial (hard) parse of a query, enter the following statement:

```
ALTER SESSION SET EVENTS 'TRACE[XSVPD] disk=high';
```

Alternatively, you can enable tracing by adding the following lines to the initialization file for the database instance:

```
event="TRACE[XSXDS] disk=high"
event="TRACE[XSVPD] disk=high"
```

You can find the location of this trace file by issuing the following SQL command:

```
SHOW PARAMETER USER_DUMP_DEST;
```

If you need to disable tracing, issue the following statements:

```
ALTER SESSION SET EVENTS 'TRACE[XSVPD] off';
ALTER SESSION SET EVENTS 'TRACE[XSXDS] off';
```

See Also:

- "About Data Security (XSXDS and XSVPD) Event-Based Tracing"
- *Oracle Database Administrator's Guide* for more information about using trace files

Applying Additional Application Privileges to a Column

By default, access to rows is protected by the ACL associated with the data realm. In addition, you can protect a particular column with custom application privileges.

To protect a column for table `T`, add a list of column constraints to the data security policy that will be applied to table `T`.

Note:

For tables approaching 1000 columns, there is a limitation on the number of columns that can be protected as Real Application Security uses an internal virtual column to compute and store the authorization indicator. The sum of the number of columns and the number of protected columns should not exceed 1000. (Number of table columns + Number of protected table columns <=1000). For example, if a table has 998 columns, up to and including 2 protected columns are allowed; or, if a table has 990 columns, up to and including 10 protected columns are allowed, and so forth. If the number of columns to be protected exceeds the number allowed, an `ORA-28113: policy predicate has error` is returned.

For example, the `PRODUCT_INFORMATION` table in the `OE` schema contains the `LIST_PRICE` column. If you want to restrict the display of product prices to specific categories, you can apply an additional application privilege to the `LIST_COLUMN` table, so that only the sales representative who has logged in can see the product list prices for the categories he or she manages.

Example 5-3 shows a column constraint that protects the `LIST_PRICE` column with the `ACCESS_PRICE` application privilege.

Before you add the column constraint, a `SELECT` statement on the following columns from the `OE.PRODUCT_INFORMATION` table for products in categories 13 and 14 shows the following output:

PRODUCT_ID	PRODUCT_NAME	CATEGORY_ID	LIST_PRICE
3400	HD 8GB /SE	13	389
3355	HD 8GB /SI	13	NULL
2395	32MB Cache /M	14	123

PRODUCT_ID	PRODUCT_NAME	CATEGORY_ID	LIST_PRICE
1755	32MB Cache /NM	14	121
...	...	...	...

After the column constraint is applied, the sales representatives who are responsible for category 13 products see the following output:

PRODUCT_ID	PRODUCT_NAME	CATEGORY_ID	LIST_PRICE
3400	HD 8GB /SE	13	389
3355	HD 8GB /SI	13	NULL
2395	32MB Cache /M	14	NULL
1755	32MB Cache /NM	14	NULL
...	...	...	...

Conversely, sales representatives responsible for category 14 products see this output:

PRODUCT_ID	PRODUCT_NAME	CATEGORY_ID	LIST_PRICE
3400	HD 8GB /SE	13	NULL
3355	HD 8GB /SI	13	NULL
2395	32MB Cache /M	14	123
1755	32MB Cache /NM	14	121
...	...	...	...

In these examples, the list price for product 3355 is `NULL`. To enable a mid-tier application to distinguish between the true value of authorized data, which could include `NULL`, and an unauthorized value that is always `NULL`, use the `COLUMN_AUTH_INDICATOR` SQL function to check if the column value in a row is authorized. You can mask the unauthorized data with a value different from `NULL` by modifying the `SELECT` statement to include a `DECODE` or `CASE` function that contains the `COLUMN_AUTH_INDICATOR` SQL function.

Example 5-4 shows a `SELECT` statement that uses the `COLUMN_AUTH_INDICATOR` function to check authorized data and the `DECODE` function to replace `NULL` with the value `restricted`.

Afterward, the masked value appears in place of `NULL`. For example, if our category 13 sales representative logs on and searches for product list prices, he or she sees the following output:

PRODUCT_ID	PRODUCT_NAME	CATEGORY_ID	LIST_PRICE
3400	HD 8GB /SE	13	389
3355	HD 8GB /SI	13	NULL
2395	32MB Cache /M	14	restricted
1755	32MB Cache /NM	14	restricted
...	...	...	...

See Also:

- Oracle Database Real Application Security Data Dictionary Views for information about the column constraints data dictionary views, which list existing tables that use column level security
- "COLUMN_AUTH_INDICATOR Function"
- Example 5-1 for an example of a column constraint element within a data security policy.
- Configuring OCI and JDBC Applications for Column Authorization if your applications use either Oracle Call Interface (OCI) or JDBC

Example 5-3 Column with an Additional Application Privilege That Has Been Applied

```
column_cons :=
  XS$COLUMN_CONSTRAINT_LIST(
    XS$COLUMN_CONSTRAINT_TYPE(column_list=> XS$LIST('LIST_PRICE'),
                          privilege=> 'ACCESS_PRICE'));
```

Example 5-4 Checking Authorized Data and Masking NULL Values

```
SELECT PRODUCT_ID, PRODUCT_NAME, CATEGORY_ID
DECODE(COLUMN_AUTH_INDICATOR(LIST_PRICE), 0, 'restricted', 1, LIST_PRICE) LIST_PRICE
FROM PRODUCT_INFORMATION
WHERE CATEGORY_ID = 13;
```

About Enabling Data Security Policy for a Database Table or View

The `XS_DATA_SECURITY.APPLY_OBJECT_POLICY` procedure applies a data security policy on a table or view.

This section includes the following topics:

- Enabling Real Application Security Using the APPLY_OBJECT_POLICY Procedure
- About How the APPLY_OBJECT_POLICY Procedure Alters a Database Table
- About How ACLs on Table Data Are Evaluated

Enabling Real Application Security Using the APPLY_OBJECT_POLICY Procedure

Use the `XS_DATA_SECURITY.APPLY_OBJECT_POLICY` procedure to enable Real Application Security for a database table or view. Example 5-5 enables the `ORDERS_DS` data security policy for the `OE.ORDERS` table. See "APPLY_OBJECT_POLICY Procedure" for more information.

Example 5-5 Using XS_DATA_SECURITY.APPLY_OBJECT_POLICY

```
BEGIN  SYS.XS_DATA_SECURITY.APPLY_OBJECT_POLICY(policy=>'ORDERS_DS',
                                        schema=>'OE',
                                        object=>'ORDERS');
END;
```

This section includes the following topic: About Applying Multiple Policies for a Table or View.

About Applying Multiple Policies for a Table or View

You can apply multiple data security policies for a table or view. When a table or view is protected by multiple data security policies, an application user has access to only those rows that are allowed by all the policies. So, for example, if the data realm for Policy 1 includes a row, but the data realm for Policy 2 does not include the same row, the application user would be unable to access the row.

Column security works similarly. Consider the case where column Col1 is protected by multiple policies: Policy1 protects it with Priv1, Policy2 protects it with Priv2, and so forth. Then an application user must have been granted all application privileges (Priv1, Priv2, and so forth) to access Col1.Thus, for columns protected by column policies, an application user must have been granted access by all policies protecting the column.

About How the APPLY_OBJECT_POLICY Procedure Alters a Database Table

The following table, `OE.ORDERS`, shown earlier under "About Understanding the Structure of a Data Realm", has been enabled with `XS_DATA_SECURITY.APPLY_OBJECT_POLICY`. It shows the addition of the hidden `SYS_ACLOID` column. This column, whose data type is `NUMBER`, lists application user-managed ACL identifiers. The following table contains the application user-managed ACL identifier 500, which is a direct grant on the object instance identified by the order ID 2356.

> **Note:**
>
> The `SYS_ACLOID` hidden column can be enabled by passing the value `XS_DATA_SECURITY.APPLY_ACLOID_COLUMN` for the `apply_option` parameter when invoking the `XS_DATA_SECURITY` procedure. Real Application Security allows only one ACLID to be added to the `SYS_ACLOID` column.

ORDER_ID	CUSTOMER_ID	ORDER_STATUS	SALES_REP_ID	ORDER_TOTAL	SYS_ALCOID
2354	104	0	155	46257	
2355	104	8	NULL	94513.5	
2356	105	5	NULL	29473.8	500
2357	108	5	158	59872.4	
2358	105	2	155	7826	

The system-managed static ACL identifiers, are stored in a Materialized View (MV).

TABLEROWID	ACLIDLIST
AAAO/8AABAAANrCABJ	60FB8AAA40D46C9EE040449864653987
AAAO/8AABAAANrCABL	60FB8AAA40D46C9EE040449864653987

To find detailed information on the data realms or data realm constraints associated with a table, query the `DBA_XS_REALM_CONSTRAINTS` data dictionary view. See "DBA_XS_REALM_CONSTRAINTS" for more information.

About How ACLs on Table Data Are Evaluated

When Oracle Database evaluates a set of ACLs, it stops the evaluation when it finds the first grant or deny. For this reason, it is important to plan the order of ACLs carefully. The ACLs associated with each row in a table are evaluated in the following order:

1. **The ACLs from grants directly on object instances (that is, application user-managed ACL identifiers) are evaluated first.** See "About Configuring Access Control Lists" for more information about creating an ACL and adding it to the object instance.
2. **The ACLs from static data realm constraint grants are evaluated next, after application user-managed ACLs.** If you have multiple static data realms, they are evaluated in the order of their physical appearance in the data security policy. See "About Using Static Data Realms" for more information about static data realms.
3. **The ACLs from dynamic data realm constraint grants are evaluated last.** If you have multiple dynamic data realms, they are evaluated in the order of their physical appearance in the policy. See "About Using Static Data Realms" for more information about dynamic data realms.

About Creating Real Application Security Policies on Master-Detail Related Tables

This section includes the following topics:

- About Real Application Security Policies on Master-Detail Related Tables
- About Understanding the Structure of Master Detail Data Realms
- Example of Creating a Real Application Security Policy on Master-Detail Related Tables

For more information about master-detail tables, see the chapter about creating a master-detail application using JPA and Oracle ADF in *Oracle Database 2 Day + Java Developer's Guide*.

About Real Application Security Policies on Master-Detail Related Tables

You can create a data security policy that can be used for master-detail related tables. Typically, you may want the same policy that protects the master table to protect its detail tables. Creating a Real Application Security policy for master-detail tables enables anyone accessing these tables to do so under a uniform policy that can be inherited from master table to detail table.

The possible inheritance paths for policies and master-detail tables are as follows:

- Multiple detail tables can inherit policies from one master table.
- Detail tables can inherit policies from other detail tables.
- One detail table can inherit policies from multiple master tables.

If any one of the policies in the master table is satisfied, then application users can access the corresponding rows in the detail table.

About Understanding the Structure of Master Detail Data Realms

To create a Real Application Security policy for master-detail related tables, you must create a data security policy for each table. In each data security policy for the detail tables, you indicate the master table from which the detail table inherits by including master detail data realms. Steps 4, 6 and 7 in the procedure under "Example of Creating a Real Application Security Policy on Master-Detail Related Tables" shows examples of creating and using master-detail data realms and creating and applying master-detail data security policies to master-detail tables.

Example 5-6 shows a sample master detail data realm.

In this specification:

- `when_condition` specifies a predicate for the detail table, similar to a `WHERE` clause, to filter data. If `when_condition` evaluates to true, then Oracle Database applies the master policy. This element is optional.
- `parent_schema` specifies the name of the schema that contains the master table.
- `parent_object` specifies the name of the master table.
- `primary_key` specifies the primary key from the master table.
- `foreign_key` specifies the foreign key of the detail table.

Example 5-6 A Master Detail Data Realm

```
realm_cons :=  XS$REALM_CONSTRAINT_TYPE
               (parent_schema=> 'OE',
                parent_object=> 'CUSTOMERS',
                key_list=> XS$KEY_LIST(XS$KEY_TYPE(primary_key=> 'CUSTOMER_ID',
                                                   foreign_key=> 'CUSTOMER_ID',
                                                   foreign_key_type=> 1)),
                when_condition=> 'ORDER_STATUS IS NOT NULL')
```

Example of Creating a Real Application Security Policy on Master-Detail Related Tables

This example uses the SH sample schema. The SH schema has a table called CUSTOMERS, which is the master table. The master table CUSTOMERS has a detail table called SALES, and another detail table called COUNTRIES. The following example demonstrates how to enforce a Real Application Security policy that virtually partitions the customer and sales data along their regional boundary defined in the COUNTRIES table for read access of the CUSTOMERS and SALES tables. In addition, there is a requirement to mask out data on the columns CUST_INCOME_LEVEL and CUST_CREDIT_LIMIT to users, except for those users who need full table access for business analysis, such as the business analyst.

> **Note:**
>
> All administrative commands in this example can be performed by a database user, such as the SYSTEM account who has the DBA roles in the database, because the DBA role has been granted appropriate privilege for Real Application Security administrative tasks. In addition, because security classes, ACLs, and data security policies are schema qualified objects, you must explicitly use the intended schema name when these objects are specified in the APIs, so they will not be resolved to objects under the database session default schema of SYSTEM.

The descriptions for the three tables, which are all in the same schema (SH), are as follows:

```
-- SH.CUSTOMERS in the master table.
 Name                                      Null?    Type
 ----------------------------------------- -------- ----------------------------
 CUST_ID                                   NOT NULL NUMBER
 CUST_FIRST_NAME                           NOT NULL VARCHAR2(20)
 CUST_LAST_NAME                            NOT NULL VARCHAR2(40)
 CUST_GENDER                                        CHAR(1)
 CUST_YEAR_OF_BIRTH                                 NUMBER(4)
 CUST_MARITAL_STATUS                                VARCHAR2(20)
 CUST_STREET_ADDRESS                       NOT NULL VARCHAR2(40)
 CUST_POSTAL_CODE                          NOT NULL VARCHAR2(10)
 CUST_CITY                                 NOT NULL VARCHAR2(30)
 CUST_STATE_PROVINCE                                VARCHAR2(40)
 COUNTRY_ID                                NOT NULL CHAR(2)
 CUST_MAIN_PHONE_NUMBER                             VARCHAR2(25)
 CUST_INCOME_LEVEL                                  VARCHAR2(30)
 CUST_CREDIT_LIMIT                                  NUMBER
 CUST_EMAIL                                         VARCHAR2(30)

-- SH.SALES is a detail table.
 Name                                      Null?    Type
 ----------------------------------------- -------- ----------------------------
 PROD_ID                                   NOT NULL NUMBER(6)
 CUST_ID                                   NOT NULL NUMBER
 TIME_ID                                   NOT NULL DATE
 CHANNEL_ID                                NOT NULL CHAR(1)
```

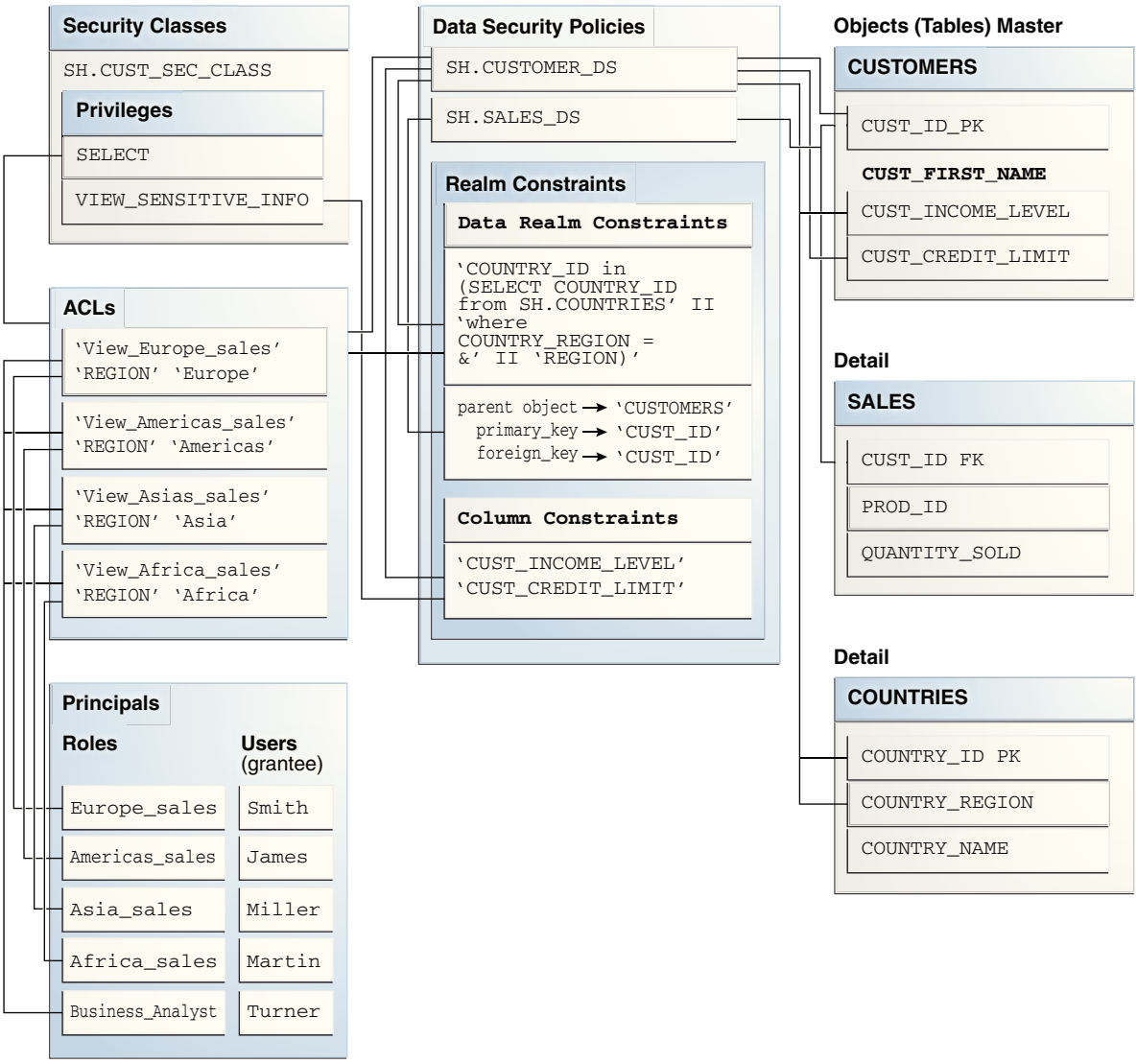
```
 PROMO_ID                                  NOT NULL NUMBER(6)
 QUANTITY_SOLD                             NOT NULL NUMBER(3)
 AMOUNT_SOLD                               NOT NULL NUMBER(10,2)

-- SH.COUNTRIES is a detail table.
 Name                                      Null?    Type
 ----------------------------------------- -------- ----------------------------
 COUNTRY_ID                                NOT NULL CHAR(2)
 COUNTRY_NAME                              NOT NULL VARCHAR2(40)
 COUNTRY_SUBREGION                                  VARCHAR2(30)
 COUNTRY_REGION                                     VARCHAR2(20)
```

Figure 5-2 shows an overview of the completed Real Application Security data security policies created and applied to the master-detail related tables (`CUSTOMERS` - `SALES` - `COUNTRIES`) that are described as an overview in the following steps and in more detail in the steps that follow this figure.

1. Create the principals, an application role and an application user, for each of four geographic regions: Europe, Americas, Asia, and Africa, in addition to a business analyst role and an associated application user.
2. Create the `VIEW_SENSITIVE_INFO` privilege and create the `SH.CUST_SEC_CLASS` in which to scope the privilege.
3. Grant the `VIEW_SENSITIVE_INFO` privilege to the business analyst role.
4. Define a data realm constraint with a rule that parameterizes regions in order for the system to recognize the string `&REGION`, which will later be used in a policy.
5. Create a column constraint to secure the two columns, `CUST_INCOME_LEVEL` and `CUST_CREDIT_LEVEL` using the `VIEW_SENSITIVE_INFO` privilege.
6. Create the data security policy `SH.CUSTOMER_DS` specifying the data realm constraint and the column constraint that was previously created.
7. Register the name and data type of the parameter in the rule for the `SH.CUSTOMER_DS` data security policy.
8. Create the ACLs for each region to authorize read access to the respective roles needing read access. For example for the Europe region, you grant `SELECT` privilege to the `Europe_sales` role and grant `SELECT` and `VIEW_SENSITIVE_INFO` privileges to the `Business_Analyst` role.
9. Associate each ACL in each region with the rows that satisfy the rule where the value of the parameter `REGION` is equal to region name, for example, Europe. You do this for each of the four regions, and then add this ACL to the `SH.CUSTOMER_DS` data security policy.
10. Create the data realm constraint for the master-detail tables, so users can access a record in the `SALES` detail table only if a user is authorized to access its parent row in the `CUSTOMERS` master table.
11. Create the `SH.SALES_DS` data security policy to enforce this data realm constraint.

In Figure 5-2, the master-detail tables also show the primary key (PK) fields and foreign key (FK) fields and a number of additional fields that are used in creating the data realm constraints and column constraints. Using these PK and FK relationships, the same data security policies that apply to the master table also apply to the detail tables. In this particular case, for example, all ACLs granting `SELECT` privilege to the `CUSTOMERS` master table and enforced by the `SH.CUSTOMER_DS` data security policy, also applies to the `SALES` detail table.

Figure 5-2 Real Application Security Data Security Policy Created on Master-Detail Related Tables



To create a Real Application Security policy for these master-detail tables, follow these steps:

1. Create the roles and users needed for each country, (role `Europe_sales`, user `SMITH`), (role `Americas_sales`, user `JAMES`), (role `Asia_sales`, user `MILLER`), (role `Africa_sales`, user `MARTIN`), and (role `Business_Analyst`, user `TURNER`), who is the only user who will have full table access.

```
BEGIN
   sys.xs_principal.create_role(name => 'Europe_sales', enabled => TRUE);
   sys.xs_principal.create_role(name => 'Americas_sales', enabled => TRUE);
   sys.xs_principal.create_role(name => 'Asia_sales', enabled => TRUE);
   sys.xs_principal.create_role(name => 'Africa_sales', enabled => TRUE);
   sys.xs_principal.create_role(name => 'Business_Analyst', enabled => TRUE);

   sys.xs_principal.create_user(name => 'SMITH', schema => 'SH');
```

```
   sys.dbms_xs_principals.set_password(username => 'SMITH',
                                       password => 'password',
                                       type => XS_PRINCIPAL.XS_SHA512);
   sys.xs_principal.grant_roles(grantee => 'SMITH', role => 'Europe_sales');

   sys.xs_principal.create_user(name =>' JAMES', schema => 'SH');
   sys.dbms_xs_principals.set_password(username => 'JAMES',
                                       password => 'password',
                                       type => XS_PRINCIPAL.XS_SHA512);
   sys.xs_principal.grant_roles(grantee => 'JAMES', role => 'Americas_sales');

   sys.xs_principal.create_user(name => 'MILLER', schema => 'SH');
   sys.dbms_xs_principals.set_password(username => 'MILLER',
                                       password => 'password',
                                       type => XS_PRINCIPAL.XS_SHA512);
   sys.xs_principal.grant_roles(grantee => 'MILLER', role => 'Asia_sales');

   sys.xs_principal.create_user(name => 'MARTIN', schema => 'SH');
   sys.dbms_xs_principals.set_password(username => 'MARTIN',
                                       password => 'password',
                                       type => XS_PRINCIPAL.XS_SHA512);
   sys.xs_principal.grant_roles(grantee => 'MARTIN', role => 'Africa_sales');

   sys.xs_principal.create_user(name => 'TURNER', schema=> 'SH');
   sys.dbms_xs_principals.set_password(username => 'TURNER',
                                       password => 'password',
                                       type => XS_PRINCIPAL.XS_SHA512);
   sys.xs_principal.grant_roles(grantee => 'TURNER', role => 'Business_Analyst');
END;
```

2. Define the `SH.CUST_SEC_CLASS` security class for the privilege, `VIEW_SENSITIVE_INFO` to protect the sensitive columns.

   The row level privileges to access data security protected objects for query and DML are predefined in the Security Class DML under the `SYS` schema.

```
DECLARE
  pr_list  XS$PRIVILEGE_LIST;
BEGIN
-- Let's call the new privilege VIEW_SENSIATIVE_INFO
  pr_list := XS$PRIVILEGE_LIST(XS$PRIVILEGE(name => 'VIEW_SENSITIVE_INFO'));

  sys.xs_security_class.create_security_class(
          name => 'SH.CUST_SEC_CLASS',
          description => 'Security Class to protect CUSTOMERS and SALES data',
          parent_list => XS$NAME_LIST('SYS.DML'),
          priv_list => pr_list);
END;
```

3. Define the data realm constraint with a rule that parameterizes regions, then define the column constraint and specify the name of the two columns, `CUST_INCOME_LEVEL` and `CUST_CREDIT_LIMIT`, to be secured by the `VIEW_SENSITIVE_INFO` privilege. Then, create a `SH.CUSTOMER_DS` data security policy and register the name and data type of the parameter in the rule.

   The security policy requires that regional customers and sales data be partitioned with different ACLs. One way to achieve this is to define as many data realms as regions and do this for both tables. However, in this example, another way is shown. That is, to parameterize the region in a data realm with a single rule and use the master-detail relationship to simplify the administrative tasks.

So, instead of creating many constraints for the policy, it is more efficient to create only one constraint with the following rule that parameterizes the region:

```
COUNTRY_ID in
 (select COUNTRY_ID from SH.COUNTRIES where COUNTRY_REGION = &REGION)
```

In order for the system to recognize that the string `&REGION` in the rule is indeed a parameter, you must invoke the `xs_data_security.create_acl_parameter` procedure to register the parameter name after the policy is created. In addition, you must specify the data type of the parameter value. Since regions are stored as character string data, the `XS_ACL.TYPE_VARCHAR` macro is used for this example. Another supported data type is `XS_ACL.TYPE_NUMBER` for numbers.

```
DECLARE
  rows_secs XS$REALM_CONSTRAINT_LIST;
  cols_secs XS$COLUMN_CONSTRAINT_LIST;
BEGIN
-- Define the realm constraint with a rule that parameterizes regions.
  rows_secs := xs$REALM_CONSTRAINT_LIST(
          XS$REALM_CONSTRAINT_TYPE(
            realm => 'COUNTRY_ID in (select COUNTRY_ID from SH.COUNTRIES ' ||
                     'where COUNTRY_REGION = &' || 'REGION)'));

-- Define the column constraint to secure CUST_INCOME_LEVEL and
-- CUST_CREDIT_LIMIT columns by using the VIEW_SENSITIVE_INFO privilege.
  cols_secs := XS$COLUMN_CONSTRAINT_LIST(
        XS$COLUMN_CONSTRAINT_TYPE(
          column_list => XS$LIST('CUST_INCOME_LEVEL', 'CUST_CREDIT_LIMIT'),
          privilege => 'VIEW_SENSITIVE_INFO'));

-- Create the data security policy.
  sys.xs_data_security.create_policy(
          name => 'SH.CUSTOMER_DS',
          realm_constraint_list => rows_secs,
          column_constraint_list => cols_secs,
          description => 'Policy to protect sh.customers table');

-- Register the name and data type of the parameter in the rule.
  sys.xs_data_security.create_acl_parameter(
           policy => 'SH.CUSTOMER_DS',
           parameter => 'REGION',
           param_type => XS_ACL.TYPE_VARCHAR);
END;
```

4. Create ACLs to authorize read access for each region. For the Europe region, grant `SELECT` to the `Europe_sales` role. In addition, `SELECT` and `VIEW_SENSITIVE_INFO` privileges are granted to the `Business_Analyst` role so that the grantee of the role has full table access and is able to see data in the columns of `CUST_INCOME_LEVEL` and `CUST_CREDIT_LIMIT` as well.

```
DECLARE
  ace_list XS$ACE_LIST;
BEGIN
  ace_list := XS$ACE_LIST(
              XS$ACE_TYPE(privilege_list => XS$NAME_LIST('SELECT'),
                          granted => true,
                          principal_name => 'Europe_sales'),
              XS$ACE_TYPE(privilege_list =>
                            XS$NAME_LIST('SELECT', 'VIEW_SENSITIVE_INFO'),
                          granted => true,
                          principal_name => 'Business_Analyst'));
```

```
  sys.xs_acl.create_acl(name => 'View_Europe_sales',
                 ace_list => ace_list,
                 sec_class => 'SH.CUST_SEC_CLASS',
                 description => 'Authorize read access for the Europe region');

-- The ACL must be associated with rows that satisfy the rule where the value
-- of the parameter REGION is equal to Europe. For example the constraint
-- rule becomes the COUNTRY_ID in
--  (select COUNTRY_ID from SH.COUNTRIES where COUNTRY_REGION = 'Europe').

  sys.xs_acl.add_acl_parameter(acl => 'View_Europe_sales',
                           policy => 'SH.CUSTOMER_DS',
                           parameter => 'REGION',
                           value => 'Europe');
END;
```

5. Create ACLs to authorize read access for the other three regions, Americas, Asia, and Africa.

```
DECLARE
  ace_list XS$ACE_LIST;
BEGIN
  ace_list := XS$ACE_LIST(
              XS$ACE_TYPE(privilege_list => XS$NAME_LIST('SELECT'),
                          granted => true,
                          principal_name => 'Americas_sales'),
              XS$ACE_TYPE(privilege_list =>
                            XS$NAME_LIST('SELECT', 'VIEW_SENSITIVE_INFO'),
                          granted => true,
                          principal_name => 'Business_Analyst'));

  sys.xs_acl.create_acl(name => 'View_Americas_sales',
                ace_list => ace_list,
                sec_class => 'SH.CUST_SEC_CLASS',
                description => 'Authorize read access for the Americas region');

  sys.xs_acl.add_acl_parameter(acl => 'View_Americas_sales',
                           policy => 'SH.CUSTOMER_DS',
                           parameter => 'REGION',
                           value => 'Americas');
END;

DECLARE
  ace_list XS$ACE_LIST;
BEGIN
  ace_list := XS$ACE_LIST(
              XS$ACE_TYPE(privilege_list => XS$NAME_LIST('SELECT'),
                          granted => true,
                          principal_name => 'Asia_sales'),
              XS$ACE_TYPE(privilege_list =>
                            XS$NAME_LIST('SELECT', 'VIEW_SENSITIVE_INFO'),
                          granted => true,
                          principal_name => 'Business_Analyst'));

  sys.xs_acl.create_acl(name => 'View_Asia_sales',
                ace_list => ace_list,
                sec_class => 'SH.CUST_SEC_CLASS',
                description => 'Authorize read access for the Asia region');

  sys.xs_acl.add_acl_parameter(acl => 'View_Asia_sales',
                           policy => 'SH.CUSTOMER_DS',
```

```
                            parameter => 'REGION',
                            value => 'Asia');
END;

DECLARE
  ace_list XS$ACE_LIST;
BEGIN
  ace_list := XS$ACE_LIST(
              XS$ACE_TYPE(privilege_list => XS$NAME_LIST('SELECT'),
                          granted => true,
                          principal_name => 'Africa_sales'),
              XS$ACE_TYPE(privilege_list =>
                           XS$NAME_LIST('SELECT', 'VIEW_SENSITIVE_INFO'),
                          granted => true,
                          principal_name => 'Business_Analyst'));

  sys.xs_acl.create_acl(name => 'View_Africa_sales',
                ace_list => ace_list,
                sec_class => 'SH.CUST_SEC_CLASS',
                description => 'Authorize read access for the Africa region');

  sys.xs_acl.add_acl_parameter(acl => 'View_Africa_sales',
                            policy => 'SH.CUSTOMER_DS',
                            parameter => 'REGION',
                            value => 'Africa');
END;
```

6. Apply the `SH.CUSTOMER_DS` policy created in Step 3 to protect read access to the `CUSTOMERS` table.

```
BEGIN
  sys.xs_data_security.apply_object_policy(
           policy => 'SH.CUSTOMER_DS',
           schema => 'SH',
           object => 'CUSTOMERS',
           statement_types => 'SELECT',
           owner_bypass => true);
END;
```

7. Create the data realm master-detail constraint to protect the `SALES` table. This master-detail constraint utilizes the same regional partitioning policy as previously described in Steps 3 through 6. This means that a user can access a record in the `SALES` detail table only if that user is authorized to access its parent row in the `CUSTOMERS` master table.

```
DECLARE
  rows_secs XS$REALM_CONSTRAINT_LIST;
BEGIN
-- Define the master-detail constraint.
  rows_secs := xs$REALM_CONSTRAINT_LIST(
    XS$REALM_CONSTRAINT_TYPE(
      parent_schema => 'SH',
      parent_object => 'CUSTOMERS',
      key_list => xs$key_list(xs$key_type(primary_key => 'CUST_ID',
                                          foreign_key => 'CUST_ID',
                                          foreign_key_type => 1))));

-- Create a policy to enforce the constraint.
  sys.xs_data_security.create_policy(
         name => 'SH.SALES_DS',
         realm_constraint_list => rows_secs,
         column_constraint_list => null);
```

```
-- Apply the policy to protect read access of the SALES table.
  sys.xs_data_security.apply_object_policy(
           policy => 'SH.SALES_DS',
           schema => 'SH',
           object => 'SALES',
           statement_types => 'SELECT',
           owner_bypass => true);
END;
```

8. Grant object level `SELECT` privilege to `PUBLIC` for users to perform a query.

```
GRANT SELECT ON sh.customers TO PUBLIC;
GRANT SELECT ON sh.countries TO PUBLIC;
GRANT SELECT ON sh.sales TO PUBLIC;
```

9. Connect as user `MARTIN` and perform a query to display user `MARTIN`'s sales data for the Africa region and to show the masking of the sensitive sales information for the `CUST_INCOME_LEVEL` and `CUST_CREDIT_LIMIT` columns.

```
CONNECT MARTIN/welcome

SELECT c.COUNTRY_NAME, c.COUNTRY_ID, ct.CUST_FIRST_NAME, PROD_ID, QUANTITY_SOLD
 FROM sh.customers ct, sh.sales s, sh.countries c
 WHERE  ct.CUST_ID = s.CUST_ID AND
        ct.COUNTRY_ID = c.COUNTRY_ID;

COUNTRY_NAME         CO CUST_FIRST_NAME         PROD_ID QUANTITY_SOLD
-------------------- -- -------------------- ---------- -------------
South Africa         ZA Forrest                    8050             2
South Africa         ZA Mitch                     17505            11
South Africa         ZA Murry                     32785             7
South Africa         ZA Heath                      3585            12
```

About Managing Application Privileges for Data Security Policies

This section includes the following topics:

- About Bypassing the Security Checks of a Real Application Security Policy
- Using the SQL*Plus SET SECUREDCOL Command

About Bypassing the Security Checks of a Real Application Security Policy

The following database users can bypass the security checks of a Real Application Security Policy:

- User `SYS`
- Database users who have the `EXEMPT ACCESS POLICY` system privilege
- The owner of the object to which the policy is applied.

  If the data security policy is applied to an object with the owner bypass specification, the owner of the object may bypass such policy. By default, owner bypass is not allowed.

The object owner also can create another view on the same table and assign this view a different Real Application Security policy.

Using the SQL*Plus SET SECUREDCOL Command

The SQL*Plus `SET SECUREDCOL` command enables you to customize how secure column values are displayed in SQL*Plus output for users without permission to view a column and for columns with unknown security. You can choose either the default text or specify the text that is displayed. The default is `OFF`.

When column level security is enabled, and `SET SECUREDCOL` is set `ON`, output from SQL*Plus for secured columns or columns of unknown security level is replaced with either your customized text or the default indicators. This only applies to scalar data types. Complex object data output is not affected.

Syntax

```
SET SECUREDCOL {OFF¦ON} [UNAUTH[ORIZED] text][UNK[NOWN] text]
```

Parameters

Parameter	Description
`ON`	Displays the default indicator asterisks (`****`) in place of column values for users without authorization to view the column, and displays question marks (?????) in place of column values where the security level is unknown for the column (when the specific privileges applied to the column are not known). The indicators "*" and "?" are filled to the defined column length or the column length defined by a current `COLUMN` command. By default this command will be `OFF`.
`OFF`	Displays null values in place of column values for application users without authorization to view the column, and in place of column values where the security level is unknown for the column.
`UNAUTH[ORIZED]`	Text enables you to specify the text to be displayed in a secured column for application users without authorization to view the column. This text appears instead of the default `*****`. You can specify any alphanumeric text up to the column length or a maximum of 30 characters. Longer text is truncated. Text containing spaces must be quoted.
`UNK[NOWN]`	Text enables you to specify the text to be displayed in a column of unknown security level (when the specific privileges applied to the column are not known). This text appears instead of the default ??????. You can specify any alphanumeric text up to the column length or a maximum of 30 characters. Longer text is truncated. Text containing spaces must be quoted.

Example 1

```
SET SECUREDCOL ON
SELECT empno, ename, sal FROM emp ORDER BY deptno;
```

The output of the example will be as follows:

```
EMPNO ENAME   DEPTNO SAL
----- ------ ------ --------
7539 KING     10    ********
7369 SMITH    20    800
7566 JONES    20    2975
7788 SCOTT    20    3000
```

```
7521 WARD     30    ********
7499 ALLEN    30    ********

6 rows selected.
```

Example 2

```
SET SECUREDCOL ON UNAUTH notallowed
SELECT empno, ename, sal FROM emp ORDER BY deptno;
```

The output of the example will be as follows:

```
EMPNO ENAME  DEPTNO SAL
----- ------ ------ -------
7539 KING    10    notallowed
7369 SMITH   20    800
7566 JONES   20    2975
7788 SCOTT   20    3000
7521 WARD    30    notallowed
7499 ALLEN   30    notallowed

6 rows selected.
```

Using BEQUEATH CURRENT_USER Views

Traditionally, views in Oracle Database use definer's rights. This means that if you invoke an identity or privilege-sensitive SQL function or an invoker's rights PL/SQL or Java function, then current schema, and current user, are set to the view owner and currently enabled roles is set to the view owner plus `PUBLIC` within the functions's execution.

If you need background information on invoker's rights and definer's rights, see *Oracle Database PL/SQL Language Reference*.

> **Note:**
>
> Certain built-in SQL functions, such as `SYS_CONTEXT()` and `USERENV()` are exceptions to the preceding rule. These functions always use the current application user's environment, even when called from definer's rights views.

Oracle Database 12*c* Release 1 (12.1) and later enables you to create views with the `BEQUEATH` clause, which lets you configure this behavior. The `BEQUEATH` clause determines whether identity or privilege-sensitive SQL functions, invoker's rights PL/SQL program units, and Java functions referenced in the view inherit the current schema, current user, and currently enabled roles from the querying user's environment. This is especially useful for Real Application Security applications, which often need to run code in the invoking application user's environment.

Using `BEQUEATH CURRENT_USER` in the view definition creates a view that allows privilege-sensitive, and invoker's rights functions referenced in the view to inherit current schema, current user, and currently enabled roles from the querying user's environment. See *Oracle Database SQL Language Reference* for the syntax of the `CREATE OR REPLACE VIEW` statement.

Example 5-7 illustrates how a BEQUEATH CURRENT_USER view enables invoker right's program units to run in the invoking application user's environment. When USER2 selects from USER1's view, the invoker's rights function is invoked in USER2's environment.

Using BEQUEATH DEFINER in the view definition creates a view that causes privilege-sensitive, and invoker's rights functions referenced in the view to inherit current schema, current user, and currently enabled roles from the view definer's environment. If no BEQUEATH clause is specified, then BEQUEATH DEFINER is assumed.

If a BEQUEATH_DEFINER view contains a reference to a BEQUEATH CURRENT_USER view, then invoker's rights functions in the referenced view would use the parent view owner's rights.

Example 5-8 illustrates how a BEQUEATH DEFINER view defines a boundary for nested invoker right's program units to run in the view owner's environment. When USER2 selects from USER1's view, the view's invoker's rights function is invoked in USER1's environment.

> **See Also:**
>
> *Oracle Database Security Guide* for the use of invoker's rights and definer's rights in VPD and FGA policies

Example 5-7 How a BEQUEATH CURRENT_USER View Works

```
SQL> CONNECT USER1/USER1
Connected.
SQL>
SQL> -- You first create an invoker's rights function to determine who the current
SQL> -- user really is.
SQL> CREATE OR REPLACE FUNCTION CALLED_AS_USER RETURN VARCHAR2 AUTHID CURRENT_USER IS
2 BEGIN
3 RETURN SYS_CONTEXT('USERENV', 'CURRENT_USER');
4 END;
5 /
Function created.

SQL> -- Note that you do not need to grant EXECUTE to called_as_user, because even
SQL> -- BEQUEATH CURRENT_USER views do name resolution and privilege checking on
SQL> -- the references present in the view body using definer's rights.

SQL> CREATE OR REPLACE VIEW BEQUEATH_INVOKER_VIEW BEQUEATH CURRENT_USER AS
2 SELECT CALLED_AS_USER FROM DUAL;
View created.

SQL> GRANT SELECT ON BEQUEATH_INVOKER_VIEW TO PUBLIC;
Grant succeeded.

SQL> CONNECT USER2/USER2
Connected.

SQL> SELECT * FROM USER1.BEQUEATH_INVOKER_VIEW;
CALLED_AS_USER
--------------------------------------------------------------------------------
USER2
```

Example 5-8 How a BEQUEATH DEFINER View Works

```
SQL> CONNECT USER1/USER1
Connected.
SQL>
SQL> -- You first create an invoker's rights function to determine who the current
SQL> -- user really is.
SQL> CREATE OR REPLACE FUNCTION CALLED_AS_USER RETURN VARCHAR2 AUTHID CURRENT_USER IS
2 BEGIN
3 RETURN SYS_CONTEXT('USERENV', 'CURRENT_USER');
4 END;
5 /
Function created.

SQL> -- Note that you do not need to grant EXECUTE to called_as_user, because even
SQL> -- BEQUEATH CURRENT_USER views do name resolution and privilege checking on
SQL> -- the references present in the view body using definer's rights.

SQL> CREATE OR REPLACE VIEW BEQUEATH_DEFINER_VIEW BEQUEATH DEFINER AS
2 SELECT CALLED_AS_USER FROM DUAL;
View created.

SQL> GRANT SELECT ON BEQUEATH_DEFINER_VIEW TO PUBLIC;
Grant succeeded.

SQL> CONNECT USER2/USER2
Connected.

SQL> SELECT * FROM USER1.BEQUEATH_DEFINER_VIEW;
CALLED_AS_USER
--------------------------------------------------------------------------------
USER1
```

This section includes the following topic: Using SQL Functions to Determine the Invoking Application User.

Using SQL Functions to Determine the Invoking Application User

SQL functions, such as `SYS_CONTEXT()` and `USERENV()`, and `XS_SYS_CONTEXT()`, always return the current application user's environment, even when called from definer's rights views. Sometimes, applications need to determine the invoking application user based on the security context (`BEQUEATH` property) of views referenced in the statement.

The following new functions introduced in Oracle Database 12*c* Release 1 (12.1) enable you to figure out the invoking application user taking into account the `BEQUEATH` property of views referenced in the statement:

- `ORA_INVOKING_USER`: Use this function to return the name of the database user whose context is currently used. If the function is invoked from within a definer's rights boundary, then the name of the database object owner is returned. If the invoking user is a Real Application Security application user, then the constant `XS$USER` is returned.
- `ORA_INVOKING_USERID`: Use this function to return the identifier (ID) of the database user whose context is currently used. If the function is invoked from within a definer's rights boundary, then the ID of the database object owner is returned.

If the invoking user is a Real Application Security application user, then the function returns an identifier common to all Real Application Security application users, but distinct from the identifier for any database user.

- `ORA_INVOKING_XS_USER`: Use this function to return the name of the Real Application Security application user whose context is currently used.

  If the invoking user is a database user, then the value `NULL` is returned.

- `ORA_INVOKING_XS_USER_GUID`: Use this function to return the identifier (ID) of the Real Application Security application user whose context is currently used.

  If the invoking user is a database user, then the value `NULL` is returned.

The following example shows a database user `USER1` querying `ORA_INVOKING_USER` and `ORA_INVOKING_XS_USER`. `ORA_INVOKING_XS_USER` returns `NULL`, as the user is not a Real Application security application user.

```
SQL> CONNECT USER1
Enter password:
Connected.
SQL> SELECT ORA_INVOKING_USER FROM DUAL;

ORA_INVOKING_USER
--------------------------------------------------------------------------------
USER1

SQL> SELECT ORA_INVOKING_XS_USER FROM DUAL;

ORA_INVOKING_XS_USER
--------------------------------------------------------------------------------
```

> **See Also:**
>
> - *Oracle Database SQL Language Reference* for detailed information on the preceding SQL functions and other functions like `SYS_CONTEXT`
> - "XS_SYS_CONTEXT Function"

Real Application Security: Putting It All Together

This section puts all the Real Application Security concepts together in order to define a basic data security policy. It builds upon the `HR` scenario example introduced in "Scenario: Security Human Resources (HR) Demonstration of Employee Information".

The section includes the following topic that discusses each implementation task described in the scenario with the help of an example.

This section includes the following topics:

- Basic HR Scenario: Implementation Tasks
- Running the Security HR Demo

Basic HR Scenario: Implementation Tasks

The following implementation tasks are discussed:

- Connecting as User SYS to Create Real Application Security Users and Roles
- Creating Roles and Application Users
- Creating the Security Class and ACLS
- Creating the Data Security Policy
- Validating the Real Application Security Objects
- Disabling a Data Security Policy for a Table

Connecting as User SYS to Create Real Application Security Users and Roles

To create Real Application Security users and roles, you need only to connect as user `SYS`.

Example 5-9 Connecting as User SYS

```
SQL> connect sys/&passwd as sysdba
Connected.
```

Creating Roles and Application Users

Creating the Database Role

Create the database role `DB_EMP` and grant this role the necessary table privileges. This role is used to grant the required object privileges to application users.

Creating the Application Roles

Grant the DB_EMP Database Role to the Application Roles

Grant the `DB_EMP` database role to the three application roles, so they each have the required object privilege to access the table.

Create the Application Users

Create application user `DAUSTIN` (in the IT department) and grant this user application roles `EMPPLOYEE` and `IT_ENGINEER`.

In this example:

> **Note:**
>
> To make logins easier, you can create the name in upper case. That way, the user can omit the quotation marks when logging in or connecting to SQL*Plus. For example:
>
> ```
> sqlplus DAUSTIN
> ```

> **See Also:**
>
> "Creating a Simple Application User Account" for information about how case sensitivity affects database logins for application users

Create application user SMAVRIS (in the HR department) and grant this user application roles EMPLOYEE and HR_REPRESENTATIVE.

Grant the HR User the Policy Administration Privilege ADMIN_ANY_SEC_POLICY

Grant the HR user the ADMIN_ANY_SEC_POLICY privilege.

Example 5-10 Creating the DB_EMP Role

```
SQL> create role db_emp;

Role created.

SQL> grant select, insert, update, delete on hr.employees to db_emp;

Grant succeeded.
```

Example 5-11 Creating the Application Role EMPLOYEE for Common Employees

```
SQL> exec sys.xs_principal.create_role(name => 'employee', enabled => true);

PL/SQL procedure successfully completed.
```

Example 5-12 Creating the Application Role IT_ENGINEER for the IT Department

```
SQL> exec sys.xs_principal.create_role(name => 'it_engineer', enabled => true);

PL/SQL procedure successfully completed.
```

Example 5-13 Creating the Application Role HR_REPRESENTATIVE for the HR Department

```
SQL> exec sys.xs_principal.create_role(name => 'hr_representative', enabled => true);

PL/SQL procedure successfully completed.
```

Example 5-14 Granting DB_EMP Database Role to Each Application Role

```
SQL> grant db_emp to employee;

Grant succeeded.

SQL> grant db_emp to it_engineer;

Grant succeeded.

SQL> grant db_emp to hr_representative;

Grant succeeded.
```

Example 5-15 Creating Application User DAUSTIN

```
SQL> exec  sys.xs_principal.create_user(name => 'daustin', schema => 'hr');

PL/SQL procedure successfully completed.

SQL> exec  sys.xs_principal.set_password('daustin', 'password');

PL/SQL procedure successfully completed.

SQL> exec  sys.xs_principal.grant_roles('daustin', 'XSCONNECT');

PL/SQL procedure successfully completed.

SQL> exec  sys.xs_principal.grant_roles('daustin', 'employee');

PL/SQL procedure successfully completed.

SQL> exec  sys.xs_principal.grant_roles('daustin', 'it_engineer');

PL/SQL procedure successfully completed.
```

Example 5-16 Creating Application User SMAVRIS

```
SQL> exec  sys.xs_principal.create_user(name => 'smavris', schema => 'hr');

PL/SQL procedure successfully completed.

SQL> exec  sys.xs_principal.set_password('smavris', 'password');

PL/SQL procedure successfully completed.

SQL> exec  sys.xs_principal.grant_roles('daustin', 'XSCONNECT');

PL/SQL procedure successfully completed.

SQL> exec  sys.xs_principal.grant_roles('smavris', 'employee');

PL/SQL procedure successfully completed.

SQL> exec  sys.xs_principal.grant_roles('smavris', 'hr_representative');

PL/SQL procedure successfully completed.
```

Example 5-17 Granting the HR User the Policy Administration Privilege ADMIN_ANY_SEC_POLICY

```
SQL> exec sys.xs_admin_util.grant_system_privilege('ADMIN_ANY_SEC_POLICY','HR');

PL/SQL procedure successfully completed.
```

Creating the Security Class and ACLS

Creating the Security Class

Create a security class `HR_PRIVILEGES` based on the predefined DML security class. `HR_PRIVILEGES` has a new privilege `VIEW_SALARY`, which controls access to the `SALARY` column.

Creating the ACIs

Create three ACLs, `EMP_ACL`, `IT_ACL`, and `HR_ACL` to grant privileges for the data security policy to be defined later.

In this example:

- **Lines 11 through 13:** Creates the `EMP_ACL` and grants `EMPLOYEE` the `SELECT` and `VIEW_SALARY` privileges.
- **Lines 21 through 23:** Creates the `IT_ACL` and grants `IT_ENGINEER` the `SELECT` privileges.
- **Lines 30 through 33:** Creates the `HR_ACL` and grants `HR_REPRESENTATIVE` the `SELECT`, `INSERT`, `UPDATE`, and `DELETE` database privileges to view and update all employee's records, and granting the `VIEW_SALARY` application privilege to view the `SALARY` column.

Example 5-18 Creating the HRPRIVS Security Class

```
SQL> declare
  2  begin
  3    xs_security_class.create_security_class(
  4      name        => 'hr_privileges',
  5      parent_list => xs$name_list('sys.dml'),
  6      priv_list   => xs$privilege_list(xs$privilege('view_salary')));
  7  end;
  8  /

PL/SQL procedure successfully completed.
```

Example 5-19 Creating ACLs: EMP_ACL, IT_ACL, and HR_ACL

```
SQL> declare
  2    aces xs$ace_list := xs$ace_list();
  3  begin
  4    aces.extend(1);
  5
  6    -- EMP_ACL: This ACL grants EMPLOYEE role the privileges to view an employee's
  7    --          own record including SALARY column.
  8    aces(1) := xs$ace_type(privilege_list => xs$name_list('select','view_salary'),
  9                           principal_name => 'employee');
 10
 11    sys.xs_acl.create_acl(name      => 'emp_acl',
 12                          ace_list  => aces,
 13                          sec_class => 'hr_privileges');
 14
 15    -- IT_ACL:  This ACL grants IT_ENGINEER the privilege to view the employee
 16    --          records in IT department, but it does not grant the VIEW_SALARY
 17    --          privilege that is required for access to SALARY column.
 18    aces(1) := xs$ace_type(privilege_list => xs$name_list('select'),
 19                           principal_name => 'it_engineer');
 20
 21    sys.xs_acl.create_acl(name      => 'it_acl',
 22                          ace_list  => aces,
 23                          sec_class => 'hr_privileges');
 24
 25    -- HR_ACL:  This ACL grants HR_REPRESENTATIVE the privileges to view and
update all
 26    --          employees' records including SALARY column.
 27    aces(1):= xs$ace_type(privilege_list => xs$name_list('select', 'insert',
```

```
 28                                              'update', 'delete', 'view_salary'),
 29                          principal_name => 'hr_representative');
 30
 31    sys.xs_acl.create_acl(name      => 'hr_acl',
 32                          ace_list  => aces,
 33                          sec_class => 'hr_privileges');
 34  end;
 35  /

PL/SQL procedure successfully completed.
```

Creating the Data Security Policy

Create the data security policy for the EMPLOYEES table. The policy defines three data realm constraints and a column constraint that protects the SALARY column.

In this example:

- **Lines 7 through 23**: Defines the three data realm constraints.
- **Lines 27 through 30:** Defines the column constraint requiring the VIEW_SALARY application privilege to view the SALARY column.
- **Lines 32 through 35:** Creates the **EMPLOYEES_DS** data security policy encompassing the three data realm constraints and the column constraint.

Applying the Data Security Policy to the Table

Apply the data security policy to the EMPLOYEES table.

Example 5-20 Creating the EMPLOYEES_DS Data Security Policy

```
SQL> declare
  2    realms   xs$realm_constraint_list := xs$realm_constraint_list();
  3    cols     xs$column_constraint_list := xs$column_constraint_list();
  4  begin
  5    realms.extend(3);
  6
  7    -- Realm #1: Only the employee's own record.
  8    --           EMPLOYEE role can view the realm including SALARY column.
  9    realms(1) := xs$realm_constraint_type(
 10      realm    => 'email = xs_sys_context(''xs$session'',''username'')',
 11      acl_list => xs$name_list('emp_acl'));
 12
 13    -- Realm #2: The records in the IT department.
 14    --           IT_ENGINEER role  can view the realm excluding SALARY column.
 15    realms(2) := xs$realm_constraint_type(
 16      realm    => 'department_id = 60',
 17      acl_list => xs$name_list('it_acl'));
 18
 19    -- Realm #3: All the records.
 20    --           HR_REPRESENTATIVE role can view and update the realm including
SALARY column.
 21    realms(3) := xs$realm_constraint_type(
 22      realm    => '1 = 1',
 23      acl_list => xs$name_list('hr_acl'));
 24
 25    -- Column constraint protects SALARY column by requiring VIEW_SALARY
 26    -- privilege.
 27    cols.extend(1);
 28    cols(1) := xs$column_constraint_type(
```

```
 29      column_list => xs$list('salary'),
 30      privilege   => 'view_salary');
 31
 32    sys.xs_data_security.create_policy(
 33      name                   => 'employees_ds',
 34      realm_constraint_list  => realms,
 35      column_constraint_list => cols);
 36  end;
 37  /

PL/SQL procedure successfully completed.
```

Example 5-21 Applying the EMPLOYEES_DS Security Policy to the EMPLOYEES Table

```
SQL> begin
  2    sys.xs_data_security.apply_object_policy(
  3      policy => 'employees_ds',
  4      schema => 'hr',
  5      object =>'employees');
  6  end;
  7  /

PL/SQL procedure successfully completed.
```

Validating the Real Application Security Objects

After you create these Real Application Security objects, validate them to ensure they are all properly configured.

Example 5-22 Validating the Real Application Security Objects

```
SQL> set serveroutput on;
SQL> begin
  2    if (xs_diag.validate_workspace()) then
  3      dbms_output.put_line('All configurations are correct.');
  4    else
  5      dbms_output.put_line('Some configurations are incorrect.');
  6    end if;
  7  end;
  8  /
All configurations are correct.

PL/SQL procedure successfully completed.

SQL> -- XS$VALIDATION_TABLE contains validation errors if any.
SQL> -- Expect no rows selected.
SQL> select * from xs$validation_table order by 1, 2, 3, 4;

no rows selected
```

Disabling a Data Security Policy for a Table

Example 5-23 shows the complementary operation of disabling data security for table HR.EMPLOYEES.

Example 5-23 Disabling a Data Security Policy for a Table

```
BEGIN
  SYS.XS_DATA_SECURITY.DISABLE_OBJECT_POLICY(policy => 'EMPLOYEES_DS', schema =>
```

```
'HR', object => 'EMPLOYEES');
END;
/
```

Running the Security HR Demo

The Security HR Demo is run in two ways:

- Using direct logon first as application user `DAUSTIN` and later as application user `SMAVRIS`.

  In each case, each user performs queries on the `HR.EMPLOYEES` table to demonstrate what each can access or cannot access to view employee records and the `SALARY` column. See "Running the Security HR Demo Using Direct Logon" for a description of this demonstration.

- Attached to a Real Application Security session

  In this demonstration, the Real Application Security Administrator creates a Real Application Security session for an application user to attach to. See "Running the Security HR Demo Attached to a Real Application Security Session" for a description of this demonstration.

About Schema Level Real Application Security Policy Administration

Describes introduction of schema level privileges for Real Application Security policy administration across different applications within the same schema.

Beginning with Oracle Database 12*c* Release 2 (12.2), Real Application Security introduces schema level privileges, which allows a policy administrator to create, update, and apply a policy in only the granted schema and administer policy enforcement within one application, thereby achieving separate management and enforcement of a policy across different applications within the same schema. This level of policy administration is essential in a Cloud computing scenario where each application may be running under one or more schemas. It then becomes highly desirable for a policy administrator to have the ability to manage and apply data security policies for each individual application in that environment.

Achieving Schema Level Data Security Policy Administration

To achieve schema level data security policy administration, the following new and changed features were introduced:

- The `GRANT_SYSTEM_PRIVILEGE` and `REVOKE_SYSTEM_PRIVILEGE` procedures were extended with the addition of the `schema` parameter to allow granting and revoking Real Application Security privileges on a particular schema to a database or application user as shown in the following syntax descriptions:

  ```
  XS_ADMIN_UTIL.GRANT_SYSTEM_PRIVILEGE (
    priv_name      IN VARCHAR2,
    user_name      IN VARCHAR2,
  ```

```
  user_type      IN PLS_INTEGER := XS_ADMIN_UTIL.PTYPE_DB,
  schema         IN VARCHAR2);


XS_ADMIN_UTIL.REVOKE_SYSTEM_PRIVILEGE (
  priv_name      IN VARCHAR2,
  user_name      IN VARCHAR2,
  user_type      IN PLS_INTEGER := XS_ADMIN_UTIL.PTYPE_DB,
  schema         IN VARCHAR2);
```

Where the `schema` parameter is the schema on which the privilege is granted. The value is `NULL` if the privilege is a system privilege.

- The system security class `ADMIN_SEC_POLICY` privilege is extended to schemas for policy management (Create, Read, Update, and Delete) operations. So a policy administrator can grant `ADMIN_SEC_POLICY` privilege on a particular schema to a user to manage policy artifacts within granted schemas and apply policy management for individual applications. The APIs that are affected by this enhancement include the Real Application Security administrator packages: `XS_ACL`, `XS_DATA_SECURITY`, and `XS_SECURITY_CLASS`
- A new system security class `APPLY_SEC_POLICY` privilege is added for policy enforcement to allow a policy administrator to enforce a policy within granted schemas within one application. The following data security APIs are checked before enforcing data security policies:
  - `XS_DATA_SECURITY.APPLY_OBJECT_POLICY`
  - `XS_DATA_SECURITY.REMOVE_OBJECT_POLICY`
  - `XS_DATA_SECURITY.ENABLE_OBJECT_POLICY`
  - `XS_DATA_SECURITY.DISABLE_OBJECT_POLICY`
- Auditing of `GRANT_SYSTEM_PRIVILEGE` procedure is provided with the audit action `AUDIT_GRANT_PRIVILEGE`.
- Auditing of `REVOKE_SYSTEM_PRIVILEGE` procedure is provided with the audit action `AUDIT_REVOKE_PRIVILEGE`.
- A new data dictionary view `DBA_XS_PRIVILEGE_GRANTS` is added to show all the Real Applicaton Security system or schema level privilege grants in the database.
- In addition, the following views are added: ALL_XS_SECURITY_CLASSES, ALL_XS_SECURITY_CLASS_DEP, ALL_XS_PRIVILEGES, ALL_XS_IMPLIED_PRIVILEGES, ALL_XS_ACLS, ALL_XS_ACES, ALL_XS_POLICIES, ALL_XS_REALM_CONSTRAINTS, ALL_XS_INHERITED_REALMS, ALL_XS_ACL_PARAMETERS, ALL_XS_COLUMN_CONSTRAINTS, ALL_XS_APPLIED_POLICIES, and DBA_XS_PRIVILEGE_GRANTS

This section includes the following topic: Setting Up and Enabling a Schema Level Data Security Policy.

Setting Up and Enabling a Schema Level Data Security Policy

Describes how to set up and enable a schema level data security policy for two application administrators.

The following set of examples describe how to set up and enable a schema level data security policy for two application administrators to administer two different schemas. Later, it will show how to disable the data security policy and revoke system privileges from these two application administrator users.

Create the application administrator users, then grant them the roles they need.

```
EXEC SYS.XS_PRINCIPAL.CREATE_USER(NAME => 'app_admin_user1', SCHEMA =>
'HR');
EXEC SYS.XS_PRINCIPAL.SET_PASSWORD('app_admin_user1', 'PASSWORD');
EXEC SYS.XS_PRINCIPAL.GRANT_ROLES('app_admin_user1', 'XSCONNECT');


EXEC SYS.XS_PRINCIPAL.CREATE_USER(NAME => 'app_admin_user2', SCHEMA =>
'SH');
EXEC SYS.XS_PRINCIPAL.SET_PASSWORD('app_admin_user2', 'PASSWORD');
EXEC SYS.XS_PRINCIPAL.GRANT_ROLES('app_admin_user2', 'XSCONNECT');
```

The Real Application Security Administrator with either `SYS` or a user granted `GRANT ANY PRIVILEGE` grants the system privileges `ADMIN_SEC_POLICY` and `APPLY_SEC_POLICY` to each application administrator user on the respective `HR` and `SH` schemas to the Real Application Security user, `PTYPE_XS`.

```
EXEC SYS.XS_ADMIN_UTIL.GRANT_SYSTEM_PRIVILEGE('ADMIN_SEC_POLICY',
'app_admin_user1', SYS.XS_ADMIN_UTIL.PTYPE_XS, 'HR');


EXEC SYS.XS_ADMIN_UTIL.GRANT_SYSTEM_PRIVILEGE('APPLY_SEC_POLICY',
'app_admin_user1', SYS.XS_ADMIN_UTIL.PTYPE_XS, 'HR');


EXEC SYS.XS_ADMIN_UTIL.GRANT_SYSTEM_PRIVILEGE('ADMIN_SEC_POLICY',
'app_admin_user2', SYS.XS_ADMIN_UTIL.PTYPE_XS, 'SH');


EXEC SYS.XS_ADMIN_UTIL.GRANT_SYSTEM_PRIVILEGE('APPLY_SEC_POLICY',
'app_admin_user2', SYS.XS_ADMIN_UTIL.PTYPE_XS, 'SH');
```

Next, the policy administrator applies the desired object policy to a particular table in an application and enables it. For example, see the HR demo script About Creating the Data Security Policy for an example of creating a data security policy `EMPLOYEES_DS` for the `EMPLOYEE` table. Once created, then the policy administrator applies the data security policy `EMPLOYEES_DS` to the `EMPLOYEES` table in the `HR` schema.

```
BEGIN
  SYS.XS_DATA_SECURITY.ENABLE_OBJECT_POLICY(policy =>'EMPLOYEES_DS',
                                            schema=>'hr',
                                            object=>'employees');
```

```
END;
/


BEGIN
  SYS.XS_DATA_SECURITY.ENABLE_OBJECT_POLICY(policy =>'CUSTOMERS_DS',
                                            schema=>'sh',
                                            object=>'customers');
END;
/
```

Disabling the Data Security Policy and Revoking the System Privileges from the User

Describes how to disable data security policy and revoke the system privileges from the user.

How to Disable the Data Security Policy and Revoke the System Privileges from the User

To disable the `EMPLOYEES_DS` data security policy for the `EMPLOYEES` table in the `HR` schema, the policy administrator does the following:

```
BEGIN
  SYS.XS_DATA_SECURITY.DISABLE_OBJECT_POLICY(policy =>'EMPLOYEES_DS',
                                             schema=>'hr',
                                             object=>'employees');
END;
/
```

To disable the `CUSTOMERS_DS` data security policy for the `CUSTOMERS` table in the `SH` schema, the policy administrator does the following:

```
BEGIN
  SYS.XS_DATA_SECURITY.DISABLE_OBJECT_POLICY(policy =>'CUSTOMERS_DS',
                                             schema=>'sh',
                                             object=>'customers');
END;
/
```

To revoke the system privileges from application administrator users `app_admin_user1` and `app_admin_user2` not from the role `policy_admin_role` because there may be other policy administrators with this same role enabled, the Real Application Security Administrator with either `SYS` privilege or a user granted `GRANT ANY PRIVILEGE` privilege revokes the system privileges `ADMIN_SEC_POLICY` and `APPLY_SEC_POLICY` from application users `app_admin_user1`and `app_admin_user2` as follows:

```
EXEC SYS.XS_ADMIN_UTIL.REVOKE_SYSTEM_PRIVILEGE('APPLY_SEC_POLICY',
'app_admin_user1', SYS.XS_ADMIN_UTIL.PTYPE_XS, 'HR');
```

```
EXEC SYS.XS_ADMIN_UTIL.REVOKE_SYSTEM_PRIVILEGE('ADMIN_SEC_POLICY',
'app_admin_user1', SYS.XS_ADMIN_UTIL.PTYPE_XS, 'HR');


EXEC SYS.XS_ADMIN_UTIL.REVOKE_SYSTEM_PRIVILEGE('APPLY_SEC_POLICY',
'app_admin_user2', SYS.XS_ADMIN_UTIL.PTYPE_XS, 'SH');
EXEC SYS.XS_ADMIN_UTIL.REVOKE_SYSTEM_PRIVILEGE('ADMIN_SEC_POLICY',
'app_admin_user2', SYS.XS_ADMIN_UTIL.PTYPE_XS, 'SH');
```

6

Using Real Application Security in Java Applications

This chapter describes how to use Real Application Security in Java applications. This chapter contains the following sections:

- About Initializing the Middle Tier
- About Managing Real Application Security Sessions
- Authenticating Application Users Using Java APIs
- About Authorizing Application Users Using ACLs
- Human Resources Administration Use Case: Implementation in Java

About Initializing the Middle Tier

The `XSSessionManager` class manages the life cycle of the session. It provides methods to create, attach, assign, detach, and destroy sessions. It also provides methods to perform cache activities.

This section describes the following topics:

- About Mid-Tier Configuration Mode
- Using the getSessionManager Method
- About Changing the Middle-Tier Cache Setting

About Mid-Tier Configuration Mode

You can use one mid-tier configuration mode:

- Dispatcher mode - get a session manager with dispatcher connections

In dispatcher mode, the dispatcher user must have session administration and cache access privileges. The application user does not need any session or cache privilege. The two predefined database roles, `xs_session_admin` and `xs_cache_admin`, can be granted to the dispatcher.

For best security practices, the application user should be given the least amount of privilege, therefore dispatcher mode is the recommended mid-tier configuration.

Using the getSessionManager Method

There is one way to get a session manager following the mid-tier configuration mode described in "About Mid-Tier Configuration Mode":

- Pass a connection or a pool of connections of the dispatcher user. In this way, the needed privileges are granted to the dispatcher. The two predefined roles, `xs_session_admin` and `xs_cache_admin`, should be granted to the dispatcher user. The dispatcher user is a direct logon Real Application Security user.

Using the dispatcher mode, you can initiate the Real Application Security middle tier by getting an instance of the session manager (see Example 6-1). Use the `getSessionManager` method (in bold typeface) of the `XSSessionManager` class to get an instance of the session manager. This method initializes a Real Application Security session manager by using either a single connection or a pool of connections. The caller of the `getSessionManager` method should have the Java Authentication and Authorization Service (JAAS) permission `XSSecurityPermission("initSecurityManager")`.

Privileges for the Session Manager

Real Application Security session manager is initialized with a connection of a privileged user, who authorizes the session operations on behalf of the regular Real Application Security application users. If the session manager has the session operation privileges, then, each application user under the session manager does not need to have session operation privileges, and the application user's session operations can be performed as a trusted party. The session manager authorizes session operations for a connection, so you do not need to grant the `createSession` and `attachToSession` privileges directly to the regular Real Application Security application user. This session manager must have the following privileges:

- Real Application Security database object privileges to manage cached data in the middle tier.
- Session life cycle management privileges for the session manager to create or attach sessions on behalf of Real Application Security application user and external users.

Roles for the Session Manager

The session manager needs the following two roles to have the privileges mentioned in "Privileges for the Session Manager":

- A database role `xs_cache_admin` with the following privileges:
  - Privilege to query Real Application Security entities and to synchronize metadata
  - Privilege to execute code for the key exchange
- A Real Application Security role, `xs_session_admin`, with `ADMIN_SESSION` privilege

These roles are predefined in the system.

Example 6-1 How to Get an Instance of the Session Manager in Java Using a Single Connection

```
static XSSessionManager manager;
static Connection dispatcherConn = null;
int cacheMaxIdleTime=30;
int cacheMaxsize=2048000;
String host;
String port;
String sid;
...
dispatcherConn = DriverManager.getConnection("jdbc:oracle:thin:@" + host + ":" +
port + ":" + sid, dispatcherUser, dispatcherPassword);
...
manager = XSSessionManager.getSessionManager(dispatcherConn, cacheMaxIdleTime,
cacheMaxsize);
```

About Changing the Middle-Tier Cache Setting

Once the session manager is initialized, it starts to add some data like the ACL and Security class information to the cache. This cache data can be reused. The cache is initialized with its default settings that can be changed later.

This section describes the following topics:

- About Setting the Maximum Cache Idle Time
- About Setting the Maximum Cache Size
- About Getting the Maximum Cache Idle Time
- About Getting the Maximum Cache Size
- About Removing Entries from the Cache
- About Clearing the Cache

About Setting the Maximum Cache Idle Time

To set the maximum cache idle time, use the `setCacheMaxIdleTime` method of the `XSSessionManager` class. The `setCacheMaxIdleTime` method sets the maximum number of minutes that the cache can go without updating.

If an attempt is made to fetch objects from the cache and the `XSSessionManager` has not called the `updateCache` method for a period of time equal to the value set by the `setCacheMaxIdleTime` method, then, before returning any objects, the `updateCache` method is invoked forcefully to check that all the cached objects are still valid. The caller of the `setCacheMaxIdleTime` method must have the JAAS permission `XSSecurityPermission("setCacheMaxIdleTime")`.

About Setting the Maximum Cache Size

To set the maximum cache size, use the `setCacheMaxSize` method of the `XSSessionManager` class. This method sets the size of the cache on the middle tier.

The default size of the cache is 10MB. The minimum cache size is 1MB. The caller of the `setCacheMaxSize` method must have the JAAS permission `XSSecurityPermission("setCacheMaxSize")`.

About Getting the Maximum Cache Idle Time

To get the maximum cache idle time, use the `getCacheMaxIdleTime` method of the `XSSessionManager` class. This method returns the maximum number of minutes for which the cache does not have an `updateCache` call to update the cache. The caller of the `getCachemaxIdleTime` method must have the JAAS permission `XSSecurityPermission("getCacheMaxIdleTime")`.

About Getting the Maximum Cache Size

To get the maximum cache size, use the `getCacheMaxSize` method of the `XSSessionManager` class. This method returns the maximum size of the cache in bytes. The caller of the `getCacheMaxSize` method must have the JAAS permission XSSecurityPermission("getCacheMaxSize").

About Removing Entries from the Cache

To remove entries from the cache, a cache eviction algorithm is used, along with watermark levels. A watermark level determines how long data should stay in memory cache before being removed. When the cache size reaches the high watermark, then the cache eviction algorithm removes entries until the cache size reaches the low watermark.

This section describes the following activities for removing entries from the cache:

- About Setting the WaterMark
- About Getting the High WaterMark
- About Getting the Low WaterMark

About Setting the WaterMark

To set the watermark, use the `setWaterMark` method from the `XSSessionManager` class. The caller of the `setWaterMark` method must have the JAAS permission `XSSecurityPermission("setWaterMark")`.

About Getting the High WaterMark

To get the high watermark for cache, use the `getHighWaterMark` method from the `XSSessionManager` class.

About Getting the Low WaterMark

To get the low watermark for cache, use the `getLowWaterMark` method from the `XSSessionManager` class.

About Clearing the Cache

To clear the cache explicitly from the middle tier, use the `clearCache` method of the `XSSessionManager` class. This method explicitly clears the shared cache from the middle tier. The caller of the `clearCache` method must have the JAAS permission `XSSecurityPermission("clearCache")`.

About Managing Real Application Security Sessions

This section describes the following topics:

- Creating a Real Application Security User Session
- Attaching an Application Session
- Assigning or Switching an Application User
- Enabling Real Application Security Application Roles
- About Performing Namespace Operations as Session User
- About Performing Miscellaneous Session-Related Activities
- Detaching an Application Session
- Destroying A Real Application Security Application Session

Creating a Real Application Security User Session

To create a Real Application Security user session, for example, `lws`, for the application user `lwuser`, use the `createSession` method of the `XSSessionManager` class (see Example 6-2). The `createSession` method (in bold typeface). creates a session on the server with the specified parameters passed. A database round-trip is required to perform this operation.

To create an anonymous Real Application Security application session, use the `createAnonymousSession` method of the `XSSessionManager` class. The application user for this session is a predefined anonymous user, so no user parameter is passed in this method.

Both methods support using a cookie and a namespace.

The cookie, passed as the parameter, can be used to identify the newly created Real Application Security application session in future calls, until the cookie value is changed or the session is destroyed.

The namespace, passed as the parameter, can be used to create a namespace in the session. For details, see "About Performing Namespace Operations as Session User".

It is possible to reassign a specific application user to take over this session. In this case, some of the state of the session for the anonymous user is still preserved. For details, see "Assigning or Switching an Application User".

Example 6-2 How to Create a Real Application Security Session in Java

```
Session lws = null;
static XSSessionManager manager;
static Connection lwsConn = null;
static String user = "lwuser";
String cookie="nst";
...
lws = manager.createSession(lwsConn, user, cookie, null);
...
```

Attaching an Application Session

To attach an application session, use the `attachSession` method of the `XSSessionManager` class (see Example 6-3). The `attachSession` method (in bold typeface) attaches the JDBC connection to the specified Real Application Security application session object. It also enables or disables the dynamic application roles, creates namespaces of the session, and sets the authentication time.

You can also attach to a session by using either ID or cookie as shown in Example 6-4. See Example 7-2 for another example of attaching to a session by using a cookie.

Example 6-3 How to Attach a Real Application Security Session in Java

```
Session lws = null;
static Connection lwsConn = null;
static XSSessionManager manager;
static String user = "lwuser";
String cookie = "lwscookie";
List <String> edynamicRoles = new ArrayList <String>();
edynamicRoles.add("EDYNROLE001");
```

```
edynamicRoles.add("EDYNROLE002");
List <String> ddynamicRoles = new ArrayList <String>();
ddynamicRoles.add("DDYNROLE001");
ddynamicRoles.add("DDYNROLE002");
...
lws = manager.createSession(lwsConn, user, cookie, null);
manager.attachSession(lwsConn, lws, edynamicRoles, ddynamicRoles, null, new
Timestamp(System.currentTimeMillis()));
```

Example 6-4 How to Attach Using a Cookie

```
Session lws = null;
static Connection lwsConn = null;
static XSSessionManager manager;
...
lws = manager.attachSessionByCookie(lwsConn, "myCookie", null, null, null, null,
null);
```

Assigning or Switching an Application User

If you have an anonymous session, you can reassign it to another application user later. Otherwise, if your session is assigned to an application user already, you can switch the session to another application user. In either case, the session must be attached first, before assigning or switching an application user.

To assign a name to a previously anonymous application user, use the `assignUser` method of the `XSSessionManager` class (see Example 6-5). The `assignUser` method (in bold typeface) changes the session context (user and roles) to the given user, for example, `lwuser`, but keeps the existing namespace. It can also change the session at the same time, by any given dynamic roles and namespace parameters, in the same way as the `attachSession` method. The associated session attributes remain in effect unless they are removed through another call.

To change a session user from a named user (non-anonymous) to another named user, use the `switchUser` method of the Session object.

Any request for retaining the dynamic application roles, which were assigned while attaching the session, is disabled. The dynamic application roles are retained for the new application user only when they are also included in the dynamic application roles list for the new application user. The associated session attributes remain in effect unless the session attributes list is reset.

This method changes the session context (user and roles) to the target user (see "Switching a Current Application User to Another Application User in the Current Application Session" for details about roles change), but *not* keeping the existing namespace by default. If you want to retain the existing namespace, you can use the `switchUserKeepState` method of the Session object. It can also change the session at the same time, by any given dynamic roles and namespace parameters, in the same way as the `attachSession` method.

Example 6-6 demonstrates how to switch the application user from `lwuser` to `lwuser1`. The `switchUser` method is in bold typeface.

Example 6-5 How to Assign an Application User to a Session in Java

```
Session lws = null;
static XSSessionManager manager;
static String user = "lwuser";
...
```

```
manager.assignUser(lws, user, null, null, null, new
Timestamp(System.currentTimeMillis()));
```

Example 6-6 How to Switch an Application User in a Session in Java

```
Session lws = null;
Vector<String> listOfNamespaces;
static String user = "lwuser";
List<String> nslist1 = new ArrayList<String>();
...
manager.assignUser(lws, user, nslist1, nslist2, nslist3, new
Timestamp(System.currentTimeMillis()));
...
lws.switchUser("lwuser1",listOfNamespaces);
```

Enabling Real Application Security Application Roles

A Real Application Security application role is a role that can be granted only to a Real Application Security application user or to another Real Application Security application role. Real Application Security application roles are granted database privileges through database roles. The database privileges are granted to a database role, which in turn is granted to a Real Application Security application role. For more information about Real Application Security application users and application roles, refer to "Principals: Users and Roles".

This section describes the following operation associated with application roles:

- Enabling a Real Application Security Application Role
- Disabling a Real Application Security Application Role
- Checking If a Real Application Security Application Role Is Enabled

Enabling a Real Application Security Application Role

To enable a Real Application Security application role granted to the current application user for the session, use the `enableRole` method of the `Session` interface (see Example 6-7).

The `enableRole` method (in bold typeface) has no effect if the particular application role is currently disabled. This operation requires a database round-trip.

Example 6-7 How to Enable a Real Application Security Application Role in Java

```
static Session lws;
static Roles r1;
...
r1=new Role("HROLE1",null,0);
lws.enableRole(r1);
```

Disabling a Real Application Security Application Role

To disable a Real Application Security application role granted to the current user for the session, use the `disableRole` method of the `Session` interface (see Example 6-8). This operation requires a database round-trip. The `disableRole` method is in bold typeface.

Example 6-8 How to Disable a Real Application Security Application Role in Java

```
static Session lws;
static Roles r1;
...
r1=new Role("HROLE1",null,0);
lws.enableRole(r1);
...
lws.disableRole(r1);
```

Checking If a Real Application Security Application Role Is Enabled

To test if the specified application role is enabled in the Real Application Security application session, use the `isRoleEnabled` method of the `Session` interface (see Example 6-9). The `isRoleEnabled` method is in bold typeface.

This method does not have an associated database operation. You must have the `administerSession` Real Application Security application privilege to call this method.

Example 6-9 How to Test If a Real Application Security Application Role Is Enabled in Java

```
static Session lws;
...
lws.enableRole("HROLE1");
...
boolean b = lws.isRoleEnabled("HROLE1");
```

About Performing Namespace Operations as Session User

A namespace is a group of additional attributes of the session context. An application uses a namespace to store application defined attribute-value pairs. The current session user should have `MODIFY_NAMESPACE` (for namespace) and `MODIFY_ATTRIBUTE` (for attribute) application privileges. For more information about namespaces, refer to "About Using Namespace Templates to Create Namespaces".

This section describes how to perform the following activities:

- Creating Namespaces
- Deleting Namespaces
- Implicitly Creating Namespaces
- About Using Namespace Attributes

Creating Namespaces

To create a namespace in Java, use the `createNamespace` method of the `Session` interface (see Example 6-10). The `createNamespace` method (in bold typeface) creates a new session namespace using the namespace template document, whose name matches with the specified name. If an event handler is specified in the template document, then the specified event handler applies to all the namespaces created using that template.

> **Note:**
>
> You can also create a namespace by passing a namespace name as a parameter with the `createSession` and `attachSession` methods discussed in the previous sections.

Example 6-10 How to Create a Namespace in Java

```
Session lws = null;
...
SessionNamespace ns = lws.createNamespace("TESTNS1");
```

Deleting Namespaces

To delete a namespace in Java, use the `deleteNamespace` method of the `Session` interface (see Example 6-11). The `deleteNamespace` method (in bold typeface) removes a namespace from a session.

Example 6-11 How to Delete a Namespace in Java

```
Session lws = null;
...
SessionNamespace ns = lws.createNamespace("TESTNS1");
...
lws.deleteNamespace("TESTNS1");
```

Implicitly Creating Namespaces

To implicitly create the namespace object to represents the session namespace, use the `getNamespace` method of the `Session` interface (see Example 6-12). The `getNamespace` method is in bold typeface. If the namespace specified already exists, an error is thrown.

To retrieve a String representation of the namespace, use the `toString` method of the `SessionNamespace` interface.

Example 6-12 How to Implicitly Create the Namespace in Java

```
Session lws = null;
...
SessionNamespace ns2 = lws.getNamespace("TESTNS1");
```

About Using Namespace Attributes

A session namespace manages the attributes that a single application module stores for the duration of the session. The session namespace stores the attributes in a single namespace, a single set of access control restrictions, or a single event handler procedure that dispatches the attribute change events for that namespace.

This section describes how to perform the following activities:

- Creating a Session Namespace Attribute
- About Setting a Session Namespace Attribute
- Getting a Session Namespace Attribute

- Listing Attributes
- Resetting Attributes
- Deleting Attributes

Creating a Session Namespace Attribute

To create a session namespace attribute in Java, use the `createAttribute` method of the `SessionNamespace` interface (see Example 6-13). The `createAttribute` method (in bold typeface) creates a new attribute in the namespace.

Example 6-13 How to Create a Session Namespace Attribute in Java

```
String name1="empid';
String value1="JB007";
SessionNamespace ns;
...
SessionNamespaceAttribute sa1=ns.createAttribute(name1,value1);
...
```

About Setting a Session Namespace Attribute

To set a session namespace attribute in Java, use the `setAttribute` method of the `SessionNamespace` interface.

Getting a Session Namespace Attribute

To retrieve a session namespace attribute in Java, use the `getAttribute` method of the `SessionNamespace` interface (see Example 6-14). The `getAttribute` method (in bold typeface) returns the attribute whose name is specified as the parameter.

Example 6-14 How to Retrieve a Session Namespace Attribute in Java

```
String name="empid';
String value="JB007";
SessionNamespace ns;
...
SessionNamespaceAttribute sa=ns.createAttribute(name,value);
...
String attrvalue =  ns.getAttribute("empid").getValue();
ns.getAttribute("empid").setValue("newValue");
...
```

Listing Attributes

To list the attributes in the namespace, use the `listAttributes` method of the `SessionNamespace` interface (see Example 6-15). The `listAttributes` method (in bold typeface) returns a collection of the attribute names in the namespace

Example 6-15 How to List Attributes in Java

```
String name1="empid';
String value1="JB007";
SessionNamespace ns;
...
SessionNamespaceAttribute sa1=ns.createAttribute(name1,value1);
...
for (Enumeration e = ns.listAttributes() ; e.hasMoreElements() ;) {
 System.out.println("   -- " + e.nextElement());
```

```
}
...
```

Resetting Attributes

To reset an attribute in Java, use the `resetAttribute` method of the `SessionNamespace` interface (see Example 6-16). The `resetAttribute` method (in bold typeface) resets the attribute in the namespace to its default value.

Example 6-16 How to Reset an Attribute in Java

```
String name1="empid';
String value1="JB007";
SessionNamespace ns;
...
SessionNamespaceAttribute sa1=ns.createAttribute(name1,value1);
...
ns.resetAttribute("empid");
...
```

Deleting Attributes

To delete an attribute in Java, use the `deleteAttribute` method of the `SessionNamespace` interface (see Example 6-17). The `deleteAttribute` method (in bold typeface) deletes the particular attribute in the namespace.

Example 6-17 How to Delete an Attribute in Java

```
String name1="empid';
String value1="JB007";
SessionNamespace ns;
...
SessionNamespaceAttribute sa1=ns.createAttribute(name1,value1);
...
ns.deleteAttribute("empid");
...
```

About Performing Namespace Operations as Session Manager

Each namespace has an associated ACL to determine who can manipulate the namespace and its attributes. If an application does not want the current session user to manipulate the namespace, but allows a session manager to do it, this can be done as session manager `XSSessionManager`.

`XSSessionManager` has a set of overloaded methods as Session, to manage the namespace. The usage is similar to that described for session user in "About Performing Namespace Operations as Session User".

Note that the session manager instance `XSSessionManager` may not be available to the application code; only the trusted infrastructure layer can use the session manager to manipulate such a secured namespace.

About Performing Miscellaneous Session-Related Activities

This section describes the following topics:

- About Getting the Oracle Connection Associated with the Session
- About Getting the Application User ID for the Session

- Getting the Session ID for the Session
- About Getting a String Representation of the Session
- Getting the Session Cookie
- Setting Session Inactivity Timeout as Session Manager
- Setting the Session Cookie as Session Manager

About Getting the Oracle Connection Associated with the Session

To get the Oracle connection associated with the session, if it is currently bound to one, use the `getConnection` method of the `Session` interface.

About Getting the Application User ID for the Session

To get the application user identifier (ID) for a particular session, use the `getUserId` method of the `Session` interface.

To check if the application user for the session is anonymous, use the `isAnonymous` method of the `Session` interface.

Getting the Session ID for the Session

To get the session identifier (ID) for a particular session, use the `getId` method of the `Session` interface (see Example 6-18). The `getId` method is in bold typeface.

Example 6-18 How to Get the Session ID for the Session in Java

```
Session lws=null;
...
System.out.println( "The Session ID is" +  lws.getId());
```

About Getting a String Representation of the Session

To get a String representation of the session, use the `toString` method of the `Session` interface.

Getting the Session Cookie

To get the secure session cookie used for the session, use the `getSessionCookie` method of the `Session` interface (see Example 6-19). The `getSessionCookie` method is in bold typeface.

Example 6-19 How to Get the Secure Session Cookie in Java

```
static Session lws;
...
System.out.println(lws.getSessionCookie());
```

Setting Session Inactivity Timeout as Session Manager

To set the timeout on the session, use the `setInactivityTimeout` method of the `SessionManager` interface. This method sets the session timeout in minutes.

The `setInactivityTimeout` method overrides the normal session timeout configuration. The method is:

```
sessionManager.setInactivityTimeout(Session session, int minutes);
```

Setting the Session Cookie as Session Manager

To set the secure session cookie used for the session, use the `setCookie` method of the `SessionManager` interface (see Example 6-20). The `setCookie` method (in bold typeface) returns the secure session cookie used for this session. The method is:

```
sessionManager.setCookie(lws,"newCookieValue");
```

Example 6-20 How to Set the Secure Session Cookie in Java

```
static XSSessionManager manager;
...
manager.sessionManager.setCookie(lws,"chocolate chip");
```

Detaching an Application Session

To detach a Real Application Security application session in Java, use the `detachSession` method of the `XSSessionManager` class (see Example 6-21). The `detachSession` method (in bold typeface) detaches the session whose object it accepts as a parameter. The `detachSession` method call commits all changes in the request at the database level. A database round-trip is required to perform this operation.

Example 6-21 How to Detach a Real Application Security Session in Java

```
Session lws = null;
static XSSessionManager manager;
static Connection lwsConn = null;
static String user = "lwuser";
String cookie;
...
lws = manager.createSession(lwsConn, user, cookie, null);
manager.attachSession(lwsConn, lws, null, null, null, new
Timestamp(System.currentTimeMillis()));
...
manager.detachSession(lws);
...
```

Destroying A Real Application Security Application Session

To destroy a Real Application Security application session in Java, use the `destroySession` method of the `XSSessionManager` class (see Example 6-22). The `destroySession` method (in bold typeface) accepts the database connection object and a session object as parameters. After you call this method, the destroyed session can no longer be accessed from any JVM. A database round-trip is required to perform this operation and for create session as well.

Example 6-22 How to Destroy a Real Application Security Session in Java

```
Session lws = null;
static Connection lwsConn = null;
static XSSessionManager manager;
static String user = "lwuser";
String cookie;
...
lws = manager.createSession(lwsConn, user, cookie, null);
```

```
manager.attachSession(lwsConn, lws, null, null, null, new
Timestamp(System.currentTimeMillis()));
...
manager.detachSession(lws);
manager.destroySession(lwsConn, lws);
...
```

Authenticating Application Users Using Java APIs

Authenticating application users is a main security function needed by applications. The `XSAuthenticationModule` class is used for authenticating application users. The `authenticate` method of the `XSAuthenticationModule` class is used to verify the application user credentials (see Example 6-23). The `authenticate` method is in bold typeface.

Example 6-23 How to Authenticate Application Users in Java

```
boolean authOk = false;
String dbUser;
String passwd;
String host;
String port;
String sid;
...
authOk = XSAuthenticationModule.authenticate(host + ":" + port + ":" + sid, dbUser,
passwd);
...
```

About Authorizing Application Users Using ACLs

Authorization is another main security feature needed by applications. In Real Application Security, the authorization policy comprises of the Access Control Lists (ACLs) and the application privileges. They are defined in the Real Application Security database and managed in a cache in the middle tier. The application privileges are data privileges. Data privileges are used to define the access of a function or operation to data. Once a function attaches a connection to the session, any query passed through the connection is automatically enforced by the database server.

The `AclId` class provides various methods to perform the following:

- Constructing an ACL Identifier
- Using the checkAcl Method
- About Getting Data Privileges Associated with a Specific ACL

Constructing an ACL Identifier

To construct an Access Control List (ACL) identifier, use one of the overloaded parameterized constructors of the `AclId` class (see Example 6-24). If you want to construct an ACL identifier from raw binary data, then use the following constructor:

```
public AclId(byte[] raw)
```

When you invoke this constructor, an ACL identifier, using raw binary returned from the `ora_get_aclids` operator of a query, is created.

If you want to construct an ACL identifier from internal ACL identifiers, then use the following constructor:

```
public AclId(java.util.List<java.lang.Long> ids)
```

When you invoke this constructor, it creates an ACL identifier using internal ACL identifiers.

Example 6-24 How to Construct an ACL Identifier

```
Session lws = null;
static byte[] aclRaw;
...
AclId id = new AclId(aclRaw);
boolean ret = lws.checkAcl(aclRaw, "UPDATE_INFO");
...
```

Using the checkAcl Method

To check one or more ACLs for specified data privileges, use the `checkAcl` method of the `XSAccessController` class. The data privileges are checked against one or more ACLs defined in the `AclId` object. The `checkAcl` method returns `true` only when all the data privileges are granted in the ACLs. It is important to note that all privileges need not be granted in a single ACL. A session is needed for using the `checkAcl` method as Example 6-25 indicates.

Example 6-25 demonstrates how to get the ACL associated with data privilege `privileges22`.

Example 6-25 How to get an ACL for a Specified Data Privilege

```
boolean ret;
Session lws = null;
AclId id2 = new AclId(ids);
List <String> privileges22 = new ArrayList<String>();
...
ret = XSAccessController.checkAcl(lws, id2, privileges22);
```

About Getting Data Privileges Associated with a Specific ACL

To get a collection of data privileges that are granted in the given ACL, for the given session, use the `getPrivileges` method of the `Session` class.

> **Note:**
>
> You use the `checkAcl` method for data security and the `checkPrivilege` method for function security.

Human Resources Administration Use Case: Implementation in Java

This section describes how to verify data security related application privileges at the middle tier. This Java example is based on the Security Human Resources (HR)

scenario described in "Real Application Security: Putting It All Together". It uses the EMPLOYEES table in the sample HR schema. The example uses two Real Application Security application users DAUSTIN and SMAVRIS to illustrate Real Application Security concepts. The example can be divided into the following modules:

- Setting Up the Mid-Tier Related Configuration
- Setting up the Connection and Initializing the Middle Tier
- Setting up the Session and Authorizing with Middle-Tier API
- Running a Query on the Database
- Performing Cleanup Operations
- The main Method

Setting Up the Mid-Tier Related Configuration

To set up the mid-tier configuration involves creating a DISPATCHER user and password and granting this user the xscacfeadmin and xsessionadmin Real Application Security administrator privileges.

```
exec xs_principal.create_user(name=>'dispatcher', schema=>'HR');
exec sys.xs_principal.set_password('dispatcher', 'password');

exec xs_principal.grant_roles('dispatcher', 'xscacheadmin');
exec xs_principal.grant_roles('dispatcher', 'xssessionadmin');
```

Setting up the Connection and Initializing the Middle Tier

This example uses the setupConnection method to create the connection to the database. The setupConnection method accepts a String array as argument, where:

args[0]=Database user

args[1]=Password

args[2]=Host

This method also initializes the middle tier by calling the getSessionManager method of the oracle.security.xs.XSSecurityManager class.

```
  public static void setupConnection(String[] args) throws Exception {
    mgrConnection =
        DriverManager.getConnection(args[2], "dispatcher", "password");

    mgr = XSSessionManager.getSessionManager(mgrConnection, 30, 2048000);

    appConnection = DriverManager.getConnection(args[2], args[0], args[1]);
  }
```

Setting up the Session and Authorizing with Middle-Tier API

This example uses queryAsUser method to set up the session and authorize with the middle-tier checkAcl method. This example creates a session and attaches the session, and then calls the queryEmployees method. The queryEmployees method in "Running a Query on the Database" checks the ACL for the UPDATE privilege, and if TRUE, it allows the update; it checks the ACL again for the VIEW_SALARY application privilege, and if TRUE, it allows access to the SALARY column and displays all the employees records including the sensitive data in the SALARY column. Then after displaying the employees records, it detaches the session, and destroys the session.

```
  private static void queryAsUser(String user) throws SQLException {

    System.out.println("\nQuery HR.EMPLOYEES table as user \"" + user + "\"");

    try {
      Session lws = mgr.createSession(appConnection, user, null,null);
      mgr.attachSession(appConnection, lws, null, null, null, null, null);

      queryEmployees(lws);

      mgr.detachSession(lws);
      mgr.destroySession(appConnection, lws);
    } catch (Exception e) {
      e.printStackTrace();
    }
  }
```

Running a Query on the Database

This example uses the `queryEmployees` method to run a query on the HR database.

```
  public static void queryEmployees(Session lws) throws SQLException {

    Connection conn = lws.getConnection();
    String query =
      " select email, first_name, last_name, department_id, salary,
ora_get_aclids(emp) from hr.employees emp where department_id in (40, 60, 100) order
by email";

    Statement stmt = null;
    ResultSet rs = null;

    System.out.printf("  EMAIL   | FIRST_NAME | LAST_NAME   | DEPT | SALARY | UPDATE |
VIEW_SALARY\n");

    try {

      stmt = conn.createStatement();
      rs = stmt.executeQuery(query);

      while (rs.next()) {

        String email = rs.getString("EMAIL");
        String first_name = rs.getString("FIRST_NAME");
        String last_name = rs.getString("LAST_NAME");
        String department_id = rs.getString("DEPARTMENT_ID");
        String salary;

        if (((OracleResultSet)rs).getAuthorizationIndicator("SALARY") ==
AuthorizationIndicator.NONE) {
          salary = rs.getString("SALARY");
        }
        else {
          salary = "*****";
        }

        byte[] aclRaw = rs.getBytes(6);
        String update, viewSalary;
        if (XSAccessController.checkAcl(lws, aclRaw, "UPDATE")) {
          update = "true";
        }
```

```
        else {
          update = "false";
        }

        if (XSAccessController.checkAcl(lws, aclRaw, "VIEW_SALARY")) {
          viewSalary = "true";
        }
        else {
          viewSalary = "false";
        }

        System.out.printf("%9s|%12s|%12s|%6s|%8s|%8s|%8s\n", email,
                          first_name, last_name, department_id,
                          salary, update, viewSalary);
       }
    } catch (Exception e) {
      e.printStackTrace();
    } finally {
      try { if (rs != null) rs.close(); } catch (Exception e) {};
      try { if (stmt != null) stmt.close(); } catch (Exception e) {};
    }
  }
}
```

The `queryEmployees` method is run for both application users `DAUSTIN` and `SMAVRIS`.

Performing Cleanup Operations

This examples uses the `cleanup` method for system cleanup operations.

```
  public static void cleanupConnection() throws Exception {
    mgrConnection.close();
    appConnection.close();

  }
```

The main Method

This section contains the `main` method for the Java example discussed. This section also contains the different packages that you must import to run the program.

```
import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.ResultSet;
import java.sql.SQLException;
import java.sql.Statement;


import java.util.ArrayList;
import java.util.List;
import oracle.jdbc.OracleDriver;
import oracle.jdbc.OracleResultSet;
import oracle.jdbc.OracleResultSet.AuthorizationIndicator;

import oracle.security.xs.Role;
import oracle.security.xs.Session;
import oracle.security.xs.XSAccessController;
import oracle.security.xs.XSSessionManager;

/**
 * HR demo java version, check data security related privilege at mid-tier
```

```
 */
public class HRDemo {

  static Connection mgrConnection = null;
  static Connection appConnection = null;
  static XSSessionManager mgr = null;
  static String user = null;

  public static void main(String[] args)  {

    try {
      DriverManager.registerDriver(new OracleDriver());


      if (args.length >=3) {
        user = args[0];
      } else {
        System.out.println("Usage HRDemo user pwd dbURL");
        System.exit(1);
      }

      setupConnection(args);

      queryAsUser("DAUSTIN");
      queryAsUser("SMAVRIS");

      cleanupConnection();

    } catch (Exception e1) {
      e1.printStackTrace();
    }
  }
```

1. Running the Security HR demo in Java assumes that the set up script described in "Setting Up the Security HR Demo Components" has been run to set up the Real Application Security components.
2. Compile the Java code.

```
$ORACLE_HOME/jdk6/bin/javac -classpath $ORACLE_HOME/rdbms_ho/jlib/
xs.jar:$ORACLE_HOME/dbjava/lib/ojdbc6.jar HRdemo.java
```

> **Note:**
>
> You must use JDK 6 with `xs.jar` and `ojdbc6.jar`, which are located in the Oracle home directory. Different jars and JDK may not work.

3. Run the Java code.

```
$ORACLE_HOME/jdk6/bin/java -classpath $ORACLE_HOME/rdbms_ho/jlib/
xs.jar:$ORACLE_HOME/dbjava/lib/ojdbc6.jar

HRdemo db_hr db_hr jdbc:oracle:thin:@myserver:myport:mysid
```

Output

Running the Security HR demo in Java assumes that the set up script described in "Setting Up the Security HR Demo Components" has been run to set up the Real Application Security components. When you run the Security HR demo, results of two queries are returned.

The first query runs with application user DAUSTIN, who has application roles EMP_ROLE and IT_ROLE, so he can view employee records in the IT department, but he cannot view the SALARY column except for his own salary record. The results of the query are as follows:

```
Query HR.EMPLOYEES table as user "DAUSTIN"
  EMAIL   | FIRST_NAME | LAST_NAME   | DEPT | SALARY | UPDATE | VIEW_SALARY
  AHUNOLD|   Alexander|      Hunold|    60|   *****|   false|   false
   BERNST|       Bruce|       Ernst|    60|   *****|   false|   false
  DAUSTIN|       David|      Austin|    60|    4800|   false|    true
 DLORENTZ|       Diana|     Lorentz|    60|   *****|   false|   false
 VPATABAL|       Valli|   Pataballa|    60|   *****|   false|   false
```

Note that application user DAUSTIN can only view the SALARY column data for his own record, and no others.

The second query runs with application user SMAVRIS, who has application roles EMP_ROLE and HR_ROLE, so she can view and update all the employee records. The results of the query are as follows:

```
Query HR.EMPLOYEES table as user "SMAVRIS"
  EMAIL   | FIRST_NAME | LAST_NAME   | DEPT | SALARY | UPDATE | VIEW_SALARY
  AHUNOLD|   Alexander|      Hunold|    60|    9000|    true|    true
   BERNST|       Bruce|       Ernst|    60|    6000|    true|    true
  DAUSTIN|       David|      Austin|    60|    4800|    true|    true
  DFAVIET|      Daniel|      Faviet|   100|    9000|    true|    true
 DLORENTZ|       Diana|     Lorentz|    60|    4200|    true|    true
 ISCIARRA|      Ismael|     Sciarra|   100|    7700|    true|    true
    JCHEN|        John|        Chen|   100|    8200|    true|    true
  JMURMAN| Jose Manuel|       Urman|   100|    7800|    true|    true
    LPOPP|        Luis|        Popp|   100|    6900|    true|    true
 NGREENBE|       Nancy|   Greenberg|   100|   12008|    true|    true
  SMAVRIS|       Susan|      Mavris|    40|    6500|    true|    true
 VPATABAL|       Valli|   Pataballa|    60|    4800|    true|    true
```

Note that application user SMAVRIS can view all the employee records, including all data in the SALARY column.

7

Oracle Fusion Middleware Integration with Real Application Security

Real Application Security adds external user and role support for application integration, that can be used, for example, with Oracle Fusion Middleware. For Oracle Fusion Middleware, the users and roles are also externalized to a common, single repository with centralized management and single authentication of the user interface using the Authorization Policy Manager. From a Real Application Security perspective, the integrated users and roles (including application roles) are externalized principals because Oracle Fusion Middleware manages them externally. The mid-tier initialization and authorization operations are the same as those described in Using Real Application Security in Java Applications .

This chapter describes the following topics:

- About External Users and External Roles
- Session APIs for External Users and Roles

About External Users and External Roles

An external user is an end-user accessing a service. User information is stored in the identity store, typically instantiated by the WebLogic Authenticator. This user is neither a database user nor a Real Application Security application user. An external user does not have any footprint in the database. But, an external user needs to access the database for application data. Therefore, a Real Application Security context (session) is established for such a user to control the user's access to the required data.

An anonymous user is an unauthenticated user, or a user whose credentials have not been validated. An anonymous user is permitted to access only unprotected resources such as public data from a database. An application can enable or disable the use of anonymous users.

An external role or group is a collection of users and other groups, which can be hierarchical. For example, a group can include arbitrarily nested groups.

An external application role is a collection of users, groups, and application roles, which can be hierarchical. This role is specific to the application, defined by the application policy, and may not be known to the J2EE container. Application roles are scoped because they are visible only when the application runs. They can be mapped to other application roles defined in the same application scope and also to enterprise users or groups. Application roles are used in authorization decisions.

Similar to external users, external roles and application roles have no footprint in the Real Application Security system. They are used to control the way the Real Application Security ACLs grant data access to an application.

External roles and application roles also enforce the details of data access. External users need some basic database privileges, typically the object privilege to run SELECT on an application table. These privileges can be granted through a Real Application Security dynamic application role, which is enabled when a user session is

attached. For example, to grant privileges to an external user or role, specify the principal type as `XS_ACL.PTYPE_EXTERNAL` in an ACE list when creating an ACL. See the "CREATE_ACL Procedure" for more information.

Session Modes for External Users

Real Application Security supports the following two modes of operation for sessions:

- Secure Mode

  In secure mode, data security is enforced at the database server. By default, a session is created in a secure mode for all users.

- Trusted mode

  A trusted mode is a mode in which data security is enforced at the middle tier and not at the database server. In such a mode, the data security implemented by Real Application Security is bypassed. So, creating a session in trusted mode is a privileged operation.

  Trusted mode is allowed only for external users, and only when the dispatcher has `CREATE_TRUSTED_SESSION` privilege. This privilege can be granted to the dispatcher user as follows:

```
XS_ADMIN_UTIL.grant_system_privilege('CREATE_TRUSTED_SESSION','dispatcher',
XS_ADMIN_UTIL.PTYPE_XS);
```

Session APIs for External Users and Roles

This section describes the following topics for external users and roles:

- Namespace for External Users
- Creating a Session
- Attaching a Session
- Assigning a User to a Session
- Saving a Session and Aborting a Session

Namespace for External Users

The namespaces for external users are enhanced with attribute manipulation features during creating, attaching, and assigning a session. External users are able to perform the following activities:

- Creating namespace with attributes while creating a session
- Setting namespace attributes while attaching a session and assigning a user
- Saving a session and leaving it as attached

Creating a Session

To create a Real Application Security application session, use the `createSession` method of the `XSSessionManager` class.

For external users, this method creates a Session object on the server as well as its corresponding middle-tier representation with namespaces and attributes. This method also creates the Namespaces and sets corresponding attributes given in the

Namespace/AttributeValue. The cookie can be used to identify the newly created Real Application Security application session in future calls, until the cookie value is changed or the session is destroyed.

Syntax

```
public abstract Session createSession(java.sql.Connection conn,
                                      ExternalUser eUser,
                                      java.lang.String cookie,
                                      java.util.Collection<NamespaceValue> nav)
                                      throws InvalidXSUserException,
                                             AccessDeniedException,
                                             java.sql.SQLException,
                                             XSSessionException,
                                             InvalidXSNamespaceException


public abstract Session createSessionTrusted(java.sql.Connection conn,
                                ExternalUser externalUser,
                                java.lang.String cookie,
                                java.util.Collection<NamespaceValue> nameSpaceValues)
                                throws InvalidXSUserException,
                                AccessDeniedException,
                                java.sql.SQLException,
                                SQLException,
                                XSException,
                                InvalidXSNamespaceException
```

Parameter

Parameter	Description
`conn`	The JDBC connection for database server roundtrip
`eUser` or `externalUser`	The external user associated with the session
`cookie`	The session cookie used to identify the external user
`nav` or `nameSpaceValues`	A list of namespaces with corresponding attributes to be created for the namespaces

Example

Example 7-1 demonstrates how to create a Real Application Security session for external users. The `createSession` method is in bold typeface.

Example 7-1 Creating a Real Application Security Session for External Users

```
.
.
.
static Connection lws_conn =null;
static XSSessionManager sm = null;
lws_conn = DriverManager.getConnection(lws_conn_string, username, password);
sm = XSSessionManager.getSessionManager(privConn,20,29999999);
.
.
.
String trituser = "TUSER01";
String cookie = "some_cookie";
```

```
String extuser = "ExtPrincp";
String extuuid = "ExtPrincp";

Session lws = null;

List<AttributeValue> nsavList = new ArrayList<AttributeValue>();
AttributeValue nsav1 = new AttributeValue("ATTR01","value1");
nsavList.add(nsav1);
AttributeValue nsav2 = new AttributeValue("ATTR02","value2");
nsavList.add(nsav2);
NamespaceValue nav = new NamespaceValue("NST01",nsavList);
List<NamespaceValue> nsList = new ArrayList();
nsList.add(nav);

/* create session with external user name in secure mode with namespace attr-vals
and cookie */
lws = sm.createSession(lws_conn, new ExternalUser(extuser, extuuid), cookie, nsList);
sm.destroySession(lws_conn, lws);

/*Create external user session in secure mode*/
lws = sm.createSession(lws_conn, new ExternalUser(extuser, extuuid), null, null);
sm.destroySession(lws_conn, lws);

/*Create external user session in secure mode with namespace attribute values */
lws = sm.createSession(lws_conn, new ExternalUser(extuser, extuuid), null, nsList);
sm.destroySession(lws_conn, lws);

/* create session with external user name in secure mode with cookie */
lws = sm.createSession(lws_conn, new ExternalUser(extuser, extuuid), cookie, null);
sm.destroySession(lws_conn, lws);

/* create trusted session with only external user name */
lws = sm.createSessionTrusted(lws_conn, new ExternalUser(extuser, extuuid), null,
null);
sm.destroySession(lws_conn, lws);

/* create session with RAS user name in secure mode with namespace and cookie */
lws = sm.createSession(lws_conn, trituser, cookie, nsList);
sm.destroySession(lws_conn, lws);
```

Attaching a Session

To attach an application session, use the `attachSession` method of the `XSSessionManager` class.

For external users, this method attaches the JDBC connection to the specified session object. This method also sets the dynamic application roles, external roles, authentication time, and creates namespaces for the session. It also gives a list of a namespace and its corresponding namespace attributes to be created and set. If the namespace does not exist, then this method creates the namespace, and then sets the corresponding attributes.

Syntax

```
public abstract void attachSession(
             java.sql.Connection conn,
             Session session,
             java.util.Collection<java.lang.String> enabledDynamicRoles,
             java.util.Collection<java.lang.String> disabledDynamicRoles,
             java.util.Collection<ExternalRole> externalRoles,
```

```
            java.util.Collection<NamespaceValue> nav,
            java.sql.Timestamp authenticationTime)
            throws java.sql.SQLException,
                   AccessDeniedException,
            InvalidSessionException,
            XSSessionException,
            InvalidXSNamespaceException

public abstract Session attachSessionByCookie(
          java.sql.Connection conn,
          java.lang.String cookie,
          java.util.Collection<java.lang.String> enabledDynamicRoles,
          java.util.Collection<java.lang.String> disabledDynamicRoles,
          java.util.Collection<oracle.security.xs.ExternalRole> externalRoles,
          java.util.Collection<oracle.security.xs.NamespaceValue> namespaceValues,
          java.sql.Timestamp authenticationTime)
          throws java.sql.SQLException,
                 AccessDeniedException,
                 InvalidSessionException,
                 XSException,
                 InvalidXSNamespaceException

public abstract Session attachSessionByID(
          java.sql.Connection conn,
          java.lang.String id,
          java.util.Collection<java.lang.String> enabledDynamicRoles,
          java.util.Collection<java.lang.String> disabledDynamicRoles,
          java.util.Collection<oracle.security.xs.ExternalRole> externalRoles,
          java.util.Collection<oracle.security.xs.NamespaceValue> namespaceValues,
          java.sql.Timestamp authenticationTime)
          throws java.sql.SQLException,
                 AccessDeniedException,
                 InvalidSessionException,
                 XSException,
                 InvalidXSNamespaceException
```

Parameters

Parameter	Description
`conn`	The database connection to be attached to the application session
`session`	The Session object to be attached
`cookie`	The session cookie
`id`	The session identifier
`enabledDynamicRoles`	A collection of dynamic application role names to be enabled
`disabledDynamicRoles`	A collection of dynamic application role names to be disabled
`externalRoles`	A collection of external roles to be enabled
`nav` or `namespaceValues`	A list of namespaces with corresponding attributes to be set
`authenticationTime`	The authentication time to be sent to the database server

Example

Example 7-2 demonstrates how to attach a Real Application Security session for external users. The `attachSession` method is in bold typeface.

External Role Behavior while Attaching a Session

- After an external role is enabled for a session, it is stored as part of the session context as an ID. This role ID is used in access control, when you call the `checkAcl` method on both middle tier and database server. This is same as regular Real Application Security application role or dynamic application role.
- A Real Application Security ID is assigned for every external role passed while attaching a session, whether the role is referred by ACL or not.
- The scope of the external role is within the boundary of attaching or detaching a session. An external role cannot be enabled for attaching multiple sessions, and it does not need to be explicitly disabled. So, the roles assigned for attaching the first session will not be automatically enabled while attaching the next session, unless the roles are assigned again.

  This behavior is completely different from the behavior of regular Real Application Security application roles or dynamic application roles, where the application roles assigned for attaching the first session are automatically enabled while attaching the next session.
- After a session is attached, the external role remains consistent till detaching and reattach the session. The role may even be revoked for the user.

Example 7-2 Attaching a Real Application Security Session for External Users

```
.
.
.
static Connection lws_conn =null;
static XSSessionManager sm = null;
.
.
.
lws_conn = DriverManager.getConnection(lws_conn_string, username, password);
sm = XSSessionManager.getSessionManager(privConn,20,29999999);
.
.
.
String cookie = "some_cookie";
String extuser = "ExtPrincp";
String extuuid = "ExtPrincp";

Session lws = null;
Session lws2 = null

List<AttributeValue> nsavList = new ArrayList<AttributeValue>();

AttributeValue nsav1 = new AttributeValue("ATTR01","value1");
nsavList.add(nsav1);
AttributeValue nsav2 = new AttributeValue("ATTR02","value2");
nsavList.add(nsav2);

NamespaceValue nav = new NamespaceValue("NST01",nsavList);

List<NamespaceValue> nsList = new ArrayList();
nsList.add(nav);

List <String> dynamicRoles = new ArrayList <String>();
dynamicRoles.add("DYNROLE001");
dynamicRoles.add("DYNROLE002");
```

```
List <ExternalRole> extRoles = new ArrayList <ExternalRole>();
extRoles.add(new ExternalRole("EXTPRIN01"));
extRoles.add(new ExternalRole("MYEXTPRIN02"));

lws = sm.createSession(lws_conn, new ExternalUser(extuser, extuuid), cookie +
"secure", nsList, false);
sm.attachSession(lws_conn, lws, enabledDynamicRoles, disabledDynamicRoles, extRoles,
null, null);
sm.detachSession(lws);
sm.attachSession(lws_conn, lws, enabledDynamicRoles, disabledDynamicRoles, extRoles,
null, new Timestamp(System.currentTimeMillis()));
sm.detachSession(lws);
sm.attachSession(lws_conn, lws, enabledDynamicRoles, disabledDynamicRoles, extRoles,
nsList, null);
sm.detachSession(lws);
sm.attachSession(lws_conn, lws, enabledDynamicRoles, disabledDynamicRoles, extRoles,
nsList, new Timestamp(System.currentTimeMillis()));
sm.detachSession(lws);

lws2 = sm.createSession(lws_conn, new ExternalUser(extuser, extuuid), cookie +
"trusted", nsList, true);
lws2 = sm.attachSessionByCookie(lws_conn, lws.getSessionCookie(), null,
enabledDynamicRoles, disabledDynamicRoles, extRoles, null, null);
sm.detachSession(lws2);
lws2 = sm.attachSessionByCookie(lws_conn, lws.getSessionCookie(), null,
enabledDynamicRoles, disabledDynamicRoles, extRoles, nsList, new
Timestamp(System.currentTimeMillis()));
sm.detachSession(lws2);
```

Assigning a User to a Session

To assign a name to a previously anonymous user, use the `assignUser` method of the `XSSessionManager` class.

For external users, this method assigns a named user to a previously anonymous user, sets the dynamic application roles, external role, and authentication time. If a list of Namespace/Attribute values is given, this method creates each namespace that does not exist, and sets the corresponding attributes.

Syntax

```
public abstract void assignUser(
                     Session session,
                     ExternalUser targetUser,
                     java.util.Collection<java.lang.String> enabledDynamicRoles,
                     java.util.Collection<java.lang.String> disabledDynamicRoles,
                     java.util.Collection<ExternalRole> externalRoles,
                     java.util.Collection<NamespaceValue> naValues,
                     java.sql.Timestamp authenticationTime)
                     throws java.sql.SQLException,
                            AccessDeniedException,
                            InvalidSessionException,
                            XSSessionException,
                            InvalidXSNamespaceException
```

Parameters

Parameters	Description
`session`	The session object to assign the user to
`targetUser`	An `ExternalUser` object initialized based on authentication
`enabledDynamicRoles`	A list of dynamic application role names to be enabled
`disabledDynamicRoles`	A list of dynamic application role names to be disabled
`externalRoles`	A collection of external roles to be enabled
`namespaceValues`	A list of namespaces with corresponding attributes to be set
`authenticationTime`	The a timestamp indicated when the user authenticated

Example

Example 7-3 demonstrates how to assign a Real Application Security session to external users. The `assignUser` method is in bold typeface.

Example 7-3 How to Assign a Real Application Security Session to External Users

```
.
.
.
static Connection lws_conn =null;
static XSSessionManager sm = null;
.
.
.
lws_conn = DriverManager.getConnection(lws_conn_string, username, password);
sm = XSSessionManager.getSessionManager(privConn,20,29999999);
.
.
.
String cookie = "some_cookie";
String extuser = "ExtPrincp";
String extuuid = "ExtPrincp";

Session lws = null;

List<AttributeValue> nsavList = new ArrayList<AttributeValue>();

AttributeValue nsav1 = new AttributeValue("ATTR01","value1");
nsavList.add(nsav1);
AttributeValue nsav2 = new AttributeValue("ATTR02","value2");
nsavList.add(nsav2);

NamespaceValue nav = new NamespaceValue("NST01",nsavList);

List<NamespaceValue> nsList = new ArrayList();
nsList.add(nav);

List <String> dynamicRoles = new ArrayList <String>();
dynamicRoles.add("DYNROLE001");
dynamicRoles.add("DYNROLE002");

List <ExternalRole> extRoles = new ArrayList <ExternalRole>();
```

```
extRoles.add(new ExternalRole("EXTPRIN01"));
extRoles.add(new ExternalRole("MYEXTPRIN02"));

lws = sm.createAnonymousSession(lws_conn, cookie + "trusted", nsList, true);
sm.attachSession(lws_conn, lws, null, null, null, null, null);
sm.assignUser(lws, euser, dynamicRoles, dynamicRoles, extRoles, null, null);
sm.detachSession(lws);

lws = sm.createAnonymousSession(lws_conn, cookie + "secure", nsList, false);
sm.attachSession(lws_conn, lws, null, null, null, null, null);
sm.assignUser(lws, euser, dynamicRoles, dynamicRoles, extRoles, null, new
Timestamp(System.currentTimeMillis()));
sm.detachSession(lws);


lws = sm.createAnonymousSession(lws_conn, cookie + "trusted", nsList, true);
sm.attachSession(lws_conn, lws, null, null, null, null, null);
sm.assignUser(lws, euser, dynamicRoles, dynamicRoles, null, nsList, null);
sm.detachSession(lws);
```

Saving a Session and Aborting a Session

To save the changes of a session at the database server and keep the session still attached, use the `saveSession` method of the `XSSessionManager` class.

For external users, this method saves the current session. Similar to the `detachSession` method, this method commits all session changes to the back end and a database roundtrip is required to perform this operation. But, unlike the `detachSession` method, this method keeps the session attached. This method is mainly used to save an application context (namespace).

To abort the changes of a session at the database server and detach from the session, use the `abortSession` method of the `XSSessionManager` class.

Syntax

```
public abstract void saveSession(Session session)
                          throws java.sql.SQLException,
                                 NotAttachedException,
                                 XSSessionException

public abstract void abortSession(Session session)
                          throws java.sql.SQLException,
                                 NotAttachedException,
                                 XSException
```

Example

Example 7-4 demonstrates how to save a Real Application Security external user session. The `saveSession` method is in bold typeface.

Example 7-4 How to Save a Real Application Security External User Session

```
.
.
.
static Connection lws_conn =null;
static XSSessionManager sm = null;
.
.
```

```
.
lws_conn = DriverManager.getConnection(lws_conn_string, username, password);
sm = XSSessionManager.getSessionManager(privConn,20,29999999);
.
.
.
String cookie = "some_cookie";
String extuser = "ExtPrincp";
String extuuid = "ExtPrincp";

Session lws = null;

List<AttributeValue> nsavList = new ArrayList<AttributeValue>();

AttributeValue nsav1 = new AttributeValue("ATTR01","value1");
nsavList.add(nsav1);
AttributeValue nsav2 = new AttributeValue("ATTR02","value2");
nsavList.add(nsav2);

NamespaceValue nav = new NamespaceValue("NST01",nsavList);

List<NamespaceValue> nsList = new ArrayList();
nsList.add(nav);

List <String> dynamicRoles = new ArrayList <String>();
dynamicRoles.add("DYNROLE001");
dynamicRoles.add("DYNROLE002");

List <ExternalRole> extRoles = new ArrayList <ExternalRole>();
extRoles.add(new ExternalRole("EXTPRIN01"));
extRoles.add(new ExternalRole("MYEXTPRIN02"));

lws = sm.createAnonymousSession(lws_conn, cookie + "trusted", nsList, true);
sm.attachSession(lws_conn, lws, null, null, null, null, null);
sm.assignUser(lws, euser, dynamicRoles, dynamicRoles, extRoles, null, null);
lws.deleteNamespace("NST01");
sm.saveSession(lws);
```

8

Application Session Service in Oracle Fusion Middleware

Real Application Security provides an application session service in Oracle Fusion Middleware to set up an application session transparently and securely that supports existing application users, roles, and security context. This application session service is a servlet filter that is responsible for application session setup and a set of APIs that the application can use with the application session. This application session service supports user and roles managed externally by Oracle Fusion Middleware.

Beginning with Oracle Database 12*c* Release 1 (12.1.0.2), this application session service supports a Java EE Web application using Oracle Platform Security Service (OPSS) as the application security provider. This application session service can be deployed to the Java EE container that OPSS can support, together with the application.

This chapter describes the following topics:

- About Real Application Security Concepts
- About Application Session Service in Oracle Fusion Middleware
- About the Application Session Filter
- About Deployment
- About Application Configuration of the Application Session Filter
- Domain Configuration: Setting Up an Application Session Service to Work with OPSS and Oracle Fusion Middleware
- About Application Session APIs
- Human Resources Demo Use Case: Implementation in Java

About Real Application Security Concepts

As an Oracle Database authorization system, Real Application Security supports application security by enforcing who (application user) can do what application-level operations (ApprovePurchaseOrder, ViewSSN) on which database resource (purchase order records of employees under my report, my SSN). An application session is used to enforce application security. Typically, the users and roles are provisioned externally, that is, enterprise users are provisioned in an identity store and application roles are managed in a policy store, such as, Oracle Identity Management and Oracle Entitlement Server (OES).

Application Users and Roles Managed Externally

Real Application Security supports users and roles that are provisioned by an external party, such as Oracle Entitlement Server for managing application users and roles provisioning, while OPSS provides a runtime security framework for enforcing security for application roles. Theses are referred to as external application users and

application roles (see Oracle Fusion Middleware Integration with Real Application Security for more information.)

Real Application Security also has users and roles for the application natively managed in the database, and these are referred to as Real Application Security application users and application roles (see Configuring Application Users and Application Roles for more information).

For external application users and application roles, Real Application Security does not manage user provisioning including users' role assignment. However, for native application users and application roles in the database, grants of application roles to application users, database roles to application roles, and application roles to application roles are managed in the database. Both Real Application Security application users and application roles, and external application users and application roles are supported in an application session, and can be used in a data security policy. An application privilege can be granted to users managed both in the identity store externally or in the database natively.

Application Session in Oracle Fusion Middleware

An application session represents an application user's runtime security context, which includes the user identity, database and application roles, and namespace attribute values. The application session here in Oracle Fusion Middleware is using externally managed user and roles. See Configuring Application Sessions for more information about configuring an application session.

Session Manager in Oracle Fusion Middleware

In Real Application Security, the session manager authorizes the application session operation and has the necessary privileges to create or modify the application session. The application code or application database connection should *not* have these privileges. To the database, the session manager is a Real Application Security direct logon user (see "About Creating a Direct Login Application User Account"). It communicates with the database at the beginning of application session service initialization to build a trust relation with the database server based on authorization credentials. This mechanism is used subsequently to further authorize the application session operations on behalf of the application.

Dynamic Roles in Oracle Fusion Middleware

Other than the application roles, an application session supports a dynamic role. This is a type of Real Application Security role that must be defined natively in the database (see "Dynamic Application Roles"). This role is not granted to the user or other roles. It must be enabled programmatically in the application session at run time. This can be done by the Real Application Security filter automatically or by the trusted application code explicitly.

The dynamic role can be defined as request scope or session scope. Session scope means the enabled dynamic role is still enabled in the next attach, unless you explicitly specify that it is disabled in the next attach. Request scope means that the role is disabled after the application session is detached from the connection.

Dynamic role serves two general purposes:

- Object privilege

  An application user is not a database user. These object privileges can be granted to a Real Application Security dynamic role when application users and roles are

provisioned in external identity stores. When the Real Application Security filter sets up the application session for the application user, it enables the dynamic role in every application session accessing the current application. The dynamic role is specific to the current application only.

- Application Session privilege elevation

  Certain trusted application code must temporarily have higher privileges in order to do some database operations. This is supported by enabling a Real Application Security dynamic role during application session attach from the trusted code declared using a Java code based policy. The role should be disabled upon detach.

  One use case is application namespace setup where session namespace attributes are secured in Real Application Security in a fine grained manner. The namespace must be predefined at the database as a namespace template. Upon definition, in the associated ACL of the namespace authorization policy can be specified, that is, who (user/role) can do what (modify_namespace, modify_attribute) on the namespace. To ensure that only trusted application code can modify the namespace attributes, the privileges are granted to a dynamic role. Also, the dynamic role can only be programmatically enabled by certain trusted application code identified by Java code permission. This supports the use case that only the trusted code can set up certain namespaces.

About Application Session Service in Oracle Fusion Middleware

Figure 8-1 shows application session service as it is implemented in Oracle Fusion Middleware.

Column	Datatype	NULL	Description
TABLE_NAME	VARCHAR2(128)	NOT NULL	Name of table
ACL_MVIEW_NAME	VARCHAR2(128)	NOT NULL	Name of ACL MV for this table
REFRESH_MODE	VARCHAR2(9)		ON COMMIT, SCHEDULED, or ON DEMAND
REFRESH_ABILITY	VARCHAR2(11)		COMPLETE or INCREMENTAL
ACL_STATUS	VARCHAR2(5)		STALE or FRESH
USER_SUPPLIED_MV	VARCHAR2(1)		Y or N
START_DATE	TIMESTAMP(6) WITH TIME ZONE		The refreshment job scheduled to run after the timestamp, if scheduled
REPEAT_INTERVAL	VARCHAR2(4000)		The repeat_interval to run the refreshment job, if scheduled
REFRESH_COUNT	NUMBER		Number of times this ACL MV has been refreshed so far
COMMENTS	VARCHAR2(240)		Comments for the refreshment

ALL_XDS_ACL_REFSTAT

The ALL_XDS_ACL_REFSTAT data dictionary view displays all static ACL refresh job status history that has been done for tables that are accessible to the application user.

Related Views

- DBA_XDS_ACL_REFSTAT
- USER_XDS_ACL_REFSTAT

Column	Datatype	NULL	Description
SCHEMA_NAME	VARCHAR2(128)	NOT NULL	Name of schema
TABLE_NAME	VARCHAR2(128)	NOT NULL	Name of table
REFRESH_MODE	VARCHAR2(9)		ON COMMIT, SCHEDULED, or ON DEMAND
REFRESH_ABILITY	VARCHAR2(11)		COMPLETE or INCREMENTAL
JOB_START_TIME	TIMESTAMP(6) WITH TIME ZONE		The refreshment job starting time
JOB_END_TIME	TIMESTAMP(6) WITH TIME ZONE		The refreshment job ending time
ROW_UPDATE_COUNT	NUMBER		Number of rows have been updated for static ACL sync

Column	Datatype	NULL	Description
STATUS	NUMBER		Refreshment job status: 0 means success, otherwise an error number is displayed.
ERROR_MESSAGE	VARCHAR2(4000)		The error message for the error, if there is any.

ALL_XDS_LATEST_ACL_REFSTAT

The ALL_XDS_LATEST_ACL_REFSTAT data dictionary view displays all latest static ACL refresh job status history that has been done for tables that are accessible to the application user. It has the same schema as ALL_XDS_ACL_REFSTAT dictionary view, but a subset of its rows.

Related Views

- DBA_XDS_LATEST_ACL_REFSTAT
- USER_XDS_LATEST_ACL_REFSTAT
- ALL_XDS_ACL_REFSTAT

Column	Datatype	NULL	Description
SCHEMA_NAME	VARCHAR2(128)	NOT NULL	Name of schema
TABLE_NAME	VARCHAR2(128)	NOT NULL	Name of table
REFRESH_MODE	VARCHAR2(9)		ON COMMIT, SCHEDULED, or ON DEMAND
REFRESH_ABILITY	VARCHAR2(11)		COMPLETE or INCREMENTAL
JOB_START_TIME	TIMESTAMP(6) WITH TIME ZONE		The refreshment job starting time
JOB_END_TIME	TIMESTAMP(6) WITH TIME ZONE		The refreshment job ending time
ROW_UPDATE_COUNT	NUMBER		Number of rows have been updated for static ACL sync
STATUS	NUMBER		Refreshment job status: 0 means success, otherwise an error number is displayed.
ERROR_MESSAGE	VARCHAR2(4000)		The error message for the error, if there is any.

DBA_XDS_ACL_REFRESH

The DBA_XDS_ACL_REFRESH data dictionary view displays all static ACL refresh settings in the database.

Related Views

- ALL_XDS_ACL_REFRESH
- USER_XDS_ACL_REFRESH

Column	Datatype	NULL	Description
SCHEMA_NAME	VARCHAR2(128)	NOT NULL	Name of schema
TABLE_NAME	VARCHAR2(128)	NOT NULL	Name of table
ACL_MVIEW_NAME	VARCHAR2(128)	NOT NULL	Name of ACL MV for this table
REFRESH_MODE	VARCHAR2(9)		ON COMMIT, SCHEDULED, or ON DEMAND
REFRESH_ABILITY	VARCHAR2(11)		COMPLETE or INCREMENTAL
ACL_STATUS	VARCHAR2(5)		STALE or FRESH
USER_SUPPLIED_MV	VARCHAR2(1)		Y or N
START_DATE	TIMESTAMP(6) WITH TIME ZONE		The refreshment job scheduled to run after the timestamp, if scheduled
REPEAT_INTERVAL	VARCHAR2(4000)		The repeat_interval to run the refreshment job, if scheduled.
REFRESH_COUNT	NUMBER		Number of refreshment has been done so far
COMMENTS	VARCHAR2(240)		Comments for the refreshment

DBA_XDS_ACL_REFSTAT

The DBA_XDS_ACL_REFSTAT data dictionary view displays all static ACL refresh job status history that has been done in the database.

Related Views

- ALL_XDS_ACL_REFSTAT
- USER_XDS_ACL_REFSTAT

Column	Datatype	NULL	Description
SCHEMA_NAME	VARCHAR2(128)	NOT NULL	Name of schema
TABLE_NAME	VARCHAR2(128)	NOT NULL	Name of table
REFRESH_MODE	VARCHAR2(9)		ON COMMIT, SCHEDULED, or ON DEMAND
REFRESH_ABILITY	VARCHAR2(11)		COMPLETE or INCREMENTAL
JOB_START_TIME	TIMESTAMP(6) WITH TIME ZONE		The refreshment job starting time

Column	Datatype	NULL	Description
JOB_END_TIME	TIMESTAMP(6) WITH TIME ZONE		The refreshment job ending time
ROW_UPDATE_COUNT	NUMBER		Number of rows have been updated for static ACL sync
STATUS	NUMBER		Refreshment job status: 0 means success, otherwise an error number is displayed.
ERROR_MESSAGE	VARCHAR2(4000)		The error message for the error, if there is any.

DBA_XDS_LATEST_ACL_REFSTAT

The DBA_XDS_LATEST_ACL_REFSTAT data dictionary view displays all latest static ACL refresh job status history that has been done in the database. It has the same schema as DBA_XDS_ACL_REFSTAT dictionary view, but a subset of its rows.

Related Views

- ALL_XDS_LATEST_ACL_REFSTAT
- USER_XDS_LATEST_ACL_REFSTAT
- DBA_XDS_ACL_REFSTAT

Column	Datatype	NULL	Description
SCHEMA_NAME	VARCHAR2(128)	NOT NULL	Name of schema
TABLE_NAME	VARCHAR2(128)	NOT NULL	Name of table
REFRESH_MODE	VARCHAR2(9)		ON COMMIT, SCHEDULED, or ON DEMAND
REFRESH_ABILITY	VARCHAR2(11)		COMPLETE or INCREMENTAL
JOB_START_TIME	TIMESTAMP(6) WITH TIME ZONE		The refreshment job starting time
JOB_END_TIME	TIMESTAMP(6) WITH TIME ZONE		The refreshment job ending time
ROW_UPDATE_COUNT	NUMBER		Number of rows have been updated for static ACL sync
STATUS	NUMBER		Refreshment job status: 0 means success, otherwise an error number is displayed.
ERROR_MESSAGE	VARCHAR2(4000)		The error message for the error, if there is any.

USER_XDS_ACL_REFRESH

The USER_XDS_ACL_REFRESH data dictionary view displays all static ACL refresh settings for tables that are owned by the user.

Related Views

- ALL_XDS_ACL_REFRESH
- DBA_XDS_ACL_REFRESH

Column	Datatype	NULL	Description
SCHEMA_NAME	VARCHAR2(128)	NOT NULL	Name of schema
TABLE_NAME	VARCHAR2(128)	NOT NULL	Name of table
ACL_MVIEW_NAME	VARCHAR2(128)	NOT NULL	Name of ACL MV for this table
REFRESH_MODE	VARCHAR2(9)		ON COMMIT, SCHEDULED, or ON DEMAND
REFRESH_ABILITY	VARCHAR2(11)		COMPLETE or INCREMENTAL
ACL_STATUS	VARCHAR2(5)		STALE or FRESH
USER_SUPPLIED_MV	VARCHAR2(1)		Y or N
START_DATE	TIMESTAMP(6) WITH TIME ZONE		The refreshment job scheduled to run after the timestamp, if scheduled
REPEAT_INTERVAL	VARCHAR2(4000)		The repeat_interval to run the refreshment job, if scheduled.
REFRESH_COUNT	NUMBER		Number of refreshment has been done so far
COMMENTS	VARCHAR2(240)		Comments for the refreshment

USER_XDS_ACL_REFSTAT

The USER_XDS_ACL_REFSTAT data dictionary view displays all static ACL refresh job status history that has been done for tables that are owned by the user.

Related Views

- ALL_XDS_ACL_REFSTAT
- DBA_XDS_ACL_REFSTAT

Column	Datatype	NULL	Description
SCHEMA_NAME	VARCHAR2(128)	NOT NULL	Name of schema
TABLE_NAME	VARCHAR2(128)	NOT NULL	Name of table

Column	Datatype	NULL	Description
REFRESH_MODE	VARCHAR2(9)		ON COMMIT, SCHEDULED, or ON DEMAND
REFRESH_ABILITY	VARCHAR2(11)		COMPLETE or INCREMENTAL
JOB_START_TIME	TIMESTAMP(6) WITH TIME ZONE		The refreshment job starting time
JOB_END_TIME	TIMESTAMP(6) WITH TIME ZONE		The refreshment job ending time
ROW_UPDATE_COUNT	NUMBER		Number of rows have been updated for static ACL sync
STATUS	NUMBER		Refreshment job status: 0 means success, otherwise an error number is displayed.
ERROR_MESSAGE	VARCHAR2(4000)		The error message for the error, if there is any.

USER_XDS_LATEST_ACL_REFSTAT

The USER_XDS_LATEST_ACL_REFSTAT data dictionary view displays all latest static ACL refresh job status history that has been done for tables that are owned by the user. It has the same schema as USER_XDS_ACL_REFSTAT dictionary view, but a subset of its rows.

Related Views

- ALL_XDS_LATEST_ACL_REFSTAT
- DBA_XDS_LATEST_ACL_REFSTAT
- USER_XDS_ACL_REFSTAT

Column	Datatype	NULL	Description
SCHEMA_NAME	VARCHAR2(128)	NOT NULL	Name of schema
TABLE_NAME	VARCHAR2(128)	NOT NULL	Name of table
REFRESH_MODE	VARCHAR2(9)		ON COMMIT, SCHEDULED, or ON DEMAND
REFRESH_ABILITY	VARCHAR2(11)		COMPLETE or INCREMENTAL
JOB_START_TIME	TIMESTAMP(6) WITH TIME ZONE		The refreshment job starting time
JOB_END_TIME	TIMESTAMP(6) WITH TIME ZONE		The refreshment job ending time
ROW_UPDATE_COUNT	NUMBER		Number of rows have been updated for static ACL sync

Column	Datatype	NULL	Description
STATUS	NUMBER		Refreshment job status: 0 means success, otherwise an error number is displayed.
ERROR_MESSAGE	VARCHAR2(4000)		The error message for the error, if there is any.

V$XS_SESSION_NS_ATTRIBUTES

The V$XS_SESSION_NS_ATTRIBUTES dynamic data dictionary view displays information about the namespaces and attributes in all application sessions in the database as of the end of the last request. The state of any active request is not reflected in this view. Only database administrators can select from this view.

Related Views

- DBA_XS_SESSIONS
- DBA_XS_SESSION_NS_ATTRIBUTES
- V$XS_SESSION_ROLES

Column	Datatype	NULL	Description
NAMESPACE_NAME	VARCHAR2(4000)		Name of the namespace
WORKSPACE_NAME	VARCHAR2(129)		Name of the workspace space for the namespace
ATTRIBUTE_NAME	VARCHAR2(4000)		Name of the attribute
ATTRIBUTE_VALUE	VARCHAR2(4000)		Value of the attribute
ATTRIBUTE_EVENTS	VARCHAR2(4000)		Events associated with this attribute
ATTRIBUTE_DEFAULT_VALUE	VARCHAR2(4000)		Default value for the attribute
ATTRIBUTE_TYPE	VARCHAR2(4000)		Type of attribute, either TEMPLATE or CUSTOM
CON_ID	NUMBER		Container ID

V$XS_SESSION_ROLES

The V$XS_SESSION_ROLES static data dictionary view displays all enabled application roles in application session in the current request.

Related Views

- DBA_XS_SESSIONS
- DBA_XS_SESSION_ROLES
- V$XS_SESSION_NS_ATTRIBUTES

Column	Datatype	NULL	Description
ROLE_WSPACE	VARCHAR2(129)		The workspace of the application role.
ROLE_NAME	VARCHAR2(4000)		Name of enabled application role
FLAGS	NUMBER		Status flag
CON_ID	NUMBER		Container ID

10

Oracle Database Real Application Security SQL Functions

This chapter describes the SQL functions and procedures that are available with Oracle Database Real Application Security.

Table 10-1 summarizes these functions and procedures. Detailed information on each function and procedure follows this table.

Table 10-1 Oracle Database Real Application Security SQL Functions and Procedures

SQL Function or Procedure	Brief Description
COLUMN_AUTH_INDICATOR Function	Checks whether the specified table column is authorized on a particular table row.
XS_SYS_CONTEXT Function	Retrieves the session attributes and the XS$GLOBAL_VAR namespace attribute for the current application session.
ORA_CHECK_ACL Function	Checks whether an application user has the queried application privileges according to a list of ACLs.
ORA_GET_ACLIDS Function	Returns a list of ACL identifiers associated with an object instance of the XDS-enabled tables for the current application user.
ORA_CHECK_PRIVILEGE Function	Checks whether the specified system privileges have been granted to an application user
TO_ACLID Function	Returns the ACL IDs of the supplied ACL names

COLUMN_AUTH_INDICATOR Function

The `COLUMN_AUTH_INDICATOR` function checks whether the specified table column is authorized on a particular table row. If the current application user is authorized by data security policies to access the column value of the current row, or if the column is not protected by any data security policies, then it returns 1. If the application user is not authorized, it returns `0`.

Syntax

```
COLUMN_AUTH_INDICATOR(col)
RETURN BOOLEAN;
```

Parameters

Parameter	Description
`col`	A column in a table or view. This parameter does not accept object type columns or expressions.

Example

```
SELECT po_number, project_id, region,
 DECODE(COLUMN_AUTH_INDICATOR(price), 0, 'xxxxxx', 1, price) price
 FROM purchaseorder
 WHERE po_number
 BETWEEN 10000 and 10003;
```

See Also:

- "Applying Additional Application Privileges to a Column" for more detailed example of using the `COLUMN_AUTH_INDICATOR` function
- Oracle Database Real Application Security Data Dictionary Views for information about the `ALL_ATTRIBUTE_SECS`, `DBA_ATTRIBUTE_SECS`, and `USER_ATTRIBUTE_SECS` data dictionary views, which list existing tables that use column level security

XS_SYS_CONTEXT Function

The `XS_SYS_CONTEXT` function provides quick access to session attributes in the current application session without incurring the overhead that results from using the PL/SQL APIs. The `SYS_XS_CONTEXT` function definition mirrors that of the `SYS_CONTEXT` function and can be described as application session counterpart to `SYS_CONTEXT`. `XS_SYS_CONTEXT` returns the requested namespace and attribute. If they do not exist, then it returns `NULL`.

Table 10-2 lists the attributes in predefined namespace `XS$SESSION`.

Table 10-2 Predefined Parameters

Parameter	Return Value
CREATED_BY	The owner who created the current application session.
CREATE_TIME	The time in which the current application session was created.
COOKIE	The secure session cookie, passed as the parameter, that can be used to identify the newly created Real Application Security application session in future calls, until the cookie value is changed or the session is destroyed.
CURRENT_XS_USER	The name of the Real Application Security session application user whose privileges are currently active.
CURRENT_XS_USER_GUID	The identifier of the Real Application Security session application user whose privileges are currently active.
INACTIVITY_TIMEOUT	The specified inactivity timeout value in minutes for the current application session.
LAST_ACCESS_TIME	The last time the session was accessed by a session application user.

Table 10-2 (Cont.) Predefined Parameters

Parameter	Return Value
LAST_AUTHENTICATION_TIME	The last time the session application user was authenticated.
LAST_UPDATED_BY	The last time the application session was updated.
PROXY_GUID	Identifier of the Real Application Security session application user who opened the current session on behalf of SESSION_XS_USER.
SESSION_ID	The session identifier for the application session.
SESSION_XS_USER	The name of the Real Application Security session application user at logon.
SESSION_XS_USER_GUID	The identifier of the Real Application Security session application user at logon.
USERNAME	The session application user name.
USER_ID	The identifier of the session application user.

To retrieve the name of the currently attached Real Application Security session application user, you can use the following form of the XS_SYS_CONTEXT function:

```
XS_SYS_CONTEXT('XS$SESSION', 'SESSION_XS_USER')
```

The function returns NULL if no Real Application Security session is currently attached to the database session. The function returns the currently attached Real Application Security session application user even if it is called from within the body of a definer's rights unit, like a definer's rights view.

To retrieve the identifier (ID) for the currently attached Real Application Security session application user, you can use the following form of the XS_SYS_CONTEXT function:

```
XS_SYS_CONTEXT('XS$SESSION', 'SESSION_XS_USER_GUID')
```

The function returns NULL if no Real Application Security session is currently attached to the database session. The function returns the currently attached Real Application Security session application user ID even if it is called from within the body of a definer's rights unit, like a definer's rights view.

Syntax

```
XS_SYS_CONTEXT(
 namespace   IN VARCHAR2
 attribute   IN VARCHAR2)
RETURN VARCHAR2;
```

Parameters

Parameter	Description
`namespace`	The name of the application context. You can specify either a string or an expression. To find information about the namespaces and attributes for the current application session, query the V$XS_SESSION_NS_ATTRIBUTES data dictionary view.
`attribute`	A parameter within the `namespace` application context.

Example

```
SELECT XS_SYS_CONTEXT('XS$SESSION', 'SESSION_ID') FROM DUAL;
```

ORA_CHECK_ACL Function

The `ORA_CHECK_ACL` function checks whether an application user has the queried application privileges according to a list of ACLs. Oracle Database uses this function automatically when the application user runs a query on a table that has data security policy enabled. If the specified application privileges have been granted to the application user, `ORA_CHECK_ACL` returns `1`. If they are not granted to the application user, then it returns `0`.

Syntax

```
ORA_CHECK_ACL(
 acls        IN RAW,
 (privileges IN VARCHAR(128))+)
return NUMBER;
```

Parameters

Parameter	Description
`acls`	RAW list of ACL ids of 8 byte. The maximum number of acls allowed is 250.
`privileges`	The application privilege names being checked. The maximum number of application privileges allowed is 100.

Examples

The following example uses `ORA_CHECK_ACL` to check whether the application user has been granted the `P1` and `P2` application privileges in the `ACL1` ACL.

```
SELECT ORA_CHECK_ACL(TO_ACLID('ACL1'),'P1', 'P2') INTO ACLRESULT FROM DUAL;
```

ORA_GET_ACLIDS Function

The `ORA_GET_ACLIDS` function returns a list of ACL IDS associated with an object instance of data security policy enabled tables for the current application user. Oracle Database evaluates every dynamic data realm constraint rule, because `ORA_GET_ACLIDS` captures all ACL identifiers that are associated with the matching

data realm constraints, if access to the current row has been granted. If the data realm constraints are from detail tables in a master-detail relationship, ORA_GET_ACLIDS retrieves the ACL identifiers from the master table as well as the detail table. If multiple data security policies have been applied to a table, ORA_GET_ACLIDS returns the ACLs associated with each policy.

Syntax

```
ORA_GET_ACLIDS (
 table_alias  IN VARCHAR2,
 (privileges IN VARCHAR(128))+)
RETURN RAW;
```

Parameters

Parameter	Description
table_alias	Table or view object alias in the query from a clause. Ensure that the table is XDS-enabled. To do so, query the DBA_XS_APPLIED_POLICIES data dictionary view. If you specify a view that is resolved to XDS-enabled tables, and if there are more than one XDS-enabled tables in the view, then Oracle Database only returns one of the tables.
privileges	The application privilege names that are associated with the returned ACL identifiers. The maximum number of application privileges allowed is 100.

Example

```
SELECT ORA_GET_ACLIDS(t, 'SELECT', 'VIEW_LOC') from SCOTT.DEPT t;
```

ORA_CHECK_PRIVILEGE Function

The ORA_CHECK_PRIVILEGE function checks whether the specified privileges have been granted to an application user. If the specified privileges have been granted to the application user, ORA_CHECK_PRIVILEGE returns 1. This function only works for system privileges, such as CREATE_SESSION. If the system privileges are not granted to the application user, then it returns 0.

Syntax

```
ORA_CHECK_PRIVILEGE(
 (privs IN VARCHAR(128))+)
return NUMBER;
```

Parameters

Parameter	Description
privs	The privilege names being checked. The maximum number of privileges allowed is 100.

Examples

The following example uses ORA_CHECK_PRIVILEGE to check whether the application user has been granted the CREATE_SESSION system privilege.

```
SELECT ORA_CHECK_PRIVILEGE('CREATE_SESSION') FROM DUAL;
```

TO_ACLID Function

The `TO_ACLID` function returns the ACL IDs of the ACL names supplied to it.

Syntax

```
TO_ACLID(
 (acls IN VARCHAR(128))+)
return NUMBER;
```

Parameters

Parameter	Description
`acls`	The ACL names whose ACL IDs are returned.

Examples

The following example uses the `TO_ACLID` function to return the ACL ID for ACL1.

```
SELECT ORA_CHECK_ACL(TO_ACLID('ACL1'),'P1', 'P2') INTO ACLRESULT FROM DUAL;
```

11

Oracle Database Real Application Security PL/SQL Packages

This chapter describes the PL/SQL packages that are available with Oracle Database Real Application Security.

Table 11-1 lists these packages. Detailed information on each package follows this table.

Table 11-1 Oracle Database Real Application Security PL/SQL Packages

PL/SQL Package	Description
DBMS_XS_SESSIONS Package	Includes subprograms to manage an application session.
XS_ACL Package	Includes subprograms to create, manage, and delete Access Control Lists (ACLs) and to add and remove parameter values.
XS_ADMIN_UTIL Package	Includes helper subprograms.
XS_DATA_SECURITY Package	Includes subprograms to create, manage, and delete data security policies, associated data realm constraints, column constraints, and ACL parameters.
XS_DATA_SECURITY_UTIL Package	Includes subprograms to schedule automatic refreshment for static ACL to a user table and change the ACL refreshment mode to on-commit or on-demand refresh.
XS_DIAG Package	Includes subprograms to diagnose potential problems in Real Application Security objects and report identified inconsistencies.
XS_NAMESPACE Package	Includes subprograms to create, manage, and delete namespace templates and attributes.
XS_PRINCIPAL Package	Includes subprograms to create, manage, and delete application users and roles.
XS_SECURITY_CLASS Package	Includes subprograms to create, manage, and delete security classes and their privileges. Also includes subprograms for managing security class inheritance.

This section describes the following Oracle Database Real Application Security PL/SQL packages:

DBMS_XS_SESSIONS Package

The `DBMS_XS_SESSIONS` package manages an application session.

This section includes the following topics:

- Security Model
- Constants

- Object Types, Constructor Functions, Synonyms, and Grants
- Summary of DBMS_XS_SESSIONS Subprograms

Security Model

The DBMS_XS_SESSIONS package is created in the SYS schema. The privilege to execute the package is granted to PUBLIC. The executing user must have the appropriate privilege for the particular operation.

Constants

The following constants define operation codes passed into namespace event handling functions:

```
attribute_first_read_operation CONSTANT PLS_INTEGER := 1;
modify_attribute_operation     CONSTANT PLS_INTEGER := 2;
```

The following constants represent bit values that identify events of interest for a particular attribute in a namespace that has an event handling function:

```
attribute_first_read_event     CONSTANT PLS_INTEGER := 1;
modify_attribute_event         CONSTANT PLS_INTEGER := 2;
```

The following constants define return codes that can be returned by a namespace event handling function:

```
event_handling_succeeded       CONSTANT PLS_INTEGER := 0;
event_handling_failed          CONSTANT PLS_INTEGER := 1;
```

The following constants are used as input into the ADD_GLOBAL_CALLBACK, DELETE_GLOBAL_CALLBACK, and ENABLE_GLOBAL_CALLBACK procedures:

```
create_session_event       CONSTANT PLS_INTEGER := 1;
attach_session_event       CONSTANT PLS_INTEGER := 2;
guest_to_user_event        CONSTANT PLS_INTEGER := 3;
proxy_to_user_event        CONSTANT PLS_INTEGER := 4;
revert_to_user_event       CONSTANT PLS_INTEGER := 5;
enable_role_event          CONSTANT PLS_INTEGER := 6;
disable_role_event         CONSTANT PLS_INTEGER := 7;
enable_dynamic_role_event  CONSTANT PLS_INTEGER := 8;
disable_dynamic_role_event CONSTANT PLS_INTEGER := 9;
detach_session_event       CONSTANT PLS_INTEGER := 10;
terminate_session_event    CONSTANT PLS_INTEGER := 11;
direct_login_event         CONSTANT PLS_INTEGER := 12;
direct_logoff_event        CONSTANT PLS_INTEGER := 13;
```

Object Types, Constructor Functions, Synonyms, and Grants

The following object types, constructor functions, synonyms, and GRANT statements are defined for this package.

```
CREATE OR REPLACE TYPE DBMS_XS_NSATTR AS OBJECT (
  --- Member variables
  namespace        varchar2(130),
  attribute        varchar2(4000),
  attribute_value  varchar2(4000),

  --- Constructor for DBMS_XS_NSATTR type
```

```
  --- Only namespace name is mandatory
  CONSTRUCTOR FUNCTION DBMS_XS_NSATTR(
     namespace         IN VARCHAR2,
     attribute         IN VARCHAR2 DEFAULT NULL,
     attribute_value   IN VARCHAR2 DEFAULT NULL)
  RETURN SELF AS RESULT);

CREATE OR REPLACE PUBLIC SYNONYM DBMS_XS_NSATTR FOR SYS.DBMS_XS_NSATTR;
CREATE OR REPLACE TYPE DBMS_XS_NSATTRLIST AS VARRAY(1000) OF DBMS_XS_NSATTR;
CREATE OR REPLACE PUBLIC SYNONYM DBMS_XS_NSATTRLIST FOR SYS.DBMS_XS_NSATTRLIST;
GRANT EXECUTE ON DBMS_XS_NSATTR TO PUBLIC;
GRANT EXECUTE ON DBMS_XS_NSATTRLIST TO PUBLIC;
CREATE OR REPLACE PUBLIC SYNONYM DBMS_XS_SESSIONS FOR SYS.DBMS_XS_SESSIONS;
GRANT EXECUTE ON DBMS_XS_SESSIONS TO PUBLIC;
```

Summary of DBMS_XS_SESSIONS Subprograms

Table 11-2 Summary of DBMS_XS_SESSIONS Subprograms

Subprogram	Description
CREATE_SESSION Procedure	Creates a new application session for the specified application user name.
ATTACH_SESSION Procedure	Attaches the current traditional database session to the application session identified by the session ID.
ASSIGN_USER Procedure	Assigns a named user to the currently attached anonymous Real Application Security session.
SWITCH_USER Procedure	Switches the application user in the currently attached session.
CREATE_NAMESPACE Procedure	Creates a new application namespace in the currently attached application session.
CREATE_ATTRIBUTE Procedure	Creates a new custom attribute for the specified application namespace in the currently attached application session.
SET_ATTRIBUTE Procedure	Sets a new value for the specified attribute in the namespace in the currently attached application session.
GET_ATTRIBUTE Procedure	Gets the value of an attribute in the namespace in the currently attached application session.
RESET_ATTRIBUTE Procedure	Resets an application namespace attribute to its original value in the specified namespace in the currently attached application session.
DELETE_ATTRIBUTE Procedure	Deletes the specified attribute from the specified namespace in the currently attached application session.
DELETE_NAMESPACE Procedure	Deletes the specified namespace and its attributes from the currently attached application session.
ENABLE_ROLE Procedure	Enables a real application role in the currently attached application session.
DISABLE_ROLE Procedure	Disables a real application role from the currently attached application session.
SET_SESSION_COOKIE Procedure	Sets a new cookie value with the specified session ID.
REAUTH_SESSION Procedure	Updates the last authentication time for the session identified by specified session ID.
SET_INACTIVITY_TIMEOUT Procedure	Sets an inactivity timeout value, in minutes, for the specified session.

Table 11-2 (Cont.) Summary of DBMS_XS_SESSIONS Subprograms

Subprogram	Description
SAVE_SESSION Procedure	Saves or persists the changes performed in the currently attached session.
DETACH_SESSION Procedure	Detaches the current traditional database session from the application session to which it is attached.
DESTROY_SESSION Procedure	Destroys or terminates the session specified by the session ID.
ADD_GLOBAL_CALLBACK Procedure	Registers an existing event handler with the database.
ENABLE_GLOBAL_CALLBACK Procedure	Enables or disables the global callback for the session event specified by the `event_type` parameter.
DELETE_GLOBAL_CALLBACK Procedure	Deletes an existing global callback association.

This section describes the following DBMS_XS_SESSIONS subprograms:

CREATE_SESSION Procedure

The `CREATE_SESSION` procedure creates a new application session for the specified user name. It returns a session identifier that you can use to reference the session in future calls.

The session can be created with a regular application user or an external application user. The session can be created in trusted mode or secure mode. In trusted mode, data security checks are bypassed; in secure mode, they are enforced.

The combination of regular session in trusted mode is not supported. Other combinations, regular session in secure mode, external session in trusted mode, or external session in secure mode are supported.

The `namespaces` parameter is a list of triplet namespaces to be created, the attribute to be created, and the attribute value to be set. This is an optional parameter. The default value is `NULL`. The `XS$GLOBAL_VAR` and `XS$SESSION` namespaces and their attributes are always available to the session.

This function does not attach the current traditional session to the newly created application session. Use the ATTACH_SESSION Procedure to perform this task.

The user executing the procedure must have the `CREATE_SESSION` application privilege for the application user specified by the `username` parameter. You can also specify a list of namespaces to be created when the session is created. If you specify namespaces during creation of the session, the caller is required to be granted application privileges `MODIFY_NAMESPACE` or `MODIFY_ATTRIBUTE` on the namespaces, or be granted the `ADMIN_NAMESPACE` system privilege.

Syntax

```
CREATE_SESSION (
 username      IN  VARCHAR2,
 sessionid     OUT NOCOPY RAW,
 is_external   IN  BOOLEAN DEFAULT FALSE,
 is_trusted    IN  BOOLEAN DEFAULT FALSE,
 namespaces    IN  DBMS_XS_NSATTRLIST DEFAULT NULL,
 cookie        IN  VARCHAR2 DEFAULT NULL);
```

Parameters

Parameter	Description

username	The name of a regular application user or an external application user for which to create the application session.
	To find a listing of the user names and application roles for the current session, query the DBA_XS_USERS data dictionary view. To find all application users and roles, query the DBA_XS_PRINCIPALS data dictionary view as follows:
	Users:
	`SELECT NAME FROM DBA_XS_USERS;`
	Roles:
	`SELECT NAME FROM DBA_XS_ROLES;`
	`SELECT NAME FROM DBA_XS_DYNAMIC_ROLES;`

sessionid	Session ID of the newly created application session. You can get the session ID by using one of the following methods: • `SELECT XS_SYS_CONTEXT('XS$SESSION', 'SESSION_ID') FROM DUAL;` • Using the DBMS_XS_SESSIONS.GET_ATTRIBUTE procedure.
is_external	Specifies whether the session is to be created as an external principal session. This is an optional parameter. The default value is FALSE, indicating that a regular session is to be created. A NULL value is taken to mean FALSE.
is_trusted	Specifies if the session is to be created in trusted mode or secure mode. In trusted mode, data security checks are bypassed; in secure mode, they are enforced. This is an optional parameter. The default value is FALSE, indicating secure mode. A NULL value is taken to mean FALSE.
namespaces	The list of name, attribute, and attribute value triplet. If the namespace is not accessible to the session or no such namespace template exists, an error is thrown.
cookie	Specifies the server cookie to be set for the session. This is an optional parameter. The default value is NULL. The maximum allowed length of the cookie is 1024 bytes.

Examples

```
DECLARE
  nsList DBMS_XS_NSATTRLIST;
  sessionid RAW(16);
BEGIN
    nsList := DBMS_XS_NSATTRLIST(DBMS_XS_NSATTR('ns1'),DBMS_XS_NSATTR('ns2'));
    SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid, FALSE, FALSE, nsList);
END;
```

ATTACH_SESSION Procedure

The ATTACH_SESSION procedure attaches the current traditional database session to the application session identified by the session ID (session_id). The attached

session enables the roles granted (directly or indirectly) to the application user with which the session was created and the session scope dynamic application roles that were enabled until the last detach of this session. If you execute ATTACH_SESSION with a list of dynamic application roles using the optional parameter enable_dynamic_roles, the provided dynamic application roles are enabled for the session. To disable a list of dynamic roles, specify the list using the optional parameter disable_dynamic_roles.

You can specify a list of triplet values (namespace, attribute, attribute value) during the attach operation. The namespaces and attributes are then created and attribute values set. This is in addition to any namespaces and attributes that were present in the session.

To execute this procedure, the traditional session user must have the ATTACH_SESSION application privilege. If you specify namespaces, then the user is required to be granted application privileges MODIFY_NAMESPACE or MODIFY_ATTRIBUTE on the namespaces, or ADMIN_NAMESPACE system privilege.

A self password change is allowed using the SQL*Plus PASSWORD command if invoked from an explicitly attached session (a session attached using the ATTACH_SESSION procedure or the attachSession() method in Java), provided that session has the ALTER_USER privilege and the user name is provided with the PASSWORD command.

Syntax

```
ATTACH_SESSION (
 sessionid              IN RAW,
 enable_dynamic_roles   IN XS$NAME_LIST         DEFAULT NULL,
 disable_dynamic_roles  IN XS$NAME_LIST         DEFAULT NULL,
 external_roles         IN XS$NAME_LIST         DEFAULT NULL,
 authentication_time    IN TIMESTAMP WITH TIME ZONE DEFAULT NULL,
 namespaces             IN DBMS_XS_NSATTRLIST   DEFAULT NULL);
```

Parameters

Parameter	Description
sessionid	Session ID of the application session. You can get the session ID by using one of the following methods: • SELECT XS_SYS_CONTEXT('XS$SESSION', 'SESSION_ID') FROM DUAL; • Using the DBMS_XS_SESSIONS.GET_ATTRIBUTE procedure.
enable_dynamic_roles	A list of dynamic roles to be granted to be enabled in the application session. This is an optional parameter. If any of the dynamic roles specified does not exist, the attach session fails. If the session is an external principal session, a list of external roles can be specified for enabling. These roles will remain enabled until detach and will not be enabled in the next attach by default. To find a listing of the application roles for the current session, query the DBA_XS_SESSION_ROLES data dictionary view. To find a listing of all dynamic application roles, query the DBA_XS_PRINCIPALS data dictionary view as follows: SELECT NAME, TYPE FROM DBA_XS_PRINCIPALS;

Parameter	Description
disable_dynamic_roles	A list of dynamic roles to be disabled from the session. This is an optional parameter.
external_roles	A list of external roles if the session is an external principal session. This is an optional parameter. These external roles remain enabled until a detach operation and are not enabled again in the next attach by default.
authentication_time	The updated authentication time for the session. This is an optional parameter. The time must be specified in the following format: YYYY-MM-DD HH:MI:SS.FF TZR
namespaces	The list of name, attribute, and attribute value triplet. If the namespace is not accessible to the session or no such namespace template exists, an error is thrown.

Examples

```
DECLARE
  nsList DBMS_XS_NSATTRLIST;
  sessionid RAW(16);
BEGIN
    nsList := DBMS_XS_NSATTRLIST(DBMS_XS_NSATTR('ns1'),DBMS_XS_NSATTR('ns2'));
    SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
    SYS.DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid, NULL, NULL, NULL, NULL, nsList);
END;
```

ASSIGN_USER Procedure

The ASSIGN_USER procedure assigns a named application user to the currently attached anonymous application session.

Roles enabled in the current session are retained after this operation. The optional parameters enable_dynamic_roles and disable_dynamic_roles specify the additional lists of dynamic roles to be enabled or disabled. If the assigned user is external, you can specify a list of external roles to be enabled.

You can specify a list of triplet values (namespace, attribute, attribute value) during the assign operation. The namespaces and attributes are then created in the session and attribute values set. This is in addition to any namespaces and attributes that were already present in the session.

To execute this procedure, the dispatcher or connection user must have the ASSIGN_USER application privilege. If you specify namespaces, then the user is required to be granted application privileges MODIFY_NAMESPACE or MODIFY_ATTRIBUTE on the namespaces, or ADMIN_NAMESPACE system privilege.

Syntax

```
DBMS_XS_SESSIONS.ASSIGN_USER (
 username              IN VARCHAR2,
 is_external           IN BOOLEAN                DEFAULT FALSE,
 enable_dynamic_roles  IN XS$NAME_LIST           DEFAULT NULL,
 disable_dynamic_roles IN XS$NAME_LIST           DEFAULT NULL,
 external_roles        IN XS$NAME_LIST           DEFAULT NULL,
```

```
authentication_time   IN TIMESTAMP WITH TIME ZONE DEFAULT NULL,
namespaces            IN DBMS_XS_NSATTRLIST       DEFAULT NULL);
```

Parameters

Parameter	Description
username	The name of the real application user. To find a listing of existing application users, query the DBA_XS_PRINCIPALS data dictionary view as follows: `SELECT NAME FROM DBA_XS_PRINCIPALS;`
is_external	Specifies whether the named application user is an external user. This is an optional parameter. The default value is FALSE, indicating that a regular application user is assigned. A NULL value is taken to mean FALSE.
enable_dynamic_roles	A list of dynamic roles to be enabled in an application session. This is an optional parameter. To find a listing of the application roles for the current session, query the V$XS_SESSION_ROLES data dictionary view. To find a listing of all dynamic application roles, query the DBA_XS_DYNAMIC_ROLES data dictionary view as follows: `SELECT NAME FROM DBA_XS_DYNAMIC_ROLES;`
disable_dynamic_roles	A list of dynamic roles to be disabled from the session. This is an optional parameter.
external_roles	A list of external roles if the application user is an external application user. This is an optional parameter.
authentication_time	The updated authentication time for the session. This is an optional parameter. The time must be specified in the following format: `YYYY-MM-DD HH:MI:SS.FF TZR`
namespaces	The list of name, attribute, and attribute value triplet. If the namespace is not accessible to the session or no such namespace template exists, an error is thrown.

Examples

```
DECLARE
  nsList DBMS_XS_NSATTRLIST;
  sessionid RAW(16);
BEGIN
  nsList := DBMS_XS_NSATTRLIST(DBMS_XS_NSATTR('ns1'),DB);
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
  SYS.DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid);
  SYS.DBMS_XS_SESSIONS.ASSIGN_USER(username => 'lwuser2',
                                   namespaces => nsList);
END;
```

SWITCH_USER Procedure

The SWITCH_USER procedure switches the application user in the currently attached session. The current application user must be a proxy user for the target application user before performing the switch operation by using the

XS_PRINCIPAL.ADD_PROXY_USER PL/SQL API to acquire the proxy of another application user privilege. The list of filtering application roles of the target user gets enabled in the session.

You can retain current application namespaces of the session or discard them. You can also specify a list of namespaces to be created and attribute values to be set after the switch. If you specify namespaces, then the user is required to be granted application privileges MODIFY_NAMESPACE or MODIFY_ATTRIBUTE on the namespaces, or ADMIN_NAMESPACE system privilege.

Syntax

```
SWITCH_USER (
 username          IN VARCHAR2,
 keep_state        IN BOOLEAN              DEFAULT FALSE,
 namespaces        IN DBMS_XS_NSATTRLIST   DEFAULT NULL);
```

Parameters

Parameter	Description
username	User name of the user whose security context you want to switch to. To find a listing of existing application users, query the DBA_XS_USERS data dictionary view as follows: `SELECT NAME FROM DBA_XS_USERS;`
keep_state	Controls whether application namespaces are retained. Possible values are: • TRUE: Sets all other session states to remain unchanged. • FALSE: Clears the previous state in the session. The default value.
namespaces	The list of name, attribute, and attribute value triplet. If the namespace is not accessible to the session or no such namespace template exists, an error is thrown.

Examples

```
DECLARE
  nsList := DBMS_XS_NSATTRLIST(DBMS_XS_NSATTR('ns1'),DBMS_XS_NSATTR('ns2'));
  sessionid RAW(16);
BEGIN
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
  SYS.DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid);
  SYS.DBMS_XS_SESSIONS.SWITCH_USER(username => 'lwuser2',
                                   keep_state => TRUE,
                                   namespaces => nsList);
END;
```

CREATE_NAMESPACE Procedure

The CREATE_NAMESPACE procedure creates a new namespace in the currently attached application session. The namespace template corresponding to the namespace must exist in the system, else this operation throws an error. After this operation, the namespace along with its attributes as they are created in the template are available to the session.

The calling user must have the MODIFY_NAMESPACE application privilege.

Syntax

```
CREATE_NAMESPACE(
 namespace      IN VARCHAR2);
```

Parameters

Parameter	Description
namespace	The name of the namespace to create. There must be an existing namespace template document with this name. The maximum size of the case sensitive character string is 128 characters. To find a listing of existing namespaces for the current session, once attached, query the V$XS_SESSION_NS_ATTRIBUTES data dictionary view. You can query the DBA_XS_SESSION_NS_ATTRIBUTES data dictionary view to find out all the namespaces in all application sessions. You can query the DBA_XS_NS_TEMPLATES and DBA_XS_NS_TEMPLATE_ATTRIBUTES data dictionary views for a list of namespace templates and attributes.

Examples

```
BEGIN
 SYS.DBMS_XS_SESSIONS.CREATE_NAMESPACE('J_NS1');
END;
```

CREATE_ATTRIBUTE Procedure

The CREATE_ATTRIBUTE procedure creates a new custom attribute in the specified namespace in the currently attached application session. If the namespace is not already available in the session or no such namespace templates exist, an error is thrown.

The calling user is required to be granted the MODIFY_ATTRIBUTE application privilege.

Syntax

```
PROCEDURE create_attribute(
namespace IN VARCHAR2,
attribute IN VARCHAR2,
value     IN VARCHAR2    DEFAULT NULL,
eventreg  IN PLS_INTEGER DEFAULT NULL);
```

Parameters

Parameter	Description
namespace	The namespace in which the attribute gets created. If the namespace does not exist in the session, an error is thrown. The maximum size of the case sensitive character string is 128 characters.
attribute	The name of the attribute to be created. The maximum size of the case sensitive character string is 4000 characters.
value	The default value for the attribute. The maximum size of the case sensitive character string is 4000 characters.

Parameter	Description
eventreg	The event for which the handler is executed for the attribute. This is an optional parameter. This parameter can take the following values: • DBMS_XS_SESSIONS.attribute_first_read_event The handler function is called whenever an attribute get request is received and the value for the attribute has not been set. This event can be registered only if the default value is set to NULL. This value corresponds with the FIRSTREAD_EVENT constant in the XS_NAMESPACE package or Admin API. • DBMS_XS_SESSIONS.modify_attribute_event: The handler function is called whenever an attribute set request is received. This value corresponds with the UPDATE_EVENT constant in the in the XS_NAMESPACE package or Admin API. If the attribute is registered for first read event, then the handler is executed if the attribute is uninitialized, before returning the value. If the update event is registered, the handler gets called whenever the attribute is modified. Events can be registered only if the namespace has an event handler, else an error is thrown.

Examples

```
BEGIN
 SYS.DBMS_XS_SESSIONS.CREATE_ATTRIBUTE('NS1','NS1CUSTOM','NS1CUSTOMDEFAULT');
END;

-- Example with firstRead event set
BEGIN
SYS.DBMS_XS_SESSIONS.create_Attribute('ns1','attr4',NULL,
                                      DBMS_XS_SESSIONS.attribute_first_read_event);
END;
```

SET_ATTRIBUTE Procedure

The SET_ATTRIBUTE procedure sets a new value for the specified attribute in the namespace associated with the currently attached session. The handler function is called if the update event is set for the attribute. If the namespace does not exist or is deleted, an error is thrown. If there is no template corresponding to the namespace that exists, an error is thrown.

The calling user is required to be granted the MODIFY_ATTRIBUTE application privilege.

Syntax

```
SET_ATTRIBUTE (
 namespace    IN VARCHAR2,
 attribute    IN VARCHAR2,
 value        IN VARCHAR2);
```

Parameters

Parameter	Description
namespace	Name of the namespace associated with the attribute. The maximum size of the case sensitive character string is 128 characters. To find a listing of existing namespaces for the current session, once attached, query the V$XS_SESSION_NS_ATTRIBUTES data dictionary view. You can query the DBA_XS_SESSION_NS_ATTRIBUTES data dictionary view to find out all the namespaces in all application sessions. You can query the DBA_XS_NS_TEMPLATES and DBA_XS_NS_TEMPLATE_ATTRIBUTES data dictionary views for a list of namespace templates and attributes.
attribute	Name of an existing attribute in an existing namespace. To find a listing of existing namespace attributes, query the V$XS_SESSION_NS_ATTRIBUTES data dictionary view.
value	New value for the attribute. The maximum size of the case sensitive character string is 4000 characters. To find an listing of existing values associated with the attribute, query the V$XS_SESSION_NS_ATTRIBUTES data dictionary view.

Examples

```
BEGIN
 SYS.DBMS_XS_SESSIONS.SET_ATTRIBUTE('J_NS','JohnNSAttr1','John bio');
END;
```

GET_ATTRIBUTE Procedure

The GET_ATTRIBUTE procedure gets the value of the specified attribute in the namespace in the currently attached session. If no template corresponding to the namespace exists, an error is thrown. If the specified attribute does not exist, it returns empty string.

If the attribute value is NULL, the firstRead event is set, and it is the first time that the attribute value is being fetched, then the handler function for the attribute is called.

The calling user is not required to be granted any privileges.

Syntax

```
GET_ATTRIBUTE (
 namespace   IN         VARCHAR2,
 attribute   IN         VARCHAR2,
 value       OUT NOCOPY VARCHAR2);
```

Parameters

Parameter	Description
namespace	The namespace of the attribute to retrieve. The maximum size of the case sensitive character string is 128 characters. To find a listing of existing namespaces for the current session, once attached, query the V$XS_SESSION_NS_ATTRIBUTES data dictionary view. You can query the DBA_XS_SESSION_NS_ATTRIBUTES data dictionary view to find out all the namespaces in all application sessions.
attribute	The name of the attribute to retrieve. The maximum size of the case sensitive character string is 4000 characters. To find a listing of available attributes, query the V$XS_SESSION_NS_ATTRIBUTES data dictionary view.
value	The value of the attribute to retrieve. To find a listing of available attribute values, query the V$XS_SESSION_NS_ATTRIBUTES data dictionary view.

Examples

```
DECLARE
attrVal VARCHAR2(4000);

BEGIN
 SYS.DBMS_XS_SESSIONS.GET_ATTRIBUTE('J_NS1','JohnNS1Attr1',attrVal);
END;
```

RESET_ATTRIBUTE Procedure

The RESET_ATTRIBUTE procedure resets the value of an attribute to its default value (if present) or to NULL in the namespace in the current attached session. If the attribute has a default value specified, then the value is reset to the default value. If the attribute was created without a default value and marked for the attribute_first_read_event, then the value is set to NULL and the attribute is marked as uninitialized. If the attribute was created without a default value and not marked for the attribute_first_read_event, then the value is set to NULL.

The calling user is required to be granted the MODIFY_ATTRIBUTE application privilege.

Syntax

```
PROCEDURE reset_attribute(
namespace   IN VARCHAR2,
attribute   IN VARCHAR2);
```

Parameters

Parameter	Description
namespace	The name of the namespace containing the attribute. The maximum size of the case sensitive character string is 128 characters.
attribute	The name of the attribute to be reset. The maximum size of the case sensitive character string is 4000 characters.

Examples

```
BEGIN
 SYS.DBMS_XS_SESSIONS.RESET_ATTRIBUTE('ns2','attr1');
END;
```

DELETE_ATTRIBUTE Procedure

The DELETE_ATTRIBUTE procedure deletes the specified attribute and its associated value from the specified namespace in the currently attached session. Only custom attributes can be deleted. Template attributes cannot be deleted. If the specified attribute does not exist, an error is thrown.

The calling application is required to be granted the MODIFY_ATTRIBUTE application privilege.

Syntax

```
DELETE_ATTRIBUTE (
 namespace     IN VARCHAR2,
 attribute     IN VARCHAR2);
```

Parameters

Parameter	Description
namespace	The namespace associated with the attribute to delete. The maximum size of the case sensitive character string is 128 characters. To find a listing of existing namespaces for the current session, once attached, query the V$XS_SESSION_NS_ATTRIBUTES data dictionary view. You can query the DBA_XS_SESSION_NS_ATTRIBUTES data dictionary view to find out all the namespaces in all application sessions. You can query the DBA_XS_NS_TEMPLATES and DBA_XS_NS_TEMPLATE_ATTRIBUTES data dictionary views for a list of namespace templates and attributes.
attribute	The attribute to delete. To find a listing of existing namespaces for the current session, once attached, query the V$XS_SESSION_NS_ATTRIBUTES data dictionary view. You can query the DBA_XS_SESSION_NS_ATTRIBUTES data dictionary view to find out all the namespaces in all application sessions.

Examples

```
BEGIN
 SYS.DBMS_XS_SESSIONS.DELETE_ATTRIBUTE('JohnNS1','JohnNS1Attr1');
END;
```

DELETE_NAMESPACE Procedure

The DELETE_NAMESPACE procedure deletes a namespace and its attributes from the currently attached application session.

The calling user must have the MODIFY_NAMESPACE application privilege.

Syntax

```
DELETE_NAMESPACE (
 namespace   IN VARCHAR2);
```

Parameters

Parameter	Description
namespace	The name of the namespace to delete. The maximum size of the case sensitive character string is 128 characters. To find a listing of existing namespaces for the current session, once attached, query the V$XS_SESSION_NS_ATTRIBUTES data dictionary view. You can query the DBA_XS_SESSION_NS_ATTRIBUTES data dictionary view to find out all the namespaces in all application sessions. You can query the DBA_XS_NS_TEMPLATES and DBA_XS_NS_TEMPLATE_ATTRIBUTES data dictionary views for a list of namespace templates and attributes.

Examples

```
BEGIN
 SYS.DBMS_XS_SESSIONS.DELETE_NAMESPACE('JohnNS1');
END;
```

ENABLE_ROLE Procedure

The ENABLE_ROLE procedure enables a real application role in the currently attached application session. If the role is already enabled, then ENABLE_ROLE procedure performs no action. This procedure can only enable a regular application role directly granted to the current application user. You cannot enable dynamic application roles.

This operation does not require the calling user to have any additional privilege.

Syntax

```
ENABLE_ROLE (
 role   IN VARCHAR2);
```

Parameters

Parameter	Description

role	The name of the role to enable. The maximum size of the case sensitive character string is 128 characters.
	To find a listing of the application roles for the current session, query the V$XS_SESSION_ROLES data dictionary view. To find all application roles, query the DBA_XS_SESSION_ROLES data dictionary view as follows:
	`SELECT ROLE_NAME FROM V$XS_SESSION_ROLES;`
	`SELECT SESSIONID, ROLE FROM DBA_XS_SESSION_ROLES;`

Examples

```
BEGIN
 SYS.DBMS_XS_SESSIONS.ENABLE_ROLE('auth2_role');
END;
```

DISABLE_ROLE Procedure

The DISABLE_ROLE procedure disables a real application role from the specified application session. If the role is already disabled or not enabled in the currently attached application session, then DISABLE_ROLE performs no action. You cannot disable dynamic application roles. You can only disable a regular application role, which is directly granted to the application user with which the session is created.

This operation does not require the calling user to have any additional privilege.

Syntax

```
DISABLE_ROLE (
 role   IN VARCHAR2);
```

Parameters

Parameter	Description

role	The name of the role to disable. The maximum size of the case sensitive character string is 128 characters.
	To find a listing of the application roles for the current session, query the V$XS_SESSION_ROLES data dictionary view. To find all application roles, query the DBA_XS_SESSION_ROLES data dictionary view as follows:
	`SELECT ROLE_NAME FROM V$XS_SESSION_ROLES;`
	`SELECT SESSIONID, ROLE FROM DBA_XS_SESSION_ROLES;`

Examples

```
BEGIN
  SYS.DBMS_XS_SESSIONS.DISABLE_ROLE('auth1_role');
END;
```

SET_SESSION_COOKIE Procedure

The SET_SESSION_COOKIE procedure sets a new cookie value with the specified session ID. If the specified session does not exist or the cookie name is not unique among all the user application sessions, then an error is thrown.

To execute this procedure, the user is required to be granted the MODIFY_SESSION application privilege.

Syntax

```
SET_SESSION_COOKIE (
 cookie      IN VARCHAR2,
 sessionid   IN RAW DEFAULT NULL);
```

Parameters

Parameter	Description
cookie	A name for the new cookie. The maximum allowed length for the cookie is 1024 characters. Cookie names must be unique. To find a listing of existing cookies for the current session, query XS_SYS_CONTEXT(XS$SESSION','COOKIE').
sessionid	Session ID of the application session. The default value is NULL. You can get the session ID by using one of the following methods: • SELECT XS_SYS_CONTEXT('XS$SESSION', 'SESSION_ID') FROM DUAL; • Using the DBMS_XS_SESSIONS.GET_ATTRIBUTE procedure. If you do not specify a session ID or enter NULL, then SET_SESSION_COOKIE uses the session ID of the current application session.

Examples

```
DECLARE
   sessionid RAW(16);
BEGIN
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
  SYS.DBMS_XS_SESSIONS.SET_SESSION_COOKIE('cookie1', sessionid);
END;
```

REAUTH_SESSION Procedure

The REAUTH_SESSION procedure updates the last authentication time for the specified session ID as the current time. Applications must call this procedure when it has reauthenticated an application user.

Use the REAUTH_SESSION procedure to enable a role that has timed out because of a lack of recent authentication in the application or middle-tier server. You can also call the reauthSession Java method.

To execute this function, the user is required to be granted the MODIFY_SESSION application privilege.

Syntax

```
REAUTH_SESSION (
 sessionid IN RAW DEFAULT NULL);
```

Parameters

Parameter	Description
sessionid	Session ID of the application session. This parameter is optional. The default value is NULL. You can get the session ID by using one of the following methods: • SELECT XS_SYS_CONTEXT('XS$SESSION', 'SESSION_ID') FROM DUAL; • Using the DBMS_XS_SESSIONS.GET_ATTRIBUTE procedure. If you do not specify a session ID or enter NULL, then REAUTH_SESSION uses the session ID of the current application session.

Examples

```
DECLARE
  sessionid RAW(16);
BEGIN
 SYS.DBMS_XS_SESSIONS.REAUTH_SESSION(sessionid);
END;
```

SET_INACTIVITY_TIMEOUT Procedure

The SET_INACTIVITY_TIMEOUT procedure sets an inactivity time-out value, in minutes, for the current attached session. The inactivity time-out value represents the maximum period of inactivity allowed before Oracle Database terminates the application session and the resource is reclaimed. Trying to set a negative value for the time parameter throws an error. If an invalid session ID is specified or the session does not exist, an error is thrown.

Another way to set the time-out value is to use the setInactivityTimeout Java method. You can set a default global time-out value in the xmlconfig.xml configuration file. Oracle recommends 240 (4 hours).

An application session cannot time-out due to inactivity while a traditional session is attached. The last access time is updated each time a traditional session attaches to the application session.

To execute this procedure, the calling user is required to be granted the MODIFY_SESSION application privilege.

Syntax

```
SET_INACTIVITY_TIMEOUT (
 time        IN NUMBER,
 sessionid   IN RAW DEFAULT NULL);
```

Parameters

Parameter	Description
time	Inactivity time-out value in minutes. Oracle recommends setting the time parameter to 240 (4 hours). A zero (0) value means the value is infinite and that the session never expires due to inactivity.

Parameter	Description
sessionid	Session ID of the application session. The default value is NULL. You can get the session ID by using one of the following methods: • SELECT XS_SYS_CONTEXT('XS$SESSION', 'SESSION_ID') FROM DUAL; • Using the DBMS_XS_SESSIONS.GET_ATTRIBUTE procedure. If you do not specify a session ID or enter NULL, then SET_INACTIVITY_TIMEOUT uses the session ID of the current application session.

Examples

```
DECLARE
  sessionid RAW(16);
BEGIN
  SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwuser1', sessionid);
  SYS.DBMS_XS_SESSIONS.SET_INACTIVITY_TIMEOUT (300, sessionid);
END;
/
```

SAVE_SESSION Procedure

The SAVE_SESSION procedure saves all changes performed in the currently attached session and remains attached to the session as it was before saving changes.

The calling user requires no privileges to perform this operation.

Syntax

```
SAVE_SESSION;
```

Parameters

None.

Examples

```
BEGIN
 SYS.DBMS_XS_SESSIONS.SAVE_SESSION;
END;
```

DETACH_SESSION Procedure

The DETACH_SESSION procedure detaches the current traditional database session from the application session to which it is attached. The database sessions goes back to the context it was in prior to attaching to the application session. Any user can execute this procedure as the operation does not require any privileges to execute.

Syntax

```
DETACH_SESSION (abort IN BOOLEAN DEFAULT FALSE);
```

Parameters

Parameter	Description
abort	If specified as TRUE, it rolls back the changes performed in the current session. If specified as FALSE, the default value, all changes performed in the session are persisted. If a NULL value is specified for this parameter, it is treated as FALSE.

Examples

```
BEGIN
 SYS.DBMS_XS_SESSIONS.DETACH_SESSION;
END;
```

DESTROY_SESSION Procedure

The DESTROY_SESSION procedure destroys the specified session. This procedure also implicitly detaches all traditional sessions from the application session. After the session is destroyed no further attaches can be made to the session. This operation cannot destroy sessions created through direct logon of the application user.

To execute this procedure, the user must have the TERMINATE_SESSION application privilege.

Syntax

```
DESTROY_SESSION (
 sessionid IN RAW,
 force     IN BOOLEAN DEFAULT FALSE);
```

Parameters

Parameter	Description
sessionid	Session ID of the application session. You can get the session ID by using one of the following methods: • SELECT XS_SYS_CONTEXT('XS$SESSION', 'SESSION_ID') FROM DUAL; • Using the DBMS_XS_SESSIONS.GET_ATTRIBUTE procedure. If you do not specify a session ID or enter NULL, then DESTROY_SESSION uses the session ID of the current application session.
force	If set to FALSE, this operation throws an error, in case the specified session is currently attached. If set to TRUE, the currently attached application session can be destroyed. This is an optional parameter.

Examples

```
DECLARE
  sessionid RAW(16);
BEGIN
 SYS.DBMS_XS_SESSIONS.CREATE_SESSION('lwtSession1', sessionid);
 SYS.DBMS_XS_SESSIONS.DESTROY_SESSION (sessionid);
END;
```

ADD_GLOBAL_CALLBACK Procedure

The ADD_GLOBAL_CALLBACK procedure registers an existing PL/SQL procedure as the event handler with the session operation specified by the event_type parameter. You can add more than one event handler for the same session operation for execution when the associated event occurs. Adding the global callback procedure automatically enables the callback procedure for execution. If more than one callback is added for the same session event, they are executed in according to their registration sequence, that is, the callback procedure that was registered first, is executed first. This procedure throws an error if an invalid event type is specified or the callback procedure does not exist.

Successful execution of this procedure requires the CALLBACK application privilege. This role can be obtained through PROVISIONER database role.

Syntax

```
ADD_GLOBAL_CALLBACK(
  event_type         IN PLS_INTEGER,
  callback_schema    IN VARCHAR2,
  callback_package   IN VARCHAR2,
  callback_procedure IN VARCHAR2);
```

Parameters

Parameter	Description
event_type	Select from the following event types: • CREATE_SESSION_EVENT • ATTACH_SESSION_EVENT • CREATE_NAMESPACE_EVENT • GUEST_TO_USER_EVENT • PROXY_TO_USER_EVENT • REVERT_TO_USER_EVENT • ENABLE_ROLE_EVENT • DISABLE_ROLE_EVENT • ENABLE_DYNAMIC_ROLE_EVENT • DISABLE_DYNAMIC_ROLE_EVENT • DETACH_SESSION_EVENT • TERMINATE_SESSION_EVENT • DIRECT_LOGIN_EVENT
callback_schema	Enter the name of the schema in which the callback procedure was created.
callback_package	Enter the name of the package in which the callback procedure was created. If callback procedure is standalone, NULL should be passed as callback_package parameter. This parameter is optional only if the callback procedure is in a package.
callback_procedure	Enter the name of the procedure that defines the global callback.

Examples

```
BEGIN
 SYS.DBMS_XS_SESSIONS.ADD_GLOBAL_CALLBACK (
  DBMS_XS_SESSIONS.CREATE_SESSION_EVENT,
  'APPS1_SCHEMA','APPS2_PKG','CREATE_SESSION_CB');
END;
```

ENABLE_GLOBAL_CALLBACK Procedure

The ENABLE_GLOBAL_CALLBACK procedure enables or disables the global callback procedure for execution. If a callback procedure associated with this event is not specified, all callback procedures associated with this global callback are enabled or disabled. If an invalid event type is specified or invalid callback procedure is specified, an error is thrown.

Syntax

```
ENABLE_GLOBAL_CALLBACK(
  event_type         IN PLS_INTEGER,
  enable             IN BOOLEAN  DEFAULT TRUE,
  callback_schema    IN VARCHAR2 DEFAULT NULL,
  callback_package   IN VARCHAR2 DEFAULT NULL,
  callback_procedure IN VARCHAR2 DEFAULT NULL);
```

Parameters

Parameter	Description
event_type	Select from the following event types: • CREATE_SESSION_EVENT • ATTACH_SESSION_EVENT • CREATE_NAMESPACE_EVENT • GUEST_TO_USER_EVENT • PROXY_TO_USER_EVENT • REVERT_TO_USER_EVENT • ENABLE_ROLE_EVENT • DISABLE_ROLE_EVENT • ENABLE_DYNAMIC_ROLE_EVENT • DISABLE_DYNAMIC_ROLE_EVENT • DETACH_SESSION_EVENT • TERMINATE_SESSION_EVENT • DIRECT_LOGIN_EVENT
enable	Specifies whether the global callback is to be enabled or disabled. The default value is TRUE, meaning enable.
callback_schema	Enter the name of the schema in which the global callback was created.
callback_package	Enter the name of the package in which the global callback was created.
callback_procedure	Enter the name of the procedure that defines the global callback.

Examples

```
BEGIN
 SYS.DBMS_XS_SESSIONS.ENABLE_GLOBAL_CALLBACK (
  DBMS_XS_SESSIONS.CREATE_SESSION_EVENT,
  TRUE, 'APPS1_SCHEMA','APPS2_PKG','CREATE_SESSION_CB');
END;
```

DELETE_GLOBAL_CALLBACK Procedure

The `DELETE_GLOBAL_CALLBACK` procedure removes the global callback from registration. (It does not delete the global callback itself.) If a callback procedure is not specified, all callback procedures associated with this global callback are deleted. If an invalid event type is specified, an error is thrown.

Syntax

```
DELETE_GLOBAL_CALLBACK(
  event_type         IN PLS_INTEGER,
  callback_schema    IN VARCHAR2 DEFAULT NULL,
  callback_package   IN VARCHAR2 DEFAULT NULL,
  callback_procedure IN VARCHAR2 DEFAULT NULL);
```

Parameters

Parameter	Description
`event_type`	Select from the following event types: • `CREATE_SESSION_EVENT` • `ATTACH_SESSION_EVENT` • `CREATE_NAMESPACE_EVENT` • `GUEST_TO_USER_EVENT` • `PROXY_TO_USER_EVENT` • `REVERT_TO_USER_EVENT` • `ENABLE_ROLE_EVENT` • `DISABLE_ROLE_EVENT` • `ENABLE_DYNAMIC_ROLE_EVENT` • `DISABLE_DYNAMIC_ROLE_EVENT` • `DETACH_SESSION_EVENT` • `TERMINATE_SESSION_EVENT` • `DIRECT_LOGIN_EVENT`
`callback_schema`	Enter the name of the schema in which the global callback was created.
`callback_package`	Enter the name of the package in which the global callback was created.
`callback_procedure`	Enter the name of the procedure that defines the global callback.

Examples

```
BEGIN
 SYS.DBMS_XS_SESSIONS.DELETE_GLOBAL_CALLBACK (
  DBMS_XS_SESSIONS.CREATE_SESSION_EVENT,
```

```
  'APPS1_SCHEMA','APPS2_PKG','CREATE_SESSION_CB');
END;
```

XS_ACL Package

The XS_ACL package creates procedures to create and manage Access Control Lists (ACLs).

This section includes the following topics:

- Security Model for the XS_ACL Package
- Constants
- Object Types, Constructor Functions, Synonyms, and Grants
- Summary of XS_ACL Subprograms

Security Model for the XS_ACL Package

The XS_ACL package is created under the SYS schema.

The DBA role is granted the ADMIN_ANY_SEC_POLICY privilege, which allows it to administer schema objects like ACLs, security classes, and security policies across all schemas.

Users can administer schema objects in their own schema if they have been granted the RESOURCE role for the schema. The RESOURCE role and the XS_RESOURCE application role include the ADMIN_SEC_POLICY privilege, required to administer schema objects in the schema as well as administering the policy artifacts within the granted schema to achieve policy management within an application.

Users can administer policy enforcement on the schema if they have been granted the APPLY_SEC_POLICY privilege. With this privilege, the user can administer policy enforcement within granted schemas to achieve policy management within an application.

Constants

The following constants define the parent ACL type:

```
EXTENDED              CONSTANT PLS_INTEGER := 1;
CONSTRAINED           CONSTANT PLS_INTEGER := 2;
```

The following constants define the principal's type:

```
PTYPE_XS              CONSTANT PLS_INTEGER := 1;
PTYPE_DB              CONSTANT PLS_INTEGER := 2;
PTYPE_DN              CONSTANT PLS_INTEGER := 3;
PTYPE_EXTERNAL        CONSTANT PLS_INTEGER := 4;
```

The following constants define the parameter's value type:

```
TYPE_NUMBER           CONSTANT PLS_INTEGER := 1;
TYPE_VARCHAR          CONSTANT PLS_INTEGER := 2;
```

Object Types, Constructor Functions, Synonyms, and Grants

The following object types, constructor functions, synonyms, and GRANT statements are defined for this package.

```
-- Type definition for ACE
CREATE OR REPLACE TYPE XS$ACE_TYPE AS OBJECT (

-- Member Variables
  privilege_list      XS$NAME_LIST,
  is_grant_ace        NUMBER,
  is_invert_principal NUMBER,
  principal_name      VARCHAR2(130),
  principal_type      NUMBER,
  start_date          TIMESTAMP WITH TIME ZONE,
  end_date            TIMESTAMP WITH TIME ZONE,

  CONSTRUCTOR FUNCTION XS$ACE_TYPE (
    privilege_list   IN XS$NAME_LIST,
    granted          IN BOOLEAN := TRUE,
    inverted         IN BOOLEAN := FALSE,
    principal_name   IN VARCHAR2,
    principal_type   IN PLS_INTEGER := 1,
    start_date       IN TIMESTAMP WITH TIME ZONE := NULL,
    end_date         IN TIMESTAMP WITH TIME ZONE := NULL)
  RETURN SELF AS RESULT,

  MEMBER PROCEDURE set_privileges(privilege_list IN XS$NAME_LIST),
  MEMBER FUNCTION get_privileges RETURN XS$NAME_LIST,
  MEMBER PROCEDURE set_grant(granted IN BOOLEAN),
  MEMBER FUNCTION is_granted RETURN BOOLEAN,
  MEMBER PROCEDURE set_inverted_principal(inverted IN BOOLEAN),
  MEMBER FUNCTION is_inverted_principal RETURN BOOLEAN,
  MEMBER PROCEDURE set_principal(principal_name IN VARCHAR2),
  MEMBER FUNCTION get_principal RETURN VARCHAR2,
  MEMBER PROCEDURE set_principal_type (principal_type IN PLS_INTEGER),
  MEMBER FUNCTION get_principal_type RETURN PLS_INTEGER,
  MEMBER PROCEDURE set_start_date(start_date IN TIMESTAMP WITH TIME ZONE),
  MEMBER FUNCTION get_start_date RETURN TIMESTAMP WITH TIME ZONE,
  MEMBER PROCEDURE set_end_date(end_date IN TIMESTAMP WITH TIME ZONE),
  MEMBER FUNCTION get_end_date RETURN TIMESTAMP WITH TIME ZONE
);
CREATE OR REPLACE TYPE XS$ACE_LIST AS VARRAY(1000) OF XS$ACE_TYPE;
```

Summary of XS_ACL Subprograms

Table 11-3 Summary of XS_ACL Subprograms

Subprogram	Description
CREATE_ACL Procedure	Creates an Access Control List (ACL).
APPEND_ACES Procedure	Adds one or more Access Control Entries (ACEs) to an existing ACL.
REMOVE_ACES Procedure	Removes all ACEs from an ACL.
SET_SECURITY_CLASS Procedure	Sets or modifies the security class for an ACL.

Table 11-3 (Cont.) Summary of XS_ACL Subprograms

Subprogram	Description
SET_PARENT_ACL Procedure	Sets or modifies the parent ACL for an ACL.
ADD_ACL_PARAMETER Procedure	Adds an ACL parameter value for a data security policy.
REMOVE_ACL_PARAMETERS Procedure	Removes ACL parameters and values for an ACL.
SET_DESCRIPTION Procedure	Sets a description string for an ACL.
DELETE_ACL Procedure	Deletes the specified ACL.

This section describes the following XS_ACL subprograms:

CREATE_ACL Procedure

The `CREATE_ACL` procedure creates a new Access Control List (ACL).

Syntax

```
XS_ACL.CREATE_ACL (  name            IN VARCHAR2,
  ace_list        IN XS$ACE_LIST,
  sec_class       IN VARCHAR2 := NULL,
  parent          IN VARCHAR2 := NULL,
  inherit_mode    IN PLS_INTEGER := NULL,
  description     IN VARCHAR2 := NULL);
```

Parameters

Parameter	Description
`name`	The name of the ACL to be created. The name is schema qualified, for example, `SCOTT.ACL1`. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as `ACL1`, and the current schema is `SCOTT`, it would resolve to `SCOTT.ACL1`.
`ace_list`	The list of Access Control Entries (ACEs) in the ACL.
`sec_class`	The name of the security class that specifies the scope or type of the ACL. If no security class is specified, then the `DML` class is used as the default security class. The name is schema qualified, for example, `SCOTT.ACL1`. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as `ACL1`, and the current schema is `SCOTT`, it would resolve to `SCOTT.ACL1`.
`parent`	The parent ACL name, if any. The name is schema qualified, for example, `SCOTT.ACL1`. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as `ACL1`, and the current schema is `SCOTT`, it would resolve to `SCOTT.ACL1`.
`inherit_mode`	The inheritance mode if a parent ACL is specified. The allowed values are: `EXTENDED` or `CONSTRAINED`.
`description`	An optional description for the ACL.

Examples

The following example creates an ACL called HRACL. This ACL includes ACEs contained in ace_list. The privileges used in ace_list are part of the HRPRIVS security class.

```
DECLARE
  ace_list XS$ACE_LIST;
BEGIN
  ace_list := XS$ACE_LIST(
      XS$ACE_TYPE(privilege_list=>XS$NAME_LIST('"SELECT"','VIEW_SENSITIVE_INFO'),
                  granted=>true,
                  principal_name=>'HRREP'),
      XS$ACE_TYPE(privilege_list=>XS$NAME_LIST('UPDATE_INFO'),
                  granted=>true,
                  principal_name=>'HRMGR'));
  SYS.XS_ACL.CREATE_ACL(name=>'HRACL',
                        ace_list=>ace_list,
                        sec_class=>'HRPRIVS',
                        description=>'HR Representative Access');
END;
```

APPEND_ACES Procedure

The APPEND_ACES procedure adds one or more ACE to an existing ACL.

Syntax

```
XS_ACL.APPEND_ACES (
  acl      IN VARCHAR2,
  ace      IN XS$ACE_TYPE);

XS.ACL.APPEND_ACES (
  acl      IN VARCHAR2,
  ace_list IN XS$ACE_LIST);
```

Parameters

Parameter	Description
acl	The name of the ACL to which the ACE is to be added. The name is schema qualified, for example, SCOTT.ACL1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as ACL1, and the current schema is SCOTT, it would resolve to SCOTT.ACL1.
ace	The ACE to be added to the ACL.
ace_list	The list of ACEs to be added to the ACL.

Examples

The following example adds an ACE to the HRACL ACL. The ACE grants the SELECT privilege to the DB_HR database user.

```
DECLARE
  ace_entry XS$ACE_TYPE;
BEGIN
  ace_entry := XS$ACE_TYPE(privilege_list=>XS$NAME_LIST('"SELECT"'),
```

```
                          granted=>true,
                          principal_name=>'DB_HR',
                          principal_type=>XS_ACL.PTYPE_DB);
  SYS.XS_ACL.APPEND_ACES('HRACL',ace_entry);
END;
```

REMOVE_ACES Procedure

The REMOVE_ACES procedure removes all ACEs from an ACL.

Syntax

```
XS_ACL.REMOVE_ACES (
  acl IN VARCHAR2);
```

Parameters

Parameter	Description
acl	The name of the ACL from which the ACEs are to be removed. The name is schema qualified, for example, SCOTT.ACL1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as ACL1, and the current schema is SCOTT, it would resolve to SCOTT.ACL1.

Examples

The following example removes all ACEs from the ACL called HRACL:

```
BEGIN
  SYS.XS_ACL.REMOVE_ACES('HRACL');
END;
```

SET_SECURITY_CLASS Procedure

The SET_SECURITY_CLASS procedure sets or modifies the security class for an ACL.

Syntax

```
XS_ACL.SET_SECURITY_CLASS (
  acl       IN VARCHAR2,
  sec_class IN VARCHAR2);
```

Parameters

Parameter	Description
acl	The name of the ACL for which the security class is to be set. The name is schema qualified, for example, SCOTT.ACL1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as ACL1, and the current schema is SCOTT, it would resolve to SCOTT.ACL1.

Parameter	Description
sec_class	The name of the security class that defines the ACL scope or type. The name is schema qualified, for example, SCOTT.ACL1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as ACL1, and the current schema is SCOTT, it would resolve to SCOTT.ACL1.

Examples

The following example associates the HRPRIVS security class with the HRACL ACL:

```
BEGIN
  SYS.XS_ACL.SET_SECURITY_CLASS('HRACL','HRPRIVS');
END;
```

SET_PARENT_ACL Procedure

The SET_PARENT_ACL sets or modifies the parent ACL for an ACL.

Syntax

```
XS_ACL.SET_PARENT_ACL(
  acl            IN VARCHAR2,
  parent         IN VARCHAR2,
  inherit_mode   IN PLS_INTEGER);
```

Parameters

Parameter	Description
acl	The name of the ACL whose parent needs to be set. The name is schema qualified, for example, SCOTT.ACL1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as ACL1, and the current schema is SCOTT, it would resolve to SCOTT.ACL1.
parent	The name of the parent ACL. The name is schema qualified, for example, SCOTT.ACL1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as ACL1, and the current schema is SCOTT, it would resolve to SCOTT.ACL1.
inherit_mode	The inheritance mode. This can be one of the following values: EXTENDED (extends from), CONSTRAINED (constrained with)

Examples

The following example sets the AllDepACL ACL as the parent ACL for the HRACL ACL. The inheritance type is set to EXTENDED.

```
BEGIN
  SYS.XS_ACL.SET_PARENT_ACL('HRACL','AllDepACL',XS_ACL.EXTENDED);
END;
```

ADD_ACL_PARAMETER Procedure

The ADD_ACL_PARAMETER adds an ACL parameter value for a data security policy.

Syntax

```
XS_ACL.ADD_ACL_PARAMETER (
  acl         IN VARCHAR2,
  policy      IN VARCHAR2,
  parameter   IN VARCHAR2,
  value       IN NUMBER);

XS_ACL.ADD_ACL_PARAMETER (
  acl         IN VARCHAR2,
  policy      IN VARCHAR2,
  parameter   IN VARCHAR2,
  value       IN VARCHAR2);
```

Parameters

Parameter	Description
acl	The name of the ACL to which the parameter is to be added. The name is schema qualified, for example, SCOTT.ACL1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as ACL1, and the current schema is SCOTT, it would resolve to SCOTT.ACL1.
policy	The name of the data security policy for which the ACL parameter has been created. The name is schema qualified, for example, SCOTT.ACL1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as ACL1, and the current schema is SCOTT, it would resolve to SCOTT.ACL1.
parameter	The name of the ACL parameter as defined by the data security policy.
value	The value of the ACL parameter to be used.

Examples

The following example adds the REGION parameter for ACL1. The name of the data security policy for which the ACL parameter is created is TEST_DS. The value of the REGION parameter is WEST.

```
BEGIN
  SYS.XS_ACL.ADD_ACL_PARAMETER('ACL1','TEST_DS','REGION', 'WEST');
END;
```

REMOVE_ACL_PARAMETERS Procedure

The REMOVE_ACL_PARAMETERS removes the specified ACL parameter for an ACL. If no parameter name is specified, then all ACL parameters for the ACL are removed.

Syntax

```
XS_ACL.REMOVE_ACL_PARAMETERS (
  acl         IN VARCHAR2,
```

```
  parameter  IN VARCHAR2);

XS_ACL.REMOVE_ACL_PARAMETERS (
  acl IN VARCHAR2);
```

Parameters

Parameter	Description
acl	The name of the ACL from which the parameter(s) are to be removed. The name is schema qualified, for example, SCOTT.ACL1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as ACL1, and the current schema is SCOTT, it would resolve to SCOTT.ACL1.
parameter	The name of the parameter that needs to be removed from the ACL.

Examples

The following example removes the REGION parameter from the ACL1 ACL:

```
BEGIN
  XS_ACL.REMOVE_ACL_PARAMETERS('ACL1', 'REGION');
END;
```

The following example removes all ACL parameters for ACL1.

```
BEGIN
  SYS.XS_ACL.REMOVE_ACL_PARAMETERS('ACL1');
END;
```

SET_DESCRIPTION Procedure

The SET_DESCRIPTION procedure sets a description string for an ACL.

Syntax

```
XS_ACL.SET_DESCRIPTION (
  acl         IN VARCHAR2,
  description IN VARCHAR2);
```

Parameters

Parameter	Description
acl	The name of the ACL for which the description is to be set. The name is schema qualified, for example, SCOTT.ACL1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as ACL1, and the current schema is SCOTT, it would resolve to SCOTT.ACL1.
description	A string description for the ACL.

Examples

The following example sets a description for the HRACL ACL:

```
BEGIN
  SYS.XS_ACL.SET_DESCRIPTION('HRACL','Grants privileges to HR representatives and
```

```
                                managers.');
END;
```

DELETE_ACL Procedure

The DELETE_ACL procedure deletes the specified ACL.

Syntax

```
XS_ACL.DELETE_ACL (
  acl           IN VARCHAR2,
  delete_option IN PLS_INTEGER := XS_ADMIN_UTIL.DEFAULT_OPTION);
```

Parameters

Parameter	Description
acl	The name of the ACL to be deleted. The name is schema qualified, for example, SCOTT.ACL1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as ACL1, and the current schema is SCOTT, it would resolve to SCOTT.ACL1.
delete_option	The delete option to use. To the data security policy, the behavior of the following options is the same: • DEFAULT_OPTION: The default option allows deleting an ACL only if it is not referenced elsewhere. If the ACL is referenced elsewhere, then the ACL cannot be deleted. For example, the delete operation fails if you try to delete an ACL that is part of a data security policy. • CASCADE_OPTION: The cascade option deletes the ACL and also removes the ACL reference in a data realm constraint of a data security policy. • ALLOW_INCONSISTENCIES_OPTION: The allow inconsistencies option lets you delete the ACL even if other entities have late binding references to it. In this mode, the ACL will be removed but the references are not removed.

Examples

The following example deletes the HRACL ACL using the default delete option:

```
BEGIN
  SYS.XS_ACL.DELETE_ACL('HRACL');
END;
```

XS_ADMIN_UTIL Package

The XS_ADMIN_UTIL package contains helper subprograms to be used by other packages.

This section includes the following topics:

- Security Model

- Constants
- Object Types, Constructor Functions, Synonyms, and Grants
- Summary of XS_ADMIN_UTIL Subprograms

Security Model

The XS_ADMIN_UTIL package is created in the SYS schema. The caller has invoker's rights on this package. The SYS privilege is required to grant or revoke a Real Application Security system privilege to or from a user or role.

Constants

The following constants define the delete options:

```
DEFAULT_OPTION               CONSTANT PLS_INTEGER := 1;
CASCADE_OPTION               CONSTANT PLS_INTEGER := 2;
ALLOW_INCONSISTENCIES_OPTION CONSTANT PLS_INTEGER := 3;
```

The following constants define the principal's type:

```
PTYPE_XS             CONSTANT PLS_INTEGER := 1;
PTYPE_DB             CONSTANT PLS_INTEGER := 2;
PTYPE_DN             CONSTANT PLS_INTEGER := 3;
PTYPE_EXTERNAL       CONSTANT PLS_INTEGER := 4;
```

Object Types, Constructor Functions, Synonyms, and Grants

The following object types, constructor functions, synonyms, and GRANT statements are defined for this package.

```
CREATE OR REPLACE TYPE XS$LIST IS VARRAY(1000) OF VARCHAR2(4000);
CREATE OR REPLACE TYPE XS$NAME_LIST IS VARRAY(1000) OF VARCHAR2(261);
```

Summary of XS_ADMIN_UTIL Subprograms

Table 11-4 Summary of XS_ADMIN_UTIL Subprograms

Subprogram	Brief Description
GRANT_SYSTEM_PRIVILEGE Procedure	Grant a Real Application Security system privilege to a user or role.
REVOKE_SYSTEM_PRIVILEGE Procedure	Revoke a Real Application Security system privilege from a user or role.

This section describes the following XS_ADMIN_UTIL subprograms:

GRANT_SYSTEM_PRIVILEGE Procedure

The GRANT_SYSTEM_PRIVILEGE procedure is used to grant a Real Application Security system privilege or schema privilege to a user or role. Only SYS or a user who has GRANT ANY PRIVILEGE privilege can perform this operation.

The audit action AUDIT_GRANT_PRIVILEGE, audits all GRANT_SYSTEM_PRIVILEGE calls for granting system privileges or schema privileges.

Syntax

```
XS_ADMIN_UTIL.GRANT_SYSTEM_PRIVILEGE (
  priv_name      IN VARCHAR2,
  user_name      IN VARCHAR2,
  user_type      IN  PLS_INTEGER := XS_ADMIN_UTIL.PTYPE_DB,
  schema         IN VARCHAR2);
```

Parameters

Parameter	Description
priv_name	Specifies the name of the Real Application Security system privilege or schema privilege to be granted.
user_name	Specifies the name of the user or role to which the Real Application Security system privilege or schema privilege is to be granted.
user_type	The type of user. By default the database user.
schema	The schema on which the privilege is granted. The value is NULL if the privilege is a system privilege.

Examples

The following example creates a database user, dbuser1, and grants Real Application Security privilege ADMINISTER_SESSION to this database user and specifies the user_type as XS_ADMIN_UTIL.PTYPE_DB, though by default, this is the default value and need not be specified.

```
SQL> CREATE USER dbuser1 identified by password;

SQL> EXEC SYS.XS_ADMIN_UTIL.GRANT_SYSTEM_PRIVILEGE('ADMINISTER_SESSION', 'dbuser1',
XS_ADMIN_UTIL.PTYPE_DB, 'HR1');
```

The following example creates an application user, user1, and grants Real Application Security privilege ADMINISTER_SESSION to this application user, specifies the user_type as XS_ADMIN_UTIL.PTYPE_XS, and specifies the schema as HR1.

```
SQL> EXEC SYS.XS_PRINCIPAL.CREATE_USER('user1','HR1');

SQL> EXEC SYS.XS_PRINCIPAL.SET_PASSWORD('user1', 'password');

SQL> EXEC SYS.XS_ADMIN_UTIL.GRANT_SYSTEM_PRIVILEGE('ADMINISTER_SESSION', 'user1',
XS_ADMIN_UTIL.PTYPE_XS, 'HR1');
```

REVOKE_SYSTEM_PRIVILEGE Procedure

The REVOKE_SYSTEM_PRIVILEGE is used to revoke a Real Application Security ststem privilege or schema privilege from a user or role. Only SYS privilege or a user with GRANT ANY PRIVILEGE privilege can perform this operation.

The audit action AUDIT_REVOKE_PRIVILEGE, audits all REVOKE_SYSTEM_PRIVILEGE calls for revoking system privileges or schema privileges.

Syntax

```
XS_ADMIN_UTIL.REVOKE_SYSTEM_PRIVILEGE (
  priv_name      IN VARCHAR2,
  user_name      IN VARCHAR2,
  user_type      IN PLS_INTEGER := XS_ADMIN_UTIL.PTYPE_DB,
  schema         IN VARCHAR2);
```

Parameters

Parameter	Description
priv_name	Specifies the name of the Real Application Security system privilege or schema privilege to be revoked.
user_name	Specifies the name of the user or role from which the Real Application Security system privilege or schema privilege is to be revoked.
user_type	The type of user. By default the database user.
schema	The schema on which the privilege is revoked. The value is NULL if the privilege is a system privilege.

Examples

The following example creates a database user, dbuser1, and revokes Real Application Security privilege ADMINISTER_SESSION from this database user and specifies the user_type as XS_ADMIN_UTIL.PTYPE_DB, though by default, this is the default value and need not be specified.

```
CREATE USER dbuser1 identified by password;

SYS.XS_ADMIN_UTIL.REVOKE_SYSTEM_PRIVILEGE('ADMINISTER_SESSION','dbuser1',
XS_ADMIN_UTIL.PTYPE_DB, 'HR1');
```

The following example creates an application user, user1, and revokes Real Application Security privilege ADMINISTER_SESSION from this application user and specifies the user_type as XS_ADMIN_UTIL.PTYPE_XS.

```
SQL> EXEC SYS.XS_PRINCIPAL.CREATE_USER('user1','HR1');

SQL> EXEC SYS.XS_PRINCIPAL.SET_PASSWORD('user1', 'password');

SQL> EXEC SYS.XS_ADMIN_UTIL.REVOKE_SYSTEM_PRIVILEGE('ADMINISTER_SESSION','user1',
XS_ADMIN_UTIL.PTYPE_XS, 'HR1');
```

XS_DATA_SECURITY Package

The XS_DATA_SECURITY package includes procedures to create, manage, and delete data security policies, associated data realm constraints, column constraints, and ACL parameters.

This section includes the following topics:

- Security Model
- Object Types, Constructor Functions, Synonyms, and Grants
- Summary of XS_DATA_SECURITY Subprograms

Security Model for the XS_DATA_SECURITY Package

The XS_DATA_SECURITY package is created under the SYS schema. The DBA role is granted the ADMIN_ANY_SEC_POLICY, which allows it to administer schema objects like ACLs, security classes, and security policies across all schemas. In addition, users granted the ADMIN_ANY_SEC_POLICY can call the following procedures: ENABLE_OBJECT_POLICY, DISABLE_OBJECT_POLICY, APPLY_OBJECT_POLICY, and REMOVE_OBJECT_POLICY.

Users can administer schema objects in their own schema if they have been granted the RESOURCE role for the schema. The RESOURCE role and the XS_RESOURCE application role include the ADMIN_SEC_POLICY privilege, required to administer schema objects in the schema as well as administering the policy artifacts within the granted schema to achieve policy management within an application.

Users can administer policy enforcement on the schema if they have been granted the APPLY_SEC_POLICY privilege. With this privilege, the user can administer policy enforcement within granted schemas to achieve policy management within an application.

Object Types, Constructor Functions, Synonyms, and Grants

The following object types, constructor functions, synonyms, and GRANT statements are defined for this package.

```
-- Create a type for key
CREATE OR REPLACE TYPE XS$KEY_TYPE AS OBJECT (
primary_key      VARCHAR2(130),
foreign_key      VARCHAR2(4000),
-- Foreign key type; 1 = col name, 2 = col value
foreign_key_type NUMBER,
-- Constructor function
CONSTRUCTOR FUNCTION XS$KEY_TYPE
                     (primary_key      IN VARCHAR2,
                      foreign_key      IN VARCHAR2,
                      foreign_key_type IN NUMBER)
                      RETURN SELF AS RESULT,

MEMBER FUNCTION GET_PRIMARY_KEY RETURN VARCHAR2,
MEMBER FUNCTION GET_FOREIGN_KEY RETURN VARCHAR2,
MEMBER FUNCTION GET_FOREIGN_KEY_TYPE RETURN NUMBER,
);
CREATE OR REPLACE TYPE XS$KEY_LIST AS VARRAY(1000) OF XS$KEY_TYPE;
CREATE OR REPLACE TYPE XS$REALM_CONSTRAINT_TYPE AS OBJECT (
-- Member variables
realm_type    NUMBER,
-- Member evaluation rule
realm              VARCHAR2(4000),
-- acl list of instance set
acl_list             XS$NAME_LIST,
-- isStatic variable for instance set. Stored as INTEGER. No boolean datatype
-- for objects. False is stored as 0 and TRUE is stored as 1
is_static          INTEGER,
-- Indicate if the realm is parameterized.
parameterized      INTEGER,
-- parent schema name for inherited from
parent_schema      VARCHAR2(130),
```

```
-- parent object name for inherited from
parent_object      VARCHAR2(130),
-- keys for inherited from
key_list           XS$KEY_LIST,
-- when condition for inherited from
when_condition     VARCHAR2(4000),

-- Constructor function - row_level realm
CONSTRUCTOR FUNCTION XS$REALM_CONSTRAINT_TYPE
                     (realm                 IN VARCHAR2,
                      acl_list              IN XS$NAME_LIST,
                      is_static             IN BOOLEAN := FALSE)
                      RETURN SELF AS RESULT,

-- Constructor function - parameterized row_level realm
CONSTRUCTOR FUNCTION XS$REALM_CONSTRAINT_TYPE
                     (realm                 IN VARCHAR2,
                      is_static             IN BOOLEAN := FALSE)
                      RETURN SELF AS RESULT,

-- Constructor function - master realm
CONSTRUCTOR FUNCTION XS$REALM_CONSTRAINT_TYPE
                     (parent_schema  IN VARCHAR2,
                      parent_object  IN VARCHAR2,
                      key_list       IN XS$KEY_LIST,
                      when_condition IN VARCHAR2:= NULL)
                      RETURN SELF AS RESULT,

-- Accessor functions
MEMBER FUNCTION GET_TYPE RETURN NUMBER,
MEMBER FUNCTION GET_REALM RETURN VARCHAR2,
MEMBER FUNCTION GET_ACLS RETURN XS$NAME_LIST,
MEMBER FUNCTION IS_DYNAMIC_REALM RETURN BOOLEAN,
MEMBER FUNCTION IS_STATIC_REALM RETURN BOOLEAN,
MEMBER FUNCTION IS_PARAMETERIZED_REALM RETURN BOOLEAN,
MEMBER FUNCTION GET_KEYS RETURN XS$KEY_LIST,
MEMBER FUNCTION GET_PARENT_SCHEMA RETURN VARCHAR2,
MEMBER FUNCTION GET_PARENT_OBJECT RETURN VARCHAR2,
MEMBER FUNCTION GET_WHEN_CONDITION RETURN VARCHAR2,
MEMBER PROCEDURE SET_REALM(realm IN VARCHAR2),
MEMBER PROCEDURE ADD_ACLS(acl      IN VARCHAR2),
MEMBER PROCEDURE ADD_ACLS(acl_list IN XS$NAME_LIST),
MEMBER PROCEDURE SET_ACLS(acl_list IN XS$NAME_LIST),
MEMBER PROCEDURE SET_DYNAMIC,
MEMBER PROCEDURE SET_STATIC,
MEMBER PROCEDURE ADD_KEYS(key IN XS$KEY_TYPE),
MEMBER PROCEDURE ADD_KEYS(key_list IN XS$KEY_LIST),
MEMBER PROCEDURE SET_KEYS(key_list IN XS$KEY_LIST),
MEMBER PROCEDURE SET_PARENT_SCHEMA(parent_schema IN VARCHAR2),
MEMBER PROCEDURE SET_PARENT_OBJECT(parent_object IN VARCHAR2),
MEMBER PROCEDURE SET_WHEN_CONDITION(when_condition IN VARCHAR2)
);
-- Create a list of realm constraint type
CREATE OR REPLACE TYPE XS$REALM_CONSTRAINT_LIST AS VARRAY(1000)
                       OF XS$REALM_CONSTRAINT_TYPE;
-- Create a type for column(attribute) security
CREATE OR REPLACE TYPE XS$COLUMN_CONSTRAINT_TYPE AS OBJECT (
-- column list
column_list        XS$LIST,
-- privilege for column security
privilege          VARCHAR2(261),
```

```
-- Constructor function
CONSTRUCTOR FUNCTION XS$COLUMN_CONSTRAINT_TYPE
                    (column_list  IN XS$LIST,
                     privilege    IN VARCHAR2)
                     return SELF AS RESULT,
MEMBER FUNCTION GET_COLUMNS RETURN XS$LIST,
MEMBER FUNCTION GET_PRIVILEGE RETURN VARCHAR2,
MEMBER PROCEDURE ADD_COLUMNS(column IN VARCHAR2),
MEMBER PROCEDURE ADD_COLUMNS(column_list IN XS$LIST),
MEMBER PROCEDURE SET_COLUMNS(column_list IN XS$LIST),
MEMBER PROCEDURE SET_PRIVILEGE(privilege IN VARCHAR2)
);
-- Create a list of column constraint for column security
CREATE OR REPLACE TYPE XS$COLUMN_CONSTRAINT_LIST
                      IS VARRAY(1000) of XS$COLUMN_CONSTRAINT_TYPE;
```

Summary of XS_DATA_SECURITY Subprograms

Table 11-5 Summary of XS_DATA_SECURITY Subprograms

Subprogram	Brief Description
CREATE_POLICY Procedure	Creates a new data security policy.
APPEND_REALM_CONSTRAINTS Procedure	Adds one or more data realm constraints to an existing data security policy.
REMOVE_REALM_CONSTRAINTS Procedure	Removes all data realm constraints for the specified data security policy.
ADD_COLUMN_CONSTRAINTS Procedure	Adds one or more column constraint to the specified data security policy.
REMOVE_COLUMN_CONSTRAINTS Procedure	Removes all column constraints from a data security policy.
CREATE_ACL_PARAMETER Procedure	Creates an ACL parameter for the specified data security policy.
DELETE_ACL_PARAMETER Procedure	Deletes an ACL parameter from the specified data security policy.
SET_DESCRIPTION Procedure	Sets a description string for the specified data security policy.
DELETE_POLICY Procedure	Deletes a data security policy.

Table 11-6 Summary of XS_DATA_SECURITY Subprograms for Managing Data Security Policies on Tables or Views

Subprogram	Brief Description
ENABLE_OBJECT_POLICY Procedure	Enables the data security policy for the specified table or view.
DISABLE_OBJECT_POLICY Procedure	Disables the data security policy for the specified table or view.
REMOVE_OBJECT_POLICY Procedure	Removes or drops the data security from the specified table or view without deleting it.
APPLY_OBJECT_POLICY Procedure	Enables or reenables the data security policy for the specified table or view.

This section describes the following XS_DATA_SECURITY subprograms:

CREATE_POLICY Procedure

The CREATE_POLICY procedure creates a new data security policy.

Syntax

```
XS_DATA_SECURITY.CREATE_POLICY (
  name                  IN VARCHAR2,
  realm_constraint_list  IN XS$REALM_CONSTRAINT_LIST,
  column_constraint_list IN XS$COLUMN_CONSTRAINT_LIST := NULL,
  description           IN VARCHAR2 :=NULL) ;
```

Parameters

Parameter	Description
name	The name for the data security policy to be created. The name is schema qualified, for example, SCOTT.POLICY1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as POLICY1, and the current schema is SCOTT, it would resolve to SCOTT.POLICY1.
realm_constraint_list	The list of data realm constraints, which determine the rows to be protected by the data security policy.
column_constraint_list	This is optional. The list of attributes and the privileges protecting them.
description	An optional description for the data security policy.

Examples

The following example creates a data security policy called USER1.EMPLOYEES_DS. It uses a data realm constraint to protect data related to department numbers 60 and 100. In addition, access to the SALARY column (attribute) is restricted using an column constraint.

```
DECLARE
  realm_cons XS$REALM_CONSTRAINT_LIST;
  column_cons XS$COLUMN_CONSTRAINT_LIST;
BEGIN
  realm_cons :=
    XS$REALM_CONSTRAINT_LIST(
      XS$REALM_CONSTRAINT_TYPE(realm=> 'DEPARTMENT_ID in (60, 100)',
                               acl_list=> XS$NAME_LIST('HRACL')));

  column_cons :=
    XS$COLUMN_CONSTRAINT_LIST(
      XS$COLUMN_CONSTRAINT_TYPE(column_list=> XS$LIST('SALARY'),
                            privilege=> 'VIEW_SENSITIVE_INFO'));

  SYS.XS_DATA_SECURITY.CREATE_POLICY(
          name=>'USER1.EMPLOYEES_DS',
          realm_constraint_list=>realm_cons,
          column_constraint_list=>column_cons);
END;
```

APPEND_REALM_CONSTRAINTS Procedure

The APPEND_REALM_CONSTRAINTS procedure adds one or more data realm constraints to an existing data security policy.

Syntax

```
XS_DATA_SECURITY.APPEND_REALM_CONSTRAINTS (
  policy           IN VARCHAR2,
  realm_constraint IN XS$REALM_CONSTRAINT_TYPE);

XS_DATA_SECURITY.APPEND_REALM_CONSTRAINTS (
  policy               IN VARCHAR2,
  realm_constraint_list IN XS$REALM_CONSTRAINT_LIST);
```

Parameters

Parameter	Description
policy	The name of the data security policy to which the data realm constraints are to be added. The name is schema qualified, for example, SCOTT.POLICY1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as POLICY1, and the current schema is SCOTT, it would resolve to SCOTT.POLICY1.
realm_constraint	The data realm constraint to be added to the data security policy.
realm_constraint_list	The list of data realm constraints to be added to the data security policy.

Examples

The following example appends a new data realm constraint to the EMPLOYEES_DS data security policy.

```
DECLARE
  realm_cons XS$REALM_CONSTRAINT_TYPE;
BEGIN
  realm_cons :=
      XS$REALM_CONSTRAINT_TYPE(realm=> 'DEPARTMENT_ID in (40, 50)',
                               acl_list=> XS$NAME_LIST('HRACL'));

  SYS.XS_DATA_SECURITY.APPEND_REALM_CONSTRAINTS(
          policy=>'EMPLOYEES_DS',
          realm_constraint=>realm_cons);
END;
```

REMOVE_REALM_CONSTRAINTS Procedure

The REMOVE_REALM_CONSTRAINTS procedure removes all data realm constraints from a data security policy.

Syntax

```
XS_DATA_SECURITY.REMOVE_REALM_CONSTRAINTS (
  policy IN VARCHAR2);
```

Parameters

Parameter	Description
policy	The name of the data security policy from which the data realm constraints are to be removed. The name is schema qualified, for example, SCOTT.POLICY1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as POLICY1, and the current schema is SCOTT, it would resolve to SCOTT.POLICY1.

Examples

The following example removes all data realm constraints from the EMPLOYEES_DS data security policy.

```
BEGIN
  SYS.XS_DATA_SECURITY.REMOVE_REALM_CONSTRAINTS('EMPLOYEES_DS');
END;
```

ADD_COLUMN_CONSTRAINTS Procedure

The ADD_COLUMN_CONSTRAINTS procedure adds one or more column constraint to a data security policy.

Syntax

```
XS_DATA_SECURITY.ADD_COLUMN_CONSTRAINTS (
  policy            IN VARCHAR2,
  column_constraint IN XS$COLUMN_CONSTRAINT_TYPE);

XS_DATA_SECURITY.ADD_COLUMN_CONSTRAINTS (
  policy                IN VARCHAR2,
  column_constraint_list IN XS$COLUMN_CONSTRAINT_LIST);
```

Parameters

Parameter	Description
policy	The name of the data security policy to which the attribute constraints are to be added. The name is schema qualified, for example, SCOTT.POLICY1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as POLICY1, and the current schema is SCOTT, it would resolve to SCOTT.POLICY1.
column_constraint	The column constraint to be added.
column_constraint_list	The list of column constraints to be added.

Examples

The following example adds a column constraint on the COMMISSION_PCT column in the EMPLOYEES_DS data security policy:

```
DECLARE
  column_cons XS$COLUMN_CONSTRAINT_TYPE;
BEGIN
  column_cons :=
      XS$COLUMN_CONSTRAINT_TYPE(column_list=> XS$LIST('COMMISSION_PCT'),
                          privilege=> 'VIEW_SENSITIVE_INFO');

  SYS.XS_DATA_SECURITY.ADD_COLUMN_CONSTRAINTS(
          policy=>'EMPLOYEES_DS',
          column_constraint=>column_cons);
END;
```

REMOVE_COLUMN_CONSTRAINTS Procedure

The REMOVE_COLUMN_CONSTRAINTS procedure removes all column constraints from a data security policy.

Syntax

```
XS_DATA_SECURITY.REMOVE_COLUMN_CONSTRAINTS (
  policy IN VARCHAR2,);
```

Parameters

Parameter	Description
policy	The name of the data security policy for which the column constraints are to be removed. The name is schema qualified, for example, SCOTT.POLICY1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as POLICY1, and the current schema is SCOTT, it would resolve to SCOTT.POLICY1.

Examples

The following example removes all column constraints from the EMPLOYEES_DS data security policy:

```
BEGIN
  SYS.XS_DATA_SECURITY.REMOVE_COLUMN_CONSTRAINTS('EMPLOYEES_DS');
END;
```

CREATE_ACL_PARAMETER Procedure

The CREATE_ACL_PARAMETER procedure creates an ACL parameter for a data security policy.

Syntax

```
XS_DATA_SECURITY.CREATE_ACL_PARAMETER (
  policy     IN VARCHAR2,
```

```
  parameter  IN VARCHAR2,
  param_type IN NUMBER);
```

Parameters

Parameter	Description
policy	The name of the data security policy for which the ACL parameter needs to be created. The name is schema qualified, for example, SCOTT.POLICY1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as POLICY1, and the current schema is SCOTT, it would resolve to SCOTT.POLICY1.
parameter	The name of the ACL parameter to be created.
param_type	The data type of the parameter. This can be 1 (NUMBER) or 2 (VARCHAR).

Examples

The following examples creates an ACL parameter, called DEPT_POLICY, for the EMPLOYEES_DS data security policy:

```
BEGIN
  SYS.XS_DATA_SECURITY.CREATE_ACL_PARAMETER('EMPLOYEES_DS','DEPT_POLICY',1);
END;
```

DELETE_ACL_PARAMETER Procedure

The DELETE_ACL_PARAMETER procedure deletes an ACL parameter for a data security policy.

Syntax

```
XS_DATA_SECURITY.DELETE_ACL_PARAMETER (
  policy               IN VARCHAR2,
  parameter            IN VARCHAR2,
  delete_option        IN PLS_INTEGER := XS_ADMIN_UTIL.DEFAULT_OPTION);
```

Parameters

Parameter	Description
policy	The name of the data security policy for which the ACL parameter is to be deleted. The name is schema qualified, for example, SCOTT.POLICY1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as POLICY1, and the current schema is SCOTT, it would resolve to SCOTT.POLICY1.
parameter	The name of the ACL parameter to be deleted.

Parameter	Description
delete_option	The delete option to use. The following options are available: • DEFAULT_OPTION (default): The default option allows deleting an ACL parameter only if it is not referenced elsewhere. If there are other entities that reference the ACL parameter, then the ACL parameter cannot be deleted. • CASCADE_OPTION: The cascade option deletes the ACL parameter together with any references to it.The user deleting the security class must have privileges to delete these references as well. • ALLOW_INCONSISTENCIES_OPTION: The allow inconsistencies option lets you delete the entity even if other entities have late binding references to it. If the entity is part of an early dependency, then the delete fails and an error is raised.

Examples

The following example deletes the DEPT_POLICY ACL parameter from the EMPLOYEES_DS data security policy, using the default option.

```
BEGIN
  SYS.XS_DATA_SECURITY.DELETE_ACL_PARAMETER('EMPLOYEES_DS','DEPT_POLICY',
                                            XS_ADMIN_UTIL.DEFAULT_OPTION);
END;
```

SET_DESCRIPTION Procedure

The SET_DESCRPTION procedure sets a description string for the specified data security policy.

Syntax

```
XS_DATA_SECURITY.SET_DESCRIPTION (
  policy         IN VARCHAR2,
  description    IN VARCHAR2);
```

Parameters

Parameter	Description
policy	The name of the data security policy for which the description is to be set. The name is schema qualified, for example, SCOTT.POLICY1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as POLICY1, and the current schema is SCOTT, it would resolve to SCOTT.POLICY1.
description	A description string for the specified data security policy.

Examples

The following example sets a description string for the EMPLOYEES_DS data security policy:

```
BEGIN
  SYS.XS_DATA_SECURITY.SET_DESCRIPTION('EMPLOYEES_DS',
                                       'Data Security Policy for HR.EMPLOYEES');
END;
```

DELETE_POLICY Procedure

The DELETE_POLICY procedure deletes a data security policy.

Syntax

```
XS_DATA_SECURITY.DELETE_POLICY(
  policy        IN VARCHAR2,
  delete_option IN PLS_INTEGER := XS_ADMIN_UTIL.DEFAULT_OPTION);
```

Parameters

Parameter	Description
policy	The name of the data security policy to be deleted. The name is schema qualified, for example, SCOTT.POLICY1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as POLICY1, and the current schema is SCOTT, it would resolve to SCOTT.POLICY1.
delete_option	The delete option to use. To the security policy, the behavior of the following options is the same: • DEFAULT_OPTION: The default option allows deleting a data security policy only if it is not referenced elsewhere. If there are other entities that reference the data security policy, then the data security policy cannot be deleted. • CASCADE_OPTION: The cascade option deletes the data security policy together with any references to it.The user deleting the data security policy deletes these references as well. • ALLOW_INCONSISTENCIES_OPTION: The allow inconsistencies option lets you delete the entity even if other entities have late binding references to it. If the entity is part of an early dependency, then the delete fails and an error is raised.

Examples

The following example deletes the EMPLOYEES_DS data security policy using the default option.

```
BEGIN
  SYS.XS_DATA_SECURITY.DELETE_POLICY('EMPLOYEES_DS',
                                     XS_ADMIN_UTIL.DEFAULT_OPTION);
END;
```

ENABLE_OBJECT_POLICY Procedure

The ENABLE_OBJECT_POLICY procedure enables the data security policy for the specified table or view. ENABLE_OBJECT_POLICY enables the ACL-based row level security policy for the table or view.

You may want to enable data security policies after you perform an import or export on the tables that it affects, or for debugging purposes.

To find the status of the data security policies for tables or views available for the current user, query the DBA_XS_APPLIED_POLICIES data dictionary view.

Before enforcing policies, a check is made for the APPLY_SEC_POLICY privilege.

Syntax

```
XS_DATA_SECURITY.ENABLE_OBJECT_POLICY (
 policy  IN VARCHAR2,
 schema  IN VARCHAR2,
 object  IN VARCHAR2);
```

Parameters

Parameter	Description
policy	The name of the data security policy to be enabled. The name is schema qualified, for example, SCOTT.POLICY1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as POLICY1, and the current schema is SCOTT, it would resolve to SCOTT.POLICY1.
schema	The name of the schema that contains the table or view to enable.
object	The name of the table or view to enable the data security policy.

Examples

The following example enables XDS for the products table in the sales schema.

```
BEGIN
  SYS.XS_DATA_SECURITY.ENABLE_OBJECT_POLICY(policy =>'CUST_DS', schema=>'sales',
object=>'products');
END;
```

DISABLE_OBJECT_POLICY Procedure

The DISABLE_OBJECT_POLICY procedure disables the data security policy for the specified table or view. DISABLE_OBJECT_POLICY disables the ACL-based row level security policy for the table or view.

You may want to disable Real Application Security if you are performing an import or export on the tables that it affects, or for debugging purposes.

To find the status of the data security policies for tables or views available for the current user, query the DBA_XS_APPLIED_POLICIES data dictionary view.

Before enforcing policies, a check is made for the APPLY_SEC_POLICY privilege.

Syntax

```
XS_DATA_SECURITY.DISABLE_OBJECT_POLICY (
 policy  IN VARCHAR2,
 schema  IN VARCHAR2,
 object  IN VARCHAR2);
```

Parameters

Parameter	Description
policy	The name of the data security policy to be disabled. The name is schema qualified, for example, SCOTT.POLICY1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as POLICY1, and the current schema is SCOTT, it would resolve to SCOTT.POLICY1.
schema	The name of the schema that contains the table or view to disable.
object	The name of the table or view to disable a data security policy.

Examples

The following example disables XDS for the products table in the sales schema.

```
BEGIN
  SYS.XS_DATA_SECURITY.DISABLE_OBJECT_POLICY(policy =>'CUST_DS', schema=>'sales',
object=>'products');
END;
```

REMOVE_OBJECT_POLICY Procedure

The REMOVE_OBJECT_POLICY procedure drops the data security policy from the specified table or view without deleting it. REMOVE_OBJECT_POLICY drops the ACL Materialized View built by ENABLE_XDS on a static data realm constraint.

To find the status of the data security policies for tables or views available for the current user, query the DBA_XS_APPLIED_POLICIES data dictionary view.

Before enforcing policies, a check is made for the APPLY_SEC_POLICY privilege.

Syntax

```
XS_DATA_SECURITY.REMOVE_OBJECT_POLICY (
 policy  IN VARCHAR2,
 schema  IN VARCHAR2,
 object  IN VARCHAR2);
```

Parameters

Parameter	Description
policy	The name of the data security policy to be dropped. The name is schema qualified, for example, SCOTT.POLICY1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as POLICY1, and the current schema is SCOTT, it would resolve to SCOTT.POLICY1.
schema	The name of the schema that contains the table or view from which to remove the data security policy.
object	The name of the table or view from which to remove the data security. policy

Examples

The following example drops the CUST_DS data security policy from the products table in the sales schema.

```
BEGIN
  SYS.XS_DATA_SECURITY.REMOVE_OBJECT_POLICY(policy=>'CUST_DS', schema=>'sales',
object=>'products');
END;
```

APPLY_OBJECT_POLICY Procedure

The APPLY_OBJECT_POLICY procedure enables or reenables the data security policy for the specified database table or view.

To find the status of the data security policies for tables or views available for the current user, query the DBA_XS_APPLIED_POLICIES data dictionary view.

Before enforcing policies, a check is made for the APPLY_SEC_POLICY privilege.

Syntax

```
XS_DATA_SECURITY.APPLY_OBJECT_POLICY (
 policy          IN VARCHAR2,
 schema          IN VARCHAR2,
 object          IN VARCHAR2,
 row_acl         IN BOOLEAN DEFAULT FALSE,
 owner_bypass    IN BOOLEAN DEFAULT FALSE,
 statement_types IN VARCHAR2 DEFAULT NULL,
 aclmv           IN VARCHAR2 DEFAULT NULL );
```

Parameters

Parameter	Description
policy	Name of the data security policy to be enabled. The name is schema qualified, for example, SCOTT.POLICY1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as POLICY1, and the current schema is SCOTT, it would resolve to SCOTT.POLICY1.
schema	The name of the schema that contains the relational table or view to enable or re-enable.
object	The name of the relational table or view to enable or re-enable for the data security policy.
row_acl	The default is FALSE. When set to TRUE, creates the hidden column SYS_ACLOD.
owner_bypass	The owner of the object can bypass the data security policy. The default is FALSE.

Parameter	Description
statement_types	The types can be: SELECT, INSERT, UPDATE, DELETE, and INDEX. Note that if your application security requires that you must update table rows and also restrict read access to certain columns in the same table, you must use two APPLY_OBJECT_POLICY procedures to enforce each data security policy to ensure precise enforcement of each policy. For example, one APPLY_OBJECT_POLICY procedure would enforce the DML statement_types required for updating table rows (for example, INSERT, UPDATE, DELETE), while the other APPLY_OBJECT_POLICY procedure would enforce only the statement_types of SELECT for the column constraint.
aclmv	Specifies a user-provided MV name that maintains static ACL information. The MV has two columns: TABLEROWID and ACLIDLIST. The default value for aclmv is NULL.

Examples

The following example enables the DEPT_POLICY data security policy for the EMP table in the HR schema.

```
BEGIN
  sys.xs_data_security.apply_object_policy(
           policy => 'HR.EMPLOYEES_DS',
           schema => 'HR',
           object => 'EMPLOYEES',
           statement_types => 'SELECT',
           owner_bypass => true);
END;
```

XS_DATA_SECURITY_UTIL Package

The XS_DATA_SECURITY_UTIL package is a utility package that schedules automatic refreshment for static ACL to a user table and changes the ACL refreshment mode to on-commit or on-demand refresh.

This section includes the following topics:

- Security Model
- Constants
- Summary of XS_DATA_SECURITY_UTIL Subprograms

Security Model

The XS_DATA_SECURITY_UTIL package is created in the SYS schema. You need EXECUTE privileges on the package to be able to run the programs contained in this package.

Constants

The following are valid values for ACLMV refresh modes:

```
ACLMV_ON_DEMAND  CONSTANT VARCHAR2(9) := 'ON DEMAND';
ACLMV_ON_COMMIT  CONSTANT VARCHAR2(9) := 'ON COMMIT';
```

The following are types of refresh on static ACLMV:

```
XS_ON_COMMIT_MV  CONSTANT BINARY_INTEGER := 0;
XS_ON_DEMAND_MV  CONSTANT BINARY_INTEGER := 1;
XS_SCHEDULED_MV  CONSTANT BINARY_INTEGER := 2;
```

The following are types of static ACLMV:

```
XS_SYSTEM_GENERATED_MV  CONSTANT BINARY_INTEGER := 0;
XS_USER_SPECIFIED_MV    CONSTANT BINARY_INTEGER := 1;
```

Summary of XS_DATA_SECURITY_UTIL Subprograms

Table 11-7 Summary of XS_DATA_SECURITY_UTIL Subprograms

Subprogram	Brief Description
SCHEDULE_STATIC_ACL_REFRESH Procedure	Schedules automatic refreshment for static ACL to a user table
ALTER_STATIC_ACL_REFRESH Procedure	Changes the ACL refreshment mode to on-commit or on-demand refresh.

This section describes the following XS_DATA_SECURITY_UTIL subprograms:

SCHEDULE_STATIC_ACL_REFRESH Procedure

The `SCHEDULE_STATIC_ACL_REFRESH` procedure is used to invoke or schedule automatic refresh for static ACL to a user table. It can start the refresh immediately if `NULL` value is passed into the `start_date` and `repeat_interval` parameters.

To find the status of all latest static ACL refresh jobs done for tables or views available for the current user, query the ALL_XDS_LATEST_ACL_REFSTAT, DBA_XDS_LATEST_ACL_REFSTAT, and USER_XDS_LATEST_ACL_REFSTAT data dictionary views. All static ACL refresh job status history can be found in ALL_XDS_ACL_REFSTAT, DBA_XDS_ACL_REFSTAT, and USER_XDS_ACL_REFSTAT data dictionary views.

Syntax

```
XS_DATA_SECURITY_UTIL.SCHEDULE_STATIC_ACL_REFRESH (
  schema_name      IN VARCHAR2 DEFAULT NULL,
  table_name       IN VARCHAR2,
  start_date       IN TIMESTAMP WITH TIME ZONE DEFAULT NULL,
  repeat_interval  IN VARCHAR2 DEFAULT NULL,
  comments         IN VARCHAR2 DEFAULT NULL );
```

Parameters

Parameter	Description
`schema_name`	Specifies the name for the schema to which the table belongs.
`table_name`	The table name which is used with above schema name to uniquely identify a table for the static ACL refreshment.

Parameter	Description
start_date	This attribute specifies the first date on which this refresh is scheduled to run. If the function is called repeatedly, then the latest given start_date and repeat_interval is used to schedule the job. Each execution result of ACL refresh done by immediate call, on-commit, or refresh job is added into XDS_ACL_REFSTAT. If start_date and repeat_interval are left NULL, then the refresh is launched immediately and any existing refresh schedule is erased. For immediate refresh, no row will be added into XDS_ACL_REFRESH, as it does not change refresh mode.
repeat_interval	This attribute specifies how often the refresh should repeat. You can specify the repeat interval by using DBMS_SCHEDULER package calendaring syntax or using PL/SQL expressions. See *Oracle Database PL/SQL Packages and Types Reference* for more information about using calendering syntax. The expression specified is evaluated to determine the next time the refresh should run. If repeat_interval is not specified, the job runs only once at the specified start date. The start_date and repeat_interval are used to create a refresh job by using DBMS_SCHEDULER package with end_date default as NULL.
Comments	This attribute specifies a comment about the job. By default, this attribute is NULL

Examples

```
SYS.XS_DATA_SECURITY_UTIL.SCHEDULE_STATIC_ACL_REFRESH('aclmvuser', 'sales',
SYSTIMESTAMP, 'freq=hourly; interval=2');
```

ALTER_STATIC_ACL_REFRESH Procedure

The ALTER_STATIC_ACL_REFRESH procedure is used to change the ACL refresh mode to on-commit or on-demand refresh.

Syntax

```
XS_DATA_SECURITY_UTIL.ALTER_STATIC_ACL_REFRESH (
  schema_name      IN VARCHAR2 DEFAULT NULL,
  table_name       IN VARCHAR2,
  refresh_mode     IN VARCHAR2);
```

Parameters

Parameter	Description
schema_name	Specifies the name for the schema that the table belongs to.
table_name	The table name, which is used with the schema name to uniquely identify a table for altering the static ACL refreshment mode.
refresh_mode	ON COMMIT or ON DEMAND

Examples

```
SYS.XS_DATA_SECURITY_UTIL.ALTER_STATIC_ACL_REFRESH('aclmvuser','sales',
refresh_mode=>'ON COMMIT');
```

XS_DIAG Package

The XS_DIAG package includes subprograms to diagnose potential problems in data security for principals, security classes, acls, data security policies, namespaces, and all objects in the work space. All subprograms return TRUE if the object is valid; otherwise, each returns FALSE. For each identified inconsistency, a row is inserted into the XS$VALIDATION_TABLE validation table until the maximum number of inconsistencies you specify with the error_limit parameter is reached. Users can query this validation table to determine the identified inconsistencies for information that includes the message code, the description about the error, the path leading to the invalid object, and any other helpful information that might assist you in identifying the nature of the inconsistency.

This section includes the following topics:

- Security Model
- Summary of XS_DIAG Subprograms

Security Model

The XS_DIAG package is created in the SYS schema. The caller has invoker's rights on this package and needs to have ADMIN_ANY_SEC_POLICY system privilege to run the XS_DIAG package. EXECUTE permission on the XS_DIAG package is granted to PUBLIC. SELECT permission on the XS$VALIDATION_TABLE validation table is granted to PUBLIC.

Summary of XS_DIAG Subprograms

Table 11-8 Summary of XS_DIAG Subprograms

Subprogram	Description
VALIDATE_PRINCIPAL Function	Validates the principal.
VALIDATE_SECURITY_CLASS Function	Validates the security class.
VALIDATE_ACL Function	Validates the ACL.
VALIDATE_DATA_SECURITY Function	Validates the data security policy or validates the data security policy against a specific table.
VALIDATE_NAMESPACE_TEMPLATE Function	Validates the namespace template.
VALIDATE_WORKSPACE Function	Validates an entire workspace.

This section describes the following XS_DIAG subprograms:

VALIDATE_PRINCIPAL Function

The VALIDATE_PRINCIPAL function validates the principal. This function returns TRUE if the object is valid; otherwise, it returns FALSE. For each identified inconsistency, a row

is inserted into the XS$VALIDATION_TABLE validation table until the maximum number of inconsistencies that can be stored is reached. Users must query this validation table to find out what caused the validation failure.

Syntax

```
validate_principal(name         IN VARCHAR2,
                   error_limit  IN PLS_INTEGER := 1)
   RETURN BOOLEAN;
```

Parameters

Parameter	Description
name	The name of the object to be validated.
error_limit	The maximum number of inconsistencies that may be stored in the validation table.

Examples

Validate the principal, user user1, then query the validation table in case there are inconsistencies.

```
begin
  if sys.xs_diag.validate_principal('user1', 100) then
    dbms_output.put_line('The user is valid.');
  else
    dbms_output.put_line('The user is invalid.');
  end if;
end;
/
select * from xs$validation_table;
```

Validate the principal, role role1, then query the validation table in case there are inconsistencies.

```
begin
  if sys.xs_diag.validate_principal('role1', 100) then
    dbms_output.put_line('The role is valid.');
  else
    dbms_output.put_line('The role is invalid.');
  end if;
end;
/
select * from xs$validation_table;
```

VALIDATE_SECURITY_CLASS Function

The VALIDATE_SECURITY_CLASS function validates the security class. This function returns TRUE if the object is valid; otherwise, it returns FALSE. For each identified inconsistency, a row is inserted into the XS$VALIDATION_TABLE validation table until the maximum number of inconsistencies that can be stored is reached. Users must query this validation table to find out what caused the validation failure.

Syntax

```
validate_security_class(name         IN VARCHAR2,
                        error_limit  IN PLS_INTEGER := 1)
   RETURN BOOLEAN;
```

Parameters

Parameter	Description
name	The name of the object to be validated.
error_limit	The maximum number of inconsistencies that may be stored in the validation table.

Examples

Validate the security class, sec1, then query the validation table in case there are inconsistencies.

```
begin
  if sys.xs_diag.validate_security_class('sec1', 100) then
    dbms_output.put_line('The security class is valid.');
  else
    dbms_output.put_line('The security class is invalid.');
  end if;
end;
/
select * from xs$validation_table;
```

VALIDATE_ACL Function

The VALIDATE_ACL function validates the ACL. This function returns TRUE if the object is valid; otherwise, it returns FALSE. For each identified inconsistency, a row is inserted into the XS$VALIDATION_TABLE validation table until the maximum number of inconsistencies that can be stored is reached. Users must query this validation table to find out what caused the validation failure.

Syntax

```
validate_acl(name         IN VARCHAR2,
             error_limit  IN PLS_INTEGER := 1)
   RETURN BOOLEAN;
```

Parameters

Parameter	Description
name	The name of the object to be validated.
error_limit	The maximum number of inconsistencies that may be stored in the validation table.

Examples

Validate the ACL, acl1, then query the validation table in case there are inconsistencies.

```
begin
  if sys.xs_diag.validate_acl('acl1', 100) then
    dbms_output.put_line('The ACL is valid.');
  else
    dbms_output.put_line('The ACL is invalid.');
  end if;
end;
/
select * from xs$validation_table;
```

VALIDATE_DATA_SECURITY Function

The `VALIDATE_DATA_SECURITY` function validates the data security. This function returns `TRUE` if the object is valid; otherwise, it returns `FALSE`. For each identified inconsistency, a row is inserted into the `XS$VALIDATION_TABLE` validation table until the maximum number of inconsistencies that can be stored is reached. Users must query this validation table to find out what caused the validation failure.

This function has three styles of policy validation.

- When `policy` is not NULL and `table_name` is `NULL`, the function validates the policy against all the tables to which the policy is applied. Note that when `table_name` is NULL, `table_owner` is ignored even if it is not NULL.
- When both `policy` and `table_name` are not NULL, the function validates the policy against the specific table. If `table_owner` is not provided, the current schema is used.
- When policy is NULL and table_name is not NULL, the function validates all policies applied to the table against the table. If `table_owner` is not provided, the current schema is used.

Syntax

```
validate_data_security(policy       IN VARCHAR2 :=NULL,
                       table_owner  IN VARCHAR2 :=NULL,
                       table_name   IN VARCHAR2 :=NULL,
                       error_limit  IN PLS_INTEGER := 1)
   RETURN BOOLEAN;
```

Parameters

Parameter	Description
`policy`	The name of the object to be validated.
`table_owner`	The name of the schema of the table or view.
`table_name`	The name of the table or view.
`error_limit`	The maximum number of inconsistencies that may be stored in the validation table.

Examples

Validate a policy, `policy1` on all the applied tables, then query the validation table in case there are inconsistencies.

```
begin
  if sys.xs_diag.validate_data_security(policy      => 'policy1',
                                        error_limit => 100) then
```

```
    dbms_output.put_line('The policy is valid on all the applied tables.');
  else
    dbms_output.put_line('The policy is invalid on some of the applied tables.');
  end if;
end;
/
select * from xs$validation_table;
```

Validate a policy, `policy1` on a given table, then query the validation table in case there are inconsistencies.

```
begin
  if sys.xs_diag.validate_data_security(policy      => 'policy1',
                                        table_owner => 'HR',
                                        table_name  => 'EMPLOYEES',
                                        error_limit => 100) then
    dbms_output.put_line('The policy is valid on the table.');
  else
    dbms_output.put_line('The policy is invalid on the table.');
  end if;
end;
/
select * from xs$validation_table;
```

Validate all the policies applied to a given table, then query the validation table in case there are inconsistencies.

```
begin
  if sys.xs_diag.validate_data_security(table_owner => 'HR',
                                        table_name  => 'EMPLOYEES',
                                        error_limit => 100) then
    dbms_output.put_line('All the applied policies on the table are valid.');
  else
    dbms_output.put_line('Some applied policies on the table are invalid');
  end if;
end;
/
select * from xs$validation_table;
```

VALIDATE_NAMESPACE_TEMPLATE Function

The `VALIDATE_NAMESPACE_TEMPLATE` function validates the namespace. This function returns `TRUE` if the object is valid; otherwise, it returns `FALSE`. For each identified inconsistency, a row is inserted into the `XS$VALIDATION_TABLE` validation table until the maximum number of inconsistencies that can be stored is reached. Users must query this validation table to find out what caused the validation failure.

Syntax

```
validate_namespace_template(name         IN VARCHAR2,
                            error_limit  IN PLS_INTEGER := 1)
   RETURN BOOLEAN;
```

Parameters

Parameter	Description
name	The name of the object to be validated.

Parameter	Description
error_limit	The maximum number of inconsistencies that may be stored in the validation table.

Examples

Validate the namespace, ns1, then query the validation table in case there are inconsistencies.

```
begin
  if sys.xs_diag.validate_namespace_template('ns1', 100) then
    dbms_output.put_line('The namespace template is valid.');
  else
    dbms_output.put_line('The namespace template is invalid.');
  end if;
end;
/
select * from xs$validation_table;
```

VALIDATE_WORKSPACE Function

The VALIDATE_WORKSPACE function validates all the artifacts, in other words, it validates all objects that exist in the work space by using this one function. This function returns TRUE if all the objects are valid; otherwise, it returns FALSE. For each identified inconsistency, a row is inserted into the XS$VALIDATION_TABLE validation table until the maximum number of inconsistencies that can be stored is reached. Users must query this validation table to find out what caused the validation failure.

Syntax

```
validate_workspace(error_limit  IN PLS_INTEGER := 1)
   RETURN BOOLEAN;
```

Parameters

Parameter	Description
error_limit	The maximum number of inconsistencies that may be stored in the validation table.

Examples

Validate all the objects in the workspace, then query the validation table in case there are inconsistencies.

```
begin
  if sys.xs_diag.validate_workspace(100) then
    dbms_output.put_line('The objects are valid.');
  else
    dbms_output.put_line('The objects are invalid.');
  end if;
end;
/
select * from xs$validation_table;
```

XS_NAMESPACE Package

The XS_NAMESPACE package includes subprograms to create, manage, and delete namespace templates and attributes.

This section includes the following topics:

- Security Model
- Constants
- Object Types, Constructor Functions, Synonyms, and Grants
- Summary of XS_NAMESPACE Subprograms

Security Model

The XS_NAMESPACE package is created under the SYS schema. The DBA role is granted the ADMIN_ANY_SEC_POLICY, which allows it to administer namespace templates and attributes.

Constants

The following are attribute event constants:

```
NO_EVENT                     CONSTANT PLS_INTEGER := 0;
FIRSTREAD_EVENT              CONSTANT PLS_INTEGER := 1;
UPDATE_EVENT                 CONSTANT PLS_INTEGER := 2;
FIRSTREAD_PLUS_UPDATE_EVENT  CONSTANT PLS_INTEGER := 3;
```

Object Types, Constructor Functions, Synonyms, and Grants

The following object types, constructor functions, synonyms, and GRANT statements are defined for this package.

```
-- Type definition for namespace template attribute
CREATE OR REPLACE TYPE XS$NS_ATTRIBUTE AS OBJECT (
-- Member Variables
-- Name of the namespace template attribute
-- Must be unique within a namespace template
-- Cannot be null
name              VARCHAR2(4000),
-- Default value assigned to the attribute
default_value     VARCHAR2(4000),
-- Trigger events associated with the attribute
-- Allowed values are :
-- 0 : NO_EVENT
-- 1 : FIRST_READ_EVENT
-- 2 : UPDATE_EVENT
-- 3 : FIRST_READ_PLUS_UPDATE_EVENT
attribute_events  NUMBER,

-- Constructor function
CONSTRUCTOR FUNCTION XS$NS_ATTRIBUTE
                    (name             IN VARCHAR2,
                     default_value    IN VARCHAR2 := NULL,
                     attribute_events IN NUMBER := 0)
                     RETURN SELF AS RESULT,
```

```
-- Return the name of the attribute
MEMBER FUNCTION GET_NAME RETURN VARCHAR2,
-- Return the default value of the attribute
MEMBER FUNCTION GET_DEFAULT_VALUE RETURN VARCHAR2,
-- Return the trigger events associated with attribute
MEMBER FUNCTION GET_ATTRIBUTE_EVENTS RETURN NUMBER,
-- Mutator procedures
-- Set the default value for the attribute
MEMBER PROCEDURE SET_DEFAULT_VALUE(default_value IN VARCHAR2),
-- Associate trigger events to the attribute
MEMBER PROCEDURE SET_ATTRIBUTE_EVENTS(attribute_events IN NUMBER)
);
CREATE OR REPLACE TYPE XS$NS_ATTRIBUTE_LIST AS VARRAY(1000) OF XS$NS_ATTRIBUTE;
```

Summary of XS_NAMESPACE Subprograms

Table 11-9 Summary of XS_NAMESPACE Subprograms

Subprogram	Description
CREATE_TEMPLATE Procedure	Creates a new namespace template.
ADD_ATTRIBUTES Procedure	Adds one or more attributes to an existing namespace template.
REMOVE_ATTRIBUTES Procedure	Removes one or more attributes from a namespace template.
SET_HANDLER Procedure	Assigns a handler function for the specified namespace template.
SET_DESCRIPTION Procedure	Sets a description string for the specified namespace template.
DELETE_TEMPLATE Procedure	Deletes the specified namespace template.

This section describes the following XS_NAMESPACE subprograms:

CREATE_TEMPLATE Procedure

The CREATE_TEMPLATE procedure creates a new namespace template.

Syntax

```
XS_NAMESPACE.CREATE_TEMPLATE (
  name             IN VARCHAR2,
  attr_list        IN XS$NS_ATTRIBUTE_LIST := NULL,
  schema           IN VARCHAR2 := NULL,
  package          IN VARCHAR2 := NULL,
  function         IN VARCHAR2 := NULL,
  acl              IN VARCHAR2 := 'SYS.NS_UNRESTRICTED_ACL'
  description      IN VARCHAR2 := NULL);
```

Parameters

Parameter	Description
name	The name of the namespace template to be created.

Parameter	Description
attr_list	The attributes contained in the namespace template together with their default values and associated attribute events, such as UPDATE_EVENT.
schema	The schema that contains the handler function for the namespace template.
package	The package that contains the handler function for the namespace template.
function	The handler function for the namespace template. The handler function is called when an attribute event occurs.
acl	The name of the ACL for this namespace template. If no ACL is provided, the default is the predefined ACL SYS.NS_UNRESTRICTED_ACL, which allows unrestricted attribute operations by the application user.
description	An optional description string for the namespace template.

Examples

The following example creates a namespace template called POAttrs. The namespace template contains a list of attributes defined by attrlist. The handler function for the namespace template is called Populate_Order_Func. This handler function is part of the Orders_Pckg package, which is contained in the SCOTT schema. The namespace template has NS_UNRESTRICTED_ACL set on the template, which allows unrestricted operation on namespaces created from the template.

```
DECLARE
  attrlist XS$NS_ATTRIBUTE_LIST;
BEGIN
  attrlist := XS$NS_ATTRIBUTE_LIST();
  attrlist.extend(2);
  attrlist(1) := XS$NS_ATTRIBUTE('desc', 'general');
  attrlist(2) := XS$NS_ATTRIBUTE(name=>'item_no',
                 attribute_events=>XS_NAMESPACE.FIRSTREAD_EVENT);
  SYS.XS_NAMESPACE.CREATE_TEMPLATE('POAttrs', attrlist, 'SCOTT',
                                   'Orders_Pckg','Populate_Order_Func',
                                   'SYS.NS_UNRESTRICTED_ACL',
                                   'Purchase Order Attributes');
END;
```

ADD_ATTRIBUTES Procedure

The ADD_ATTRIBUTES procedure adds one or more attributes to an existing namespace template.

Syntax

```
XS_NAMESPACE.ADD_ATTRIBUTES (
  template         IN VARCHAR2,
  attribute        IN VARCHAR2,
  default_value    IN VARCHAR2 := NULL,
  attribute_events IN PLS_INTEGER := XS_NAMESPACE.NO_EVENT);

XS_NAMESPACE.ADD_ATTRIBUTES (
  template  IN VARCHAR2,
  attr_list IN XS$NS_ATTRIBUTE_LIST);
```

Parameters

Parameter	Description
`template`	The name of the namespace templates to which the attribute(s) is/are to be added.
`attribute`	The name of the attribute to be added.
`attr_list`	The list of attributes to be added.
`default_value`	The default value of the attribute.
`attribute_events`	The attribute event associated with the attribute, such as update event.

Examples

The following example adds an attribute called `item_type` to the `POAttrs` namespace. It also specifies a default value and attribute event for the new attribute that is added.

```
BEGIN
  SYS.XS_NAMESPACE.ADD_ATTRIBUTES(template=>'POAttrs',attribute=>'item_type',
                                  default_value=>'generic',
                                  attribute_events=>XS_NAMESPACE.update_event);
END;
```

REMOVE_ATTRIBUTES Procedure

The `REMOVE_ATTRIBUTES` procedure removes one or more attributes from a namespace template. If no attribute names are specified, then all attributes are removed from the namespace template.

Syntax

```
XS_NAMESPACE.REMOVE_ATTRIBUTES (
  template  IN VARCHAR2,
  attribute IN VARCHAR2);

XS_NAMESPACE.REMOVE_ATTRIBUTES (
  template  IN VARCHAR2,
  attr_list IN XS$LIST);

XS_NAMESPACE.REMOVE_ATTRIBUTES (
  template   IN VARCHAR2);
```

Parameters

Parameter	Description
`template`	The name of the namespace template from which the attribute(s) is/are to be removed.
`attribute`	The name of the attribute to be removed.
`attr_list`	The list of attribute names to be removed.

Examples

The following example removes the `item_type` attribute from the `POAttrs` namespace.

```
BEGIN
  SYS.XS_NAMESPACE.REMOVE_ATTRIBUTES('POAttrs','item_type');
END;
```

The following example removes all attributes from the `POAttrs` namespace template.

```
BEGIN
  SYS.XS_NAMESPACE.REMOVE_ATTRIBUTES('POAttrs');
END;
```

SET_HANDLER Procedure

The `SET_HANDLER` procedure assigns a handler function for the specified namespace template.

Syntax

```
XS_NAMESPACE.SET_HANDLER (
  template         IN VARCHAR2,
  schema           IN VARCHAR2,
  package          IN VARCHAR2,
  function         IN VARCHAR2);
```

Parameters

Parameter	Description
`template`	The name of the namespace template for which the handler function is to be set.
`schema`	The schema containing the handler package and function.
`package`	The name of the package that contains the handler function.
`function`	The name of the handler function for the namespace template.

Examples

The following example sets a handler function, called `Populate_Order_Func`, for the `POAttrs` namespace template.

```
BEGIN
  SYS.XS_NAMESPACE.SET_HANDLER('POAttrs','SCOTT',
                               'Orders_Pckg','Populate_Order_Func');
END;
```

SET_DESCRIPTION Procedure

The `SET_DESCRIPTION` procedure sets a description string for the specified namespace template.

Syntax

```
XS_NAMESPACE.SET_DESCRIPTION (
  template     IN VARCHAR2,
  description  IN VARCHAR2);
```

Parameters

Parameter	Description
template	The name of the namespace template whose description is to be set.
description	A description string for the specified namespace template.

Examples

The following example sets a description string for the POAttrs namespace template.

```
BEGIN
  SYS.XS_NAMESPACE.SET_DESCRIPTION('POAttrs','Purchase Order Attributes');
END;
```

DELETE_TEMPLATE Procedure

The DELETE_TEMPLATE procedure deletes the specified namespace template.

Syntax

```
XS_NAMESPACE.DELETE_TEMPLATE(
  template      IN VARCHAR2,
  delete_option IN PLS_INTEGER := XS_ADMIN_UTIL.DEFAULT_OPTION);
```

Parameters

Parameter	Description
template	The name of the namespace template to be deleted.
delete_option	The delete option to use. To the namespace template, the behavior of the following options is the same: • DEFAULT_OPTION: The default option allows deleting a namespace template only if it is not referenced elsewhere. If there are other entities that reference the namespace template, then the namespace template cannot be deleted. • CASCADE_OPTION: The cascade option deletes the namespace template together with any references to it. The user deleting the namespace template deletes these references as well. • ALLOW_INCONSISTENCIES_OPTION: The allow inconsistencies option lets you delete the entity even if other entities have late binding references to it. If the entity is part of an early dependency, then the delete fails and an error is raised.

Examples

The following example deletes the POAttrs namespace template using the default delete option.

```
BEGIN
  SYS.XS_NAMESPACE.DELETE_TEMPLATE('POAttrs',XS_ADMIN_UTIL.DEFAULT_OPTION);
END;
```

XS_PRINCIPAL Package

The XS_PRINCIPAL package contains procedures used to create, manage, and delete application principals. These application principals include application users, regular application roles, and dynamic application roles.

This section includes the following topics:

- Security Model
- Constants
- Object Types, Constructor Functions, Synonyms, and Grants
- Summary of XS_PRINCIPAL Subprograms

Security Model

The `XS_PRINCIPAL` package is created under the `SYS` schema.

Users with Real Application Security `PROVISION` privilege can create, modify, or drop application users and roles. The privileges required to create, modify, or drop application users and roles are no longer governed by the same system privileges required to create, modify, or drop database users and roles.

Constants

The following constants define the user's status:

```
ACTIVE          CONSTANT PLS_INTEGER := 1;
INACTIVE        CONSTANT PLS_INTEGER := 2;
UNLOCKED        CONSTANT PLS_INTEGER := 3;
EXPIRED         CONSTANT PLS_INTEGER := 4;
LOCKED          CONSTANT PLS_INTEGER := 5;
```

The following constants define dynamic role scope:

```
SESSION_SCOPE   CONSTANT PLS_INTEGER := 0;
REQUEST_SCOPE   CONSTANT PLS_INTEGER := 1;
```

The following constants define the verifier type:

```
XS_SHA512       CONSTANT PLS_INTEGER := 2 ;
XS_SALTED_SHA1  CONSTANT PLS_INTEGER := 1 ;
```

Object Types, Constructor Functions, Synonyms, and Grants

The following object types, constructor functions, synonyms, and `GRANT` statements are defined for this package.

```
-- Type definition for roles granted to the principals
CREATE OR REPLACE TYPE XS$ROLE_GRANT_TYPE AS OBJECT (
-- Member Variables
-- Constants defined in other packages cannot be recognized in a type.
-- e.g.  XS_ADMIN_UTIL.XSNAME_MAXLEN
-- name   VARCHAR2(XS_ADMIN_UTIL.XSNAME_MAXLEN),
  name          VARCHAR2(130),
-- Start date of the effective date
```

```
  start_date    TIMESTAMP WITH TIME ZONE,
-- End date of the effective date
  end_date      TIMESTAMP WITH TIME ZONE,

  CONSTRUCTOR FUNCTION XS$ROLE_GRANT_TYPE (
    name       IN VARCHAR2,
    start_date IN TIMESTAMP WITH TIME ZONE:= NULL,
    end_date   IN TIMESTAMP WITH TIME ZONE:= NULL)
  RETURN SELF AS RESULT,

  MEMBER FUNCTION get_role_name RETURN VARCHAR2,
  MEMBER PROCEDURE set_start_date(start_date IN TIMESTAMP WITH TIME ZONE),
  MEMBER FUNCTION get_start_date RETURN TIMESTAMP WITH TIME ZONE,
  MEMBER PROCEDURE set_end_date(end_date IN TIMESTAMP WITH TIME ZONE),
  MEMBER FUNCTION get_end_date RETURN TIMESTAMP WITH TIME ZONE
);

CREATE OR REPLACE TYPE XS$ROLE_GRANT_LIST AS VARRAY(1000) OF XS$ROLE_GRANT_TYPE;
```

Summary of XS_PRINCIPAL Subprograms

Table 11-10 Summary of XS_PRINCIPAL Subprograms

Subprogram	Description
CREATE_USER Procedure	Creates an application user.
CREATE_ROLE Procedure	Creates an application role.
CREATE_DYNAMIC_ROLE Procedure	Creates a dynamic application role.
GRANT_ROLES Procedure	Grants one or more application roles to an application principal.
REVOKE_ROLES Procedure	Revokes one or more roles from an application principal.
ADD_PROXY_USER Procedure	Adds a proxy user for a target application user.
REMOVE_PROXY_USERS Procedure	Removes specified proxy user or all proxy users for a target application user.
ADD_PROXY_TO_DBUSER	Add a proxy application user to a database user.
REMOVE_PROXY_FROM_DBUSER Procedure	Remove a proxy application user from a database user.
SET_EFFECTIVE_DATES Procedure	Sets or modifies the effective dates for an application user or role.
SET_DYNAMIC_ROLE_DURATION Procedure	Sets or modifies the duration, in minutes, for a dynamic application role.
SET_DYNAMIC_ROLE_SCOPE Procedure	Sets or modifies the scope of a dynamic application role, such as `REQUEST_SCOPE` or `SESSION_SCOPE`.
ENABLE_BY_DEFAULT Procedure	Enables or disables an application role.
ENABLE_ROLES_BY_DEFAULT Procedure	Enables or disables all directly granted roles for the specified user.
SET_USER_SCHEMA Procedure	Sets the database schema for an application user.
SET_GUID Procedure	Sets the GUID for an external user or role.
SET_ACL Procedure	Sets the Real Application Security session privilege for an application user or a dynamic role.

Table 11-10 (Cont.) Summary of XS_PRINCIPAL Subprograms

Subprogram	Description
SET_PROFILE Procedure	Sets the application user's profile. This is a set of resource limits and password parameters that restrict database usage and database instance resources for a Real Application Security application user.
SET_USER_STATUS Procedure	Sets or modifies the status of an application user account, such as `ACTIVE`, `INACTIVE`, `UNLOCK`, `LOCKED`, or `EXPIRED`.
SET_PASSWORD Procedure	Sets or modifies the password for an application user account.
SET_VERIFIER Procedure	Sets or modifies the verifier for an application user account.
SET_DESCRIPTION Procedure	Sets the description string for an application user or role.
DELETE_PRINCIPAL Procedure	Drops an application user or role.

This section describes the following XS_PRINCIPAL subprograms:

CREATE_USER Procedure

The `CREATE_USER` procedure creates a new application user. You need the `CREATE USER` system privilege to create an application user.

You can use the DBA_XS_USERS data dictionary view to get a list of all application users.

Syntax

```
CREATE_USER (
  name            IN VARCHAR2,
  schema          IN VARCHAR2    := NULL,
  status          IN PLS_INTEGER := ACTIVE,
  start_date      IN TIMESTAMP WITH TIME ZONE  := NULL,
  end_date        IN TIMESTAMP WITH TIME ZONE  := NULL,
  guid            IN RAW         := NULL,
  external_source IN VARCHAR2    := NULL,
  description     IN VARCHAR2    := NULL,
  acl             IN VARCHAR2    := NULL);
```

Parameters

Parameter	Description
`name`	The name of the application user to be created.

Parameter	Description
status	The status of the user on creation. This can be one of the following values: ACTIVE, INACTIVE. The default value is ACTIVE. The values PASSWORDEXPIRED and LOCKED are deprecated beginning with Oracle Database Release 12.1 (12.1.0.2).
schema	The database schema to be associated with the user. This is optional.
start_date	The date from which the user account becomes effective. This is optional.
end_date	The date on which the user account becomes ineffective. This is optional. If an end_date is specified, then the start_date must also be specified.
guid	GUID of the user. This is valid for external users only.
external_source	Name of the system that is the source for this user. This is optional.
description	A description for the user account. This is optional.
acl	The Real Application Security session privilege. The default value is NULL meaning no ACL is set on the principal. The ACL must reside in the SYS schema, or else an error is thrown. The Real Application Security session privilege to be set on the principal must follow the naming convention for Real Application Security objects and must exist before this procedure is called. The session privilege is enforced as per the ACL set on the Real Application Security application user involved in the session operation. For example, a create session operation requires the caller to have the CREATE SESSION privilege in the ACL set on the Real Application Security application user. Principal-specific ACL grants take precedence over existing system-level session privilege grants. A privilege check is first done in the ACL associated with the principal and if it succeeds, the operation proceeds. If the privilege check finds deny, the operation fails with an insufficient privilege error. If neither grant nor deny is found, the check is done in the system ACL associated with the SESSION_SC security class and the operation succeeds or fails based on this privilege check result.

Examples

The following example creates a user:

```
BEGIN
 SYS.XS_PRINCIPAL.CREATE_USER('TEST1');
END;
```

The following example creates a user, and also specifies a schema and start date for the user:

```
DECLARE
st_date TIMESTAMP WITH TIME ZONE;
BEGIN
```

```
  st_date := TO_TIMESTAMP_TZ('2010-06-18 11:00:00 -5:00','YYYY-MM-DD HH:MI:SS
  TZH:TZM');
  SYS.XS_PRINCIPAL.CREATE_USER(name=>'u2',
                               schema=>'scott',
                               start_date=>st_date);
END;
```

CREATE_ROLE Procedure

The `CREATE_ROLE` procedure creates a new application role. You need the `CREATE ROLE` system privilege to create a regular application role.

You can use the DBA_XS_ROLES data dictionary view to get the list of application roles together with their attributes, like start date and end date

Syntax

```
CREATE_ROLE (   name            IN VARCHAR2,
  enabled         IN BOOLEAN  := FALSE,
  start_date      IN TIMESTAMP WITH TIME ZONE := NULL,
  end_date        IN TIMESTAMP WITH TIME ZONE := NULL,
  guid            IN RAW      := NULL,
  external_source IN VARCHAR2 := NULL,
  description     IN VARCHAR2 := NULL);
```

Parameters

Parameter	Description
`name`	The name of the application role to be created.
`enabled`	Specifies whether the role is enabled on creation. The default value is FALSE, which means that the role is disabled on creation.
`start_date`	The date from which the role becomes effective. This is optional.
`end_date`	The date on which the role becomes ineffective. This is optional. If an `end_date` is specified, then the `start_date` must also be specified.
`guid`	GUID of the role. This is applicable for external roles only.
`external_source`	The name of the system that is the source for this role. This is optional.
`description`	An optional description for the role.

Examples

The following example creates an application role, called `hrmgr`:

```
BEGIN
  SYS.XS_PRINCIPAL.CREATE_ROLE('hrmgr');
END;
```

The following example creates an application role called `hrrep`. It also enables the role, and assigns the current date as start date for the role.

```
DECLARE
  st_date TIMESTAMP WITH TIME ZONE;
BEGIN
  st_date := SYSTIMESTAMP;
```

```
  SYS.XS_PRINCIPAL.CREATE_ROLE(name=>'hrrep',
                               enabled=>true,
                               start_date=>st_date);
END;
```

CREATE_DYNAMIC_ROLE Procedure

The `CREATE_DYNAMIC_ROLE` procedure creates a new dynamic application role. Dynamic application roles can be dynamically enabled or disabled by an application, based on the criteria defined by the application. You need the `CREATE ROLE` system privilege to create an dynamic application role.

You can use the DBA_XS_DYNAMIC_ROLES data dictionary view to get a list of all dynamic application roles together with their attributes, like duration.

Syntax

```
CREATE_DYNAMIC_ROLE (
  name        IN VARCHAR2,
  duration    IN PLS_INTEGER := NULL,
  scope       IN PLS_INTEGER := XS_PRINCIPAL.SESSION_SCOPE,
  description IN VARCHAR2    := NULL,
  acl         IN VARCHAR2    := NULL);
```

Parameters

Parameter	Description
`name`	The name of the dynamic application role to be created.
`duration`	The duration (in minutes) of the dynamic application role. This is an optional attribute.
`scope`	The scope attribute of the dynamic application role. The possible values are `SESSION_SCOPE` and `REQUEST_SCOPE`. The default value is `XS_PRINCIPAL.SESSION_SCOPE.`
`description`	An optional description for the dynamic application role.
`acl`	The Real Application Security session privilege. The default value is `NULL` meaning no ACL is set on the principal. The ACL must reside in the SYS schema, or else an error is thrown. The Real Application Security session privilege to be set on the principal must follow the naming convention for Real Application Security objects and must exist before this procedure is called. The session privilege is enforced as per the ACL set on the Real Application Security dynamic role involved in the session operation. For example, the attach operation with dynamic role requires the `ENABLE_DYNAMIC_ROLE` privilege in the ACLs to be set on the dynamic roles. Principal-specific ACL grants take precedence over existing system-level session privilege grants. A privilege check is first done in the ACL associated with the principal and if it succeeds, the operation proceeds. If the privilege check finds deny, the operation fails with an insufficient privilege error. If neither grant nor deny is found, the check is done in the system ACL associated with the `SESSION_SC` security class and the operation succeeds or fails based on this privilege check result.

Examples

The following example creates a dynamic application role, called `sslrole`:

```
BEGIN
  SYS.XS_PRINCIPAL.CREATE_DYNAMIC_ROLE('sslrole');
END;
```

The following example creates a dynamic application role called `reprole`. It also specifies a duration of 100 minutes for the role, and chooses the request scope for the role.

```
BEGIN
  SYS.XS_PRINCIPAL.CREATE_DYNAMIC_ROLE(name=>'reprole',
                                       duration=>100,
                                       scope=>XS_PRINCIPAL.REQUEST_SCOPE);
END;
```

GRANT_ROLES Procedure

The `GRANT_ROLES` procedure grants one or more application roles to an application principal. You need the `GRANT ANY ROLE` system privilege to grant application roles.

You can use the DBA_XS_ROLE_GRANTS data dictionary view to get the list of all role grants together with their details, like start date and end date.

Syntax

```
GRANT_ROLES (
grantee       IN VARCHAR2,
role          IN VARCHAR2,
start_date    IN TIMESTAMP WITH TIME ZONE:= NULL,
end_date      IN TIMESTAMP WITH TIME ZONE:= NULL,);

GRANT_ROLES (
grantee   IN VARCHAR2,
role_list IN XS$ROLE_GRANT_LIST);
```

Parameters

Parameter	Description
`grantee`	The name of the principal to which the role is granted.
`role`	The name of the role to be granted.
`role_list`	The list of roles to be granted.
`start_date`	The date on which the grant takes effect. This is an optional parameter.
`end_date`	The date until which the grant is in effect. This is an optional parameter.

Examples

The following example grants the `HRREP` role to user `SMAVRIS` with a start date and an end date specified:

```
DECLARE
  st_date TIMESTAMP WITH TIME ZONE;
  end_date TIMESTAMP WITH TIME ZONE;
```

```
BEGIN
  st_date := TO_TIMESTAMP_TZ('2010-06-18 11:00:00 -5:00','YYYY-MM-DD HH:MI:SS
                             TZH:TZM');
  end_date := TO_TIMESTAMP_Tz('2011-06-18 11:00:00 -5:00','YYYY-MM-DD HH:MI:SS
                              TZH:TZM');
  SYS.XS_PRINCIPAL.GRANT_ROLES('SMAVRIS', 'HRREP', st_date, end_date);
END;
```

The following example grants the HRREP and HRMGR roles to user SMAVRIS:

```
DECLARE
  rg_list XS$ROLE_GRANT_LIST;
BEGIN
  rg_list := XS$ROLE_GRANT_LIST(XS$ROLE_GRANT_TYPE('HRREP'),
                                XS$ROLE_GRANT_TYPE('HRMGR'));

  SYS.XS_PRINCIPAL.GRANT_ROLES('SMAVRIS', rg_list);
END;
```

The following example shows how to grant the role XSCONNECT to user XSUSER. This grant will allow user XSUSER using its password to connect to a database.

```
EXEC SYS.XS_PRINCIPAL.GRANT_ROLES('XSUSER', 'XSCONNECT');
```

REVOKE_ROLES Procedure

The REVOKE_ROLES procedure revokes the specified role(s) from the specified grantee. If no roles are specified, then all application roles are revoked from the grantee.You need the GRANT ANY ROLE system privilege to grant or revoke roles.

You can use the DBA_XS_ROLE_GRANTS data dictionary view to get the list of all role grants together with their details, like start date and end date.

Syntax

```
REVOKE_ROLES (
  grantee   IN VARCHAR2,
  role      IN VARCHAR2);

REVOKE_ROLES (
  grantee   IN VARCHAR2,
  role_list IN XS$NAME_LIST);

REVOKE_ROLES (
  grantee IN VARCHAR2);
```

Parameters

Parameter	Description
grantee	The application principal from whom the role(s) are to be revoked.
role	The name of the application role that is to be revoked.
role_list	The list of role names that are to be revoked.

Examples

The following example revokes the HRREP role from user SMAVRIS:

```
BEGIN
  XS_PRINCIPAL.REVOKE_ROLES('SMAVRIS','HRREP');
END;
```

The following example revokes the HRREP and HRMGR roles from user SMAVRIS:

```
DECLARE
  role_list XS$NAME_LIST;
BEGIN
  role_list := XS$NAME_LIST('HRREP','HRMGR');
  SYS.XS_PRINCIPAL.REVOKE_ROLES('SMAVRIS', role_list);
END;
```

The following example revokes all granted roles from user SMAVRIS:

```
BEGIN
  SYS.XS_PRINCIPAL.REVOKE_ROLES('SMAVRIS');
END;
```

ADD_PROXY_USER Procedure

The ADD_PROXY_USER adds a target user for the specified application user. This allows the application user to proxy as the target user. There are two signatures for this procedure. The first signature allows you to specify a subset of roles of the target user using the target_roles parameter that are to be assigned to the proxy user. For the second signature there is no target_roles parameter, so all roles of the target user are assigned to the proxy user.

You need the ALTER USER system privilege to add or remove a proxy user.

Syntax

```
ADD_PROXY_USER (
  target_user  IN VARCHAR2,
  proxy_user   IN VARCHAR2,
  target_roles IN XS$NAME_LIST);

ADD_PROXY_USER (
  target_user  IN VARCHAR2,
  proxy_user   IN VARCHAR2);
```

Parameters

Parameter	Description
target_user	The name of the target application user that can be proxied to.
proxy_user	The name of the proxy application user.
target_roles	A list of target user roles that can be proxied by the proxy user. This parameter is mandatory. If you pass an explicit NULL value, then this would be a case of configuring the proxy user without any role of the target user; otherwise, the proxy_user parameter uses the value you specify for the target_roles parameter.

Examples

The following example enables user DJONES to proxy as target user SMAVRIS. The target roles granted to DJONES are HRREP and HRMGR.

```
DECLARE
  pxy_roles XS$NAME_LIST;
BEGIN
  pxy_roles := XS$NAME_LIST('HRREP','HRMGR');
  SYS.XS_PRINCIPAL.ADD_PROXY_USER('SMAVRIS','DJONES', pxy_roles);
END;
```

The following example passes an explicit `NULL` value for the target role; in other words, it assigns no roles of the target user 'SMAVRIS' to the proxy user 'DJONES'.

```
BEGIN
  SYS.XS_PRINCIPAL.ADD_PROXY_USER('SMAVRIS','DJONES', NULL);
END;
```

The following example assigns all roles of target user 'SMAVRIS' to proxy user 'DJONES'.

```
BEGIN
  SYS.XS_PRINCIPAL.ADD_PROXY_USER('SMAVRIS','DJONES');
END;
```

REMOVE_PROXY_USERS Procedure

The `REMOVE_PROXY_USERS` procedure disassociates one or all proxy users for a target application user. The associated proxy roles are automatically removed for the proxy users.

You need the `ALTER USER` system privilege to add or remove a proxy user.

Syntax

```
REMOVE_PROXY_USERS (
  target_user  IN VARCHAR2);

REMOVE_PROXY_USERS (
  target_user IN VARCHAR2,
  proxy_user  IN VARCHAR2);
```

Parameters

Parameter	Description
`target_user`	The target application user whose proxies are to be disassociated.
`proxy_user`	The proxy application user that needs to be disassociated from the target user.

Examples

The following example removes all proxy users for target user `SMAVRIS`:

```
BEGIN
  SYS.XS_PRINCIPAL.REMOVE_PROXY_USERS('SMAVRIS');
END;
```

The following example disassociates the proxy user `DJONES` from the target user `SMAVRIS`:

```
BEGIN
  SYS.XS_PRINCIPAL.REMOVE_PROXY_USERS('SMAVRIS','DJONES');
END;
```

ADD_PROXY_TO_DBUSER

The ADD_PROXY_TO_DBUSER adds the specified target proxy application user to the specified database user. The application user must be a direct logon user. This allows the application user to proxy as the target database user. By default, all roles assigned to the target user can be used by the proxy user. Similar to Oracle Database, the default roles of the target database users would be enabled after connection. Other roles assigned to the target database user can be set by using the SET ROLE statement.

You need the ALTER USER system privilege to add a proxy user to a database user.

Syntax

```
ADD_PROXY_TO_DBUSER (
  database_user  IN VARCHAR2,
  proxy_user     IN VARCHAR2,
  is_external    IN BOOLEAN := FALSE);
```

Parameters

Parameter	Description
database_user	The name of the target database user that can be proxied to.
proxy_user	The name of the proxy application user.
is_external	The parameter to indicate whether the user is an external user or a regular Real Application Security application user.

Examples

The following example enables application user DJONES to proxy as target database user SMAVRIS.

```
BEGIN
  SYS.XS_PRINCIPAL.ADD_PROXY_TO_DBUSER('SMAVRIS','DJONES', TRUE);
END;
```

REMOVE_PROXY_FROM_DBUSER Procedure

The REMOVE_PROXY_FROM_DBUSER procedure disassociates a proxy application user from a database user. The associated proxy roles are automatically removed from the application user.

You need the ALTER USER system privilege to remove a proxy user from a database user.

Syntax

```
REMOVE_PROXY_FROM_DBUSER (
  database_user IN VARCHAR2,
  proxy_user    IN VARCHAR2);
```

Parameters

Parameter	Description
database_user	The target database user whose proxies are to be disassociated.
proxy_user	The proxy application user that needs to be disassociated from the target database user.

Examples

The following example disassociates the proxy user DJONES from the target database user SMAVRIS:

```
BEGIN
  SYS.XS_PRINCIPAL.REMOVE_PROXY_FROM_DBUSER('SMAVRIS','DJONES');
END;
```

SET_EFFECTIVE_DATES Procedure

The SET_EFFECTIVE_DATES procedure sets or modifies the effective dates for an application user or role. If the start_date and end_date values are specified as NULL by default, then the application user is not currently effective, so the session for the particular application user cannot be created.

You need the ALTER USER system privilege to run this procedure for an application user. You need the ALTER ANY ROLE system privilege to run this procedure for an application role.

Syntax

```
SET_EFFECTIVE_DATES (
  principal         IN VARCHAR2,
  start_date        IN TIMESTAMP WITH TIME ZONE:= NULL,
  end_date          IN TIMESTAMP WITH TIME ZONE:= NULL);
```

Parameters

Parameter	Description
principal	The name of the application user or role for which effective dates are to be set.
start_date	The start date of the effective dates period.
end_date	The end date of the effective dates period.

Examples

The following example sets the effective dates for user DJONES.

```
DECLARE
  st_date TIMESTAMP WITH TIME ZONE;
  end_date TIMESTAMP WITH TIME ZONE;
BEGIN
  st_date := TO_TIMESTAMP_TZ('2010-06-18 11:00:00 -5:00','YYYY-MM-DD HH:MI:SS
                             TZH:TZM');
  end_date := TO_TIMESTAMP_Tz('2011-06-18 11:00:00 -5:00','YYYY-MM-DD HH:MI:SS
                              TZH:TZM');
```

```
  SYS.XS_PRINCIPAL.SET_EFFECTIVE_DATES(principal=>'DJONES',
                                       start_date=>st_date,end_date=>end_date);
END;
```

SET_DYNAMIC_ROLE_DURATION Procedure

The `SET_DYNAMIC_ROLE_DURATION` procedure sets or modifies the duration for a dynamic application role. The duration is specified in minutes.

You need the `ALTER ANY ROLE` system privilege to modify a role.

Syntax

```
SET_DYNAMIC_ROLE_DURATION (
  role      IN VARCHAR2,
  duration  IN PLS_INTEGER);
```

Parameters

Parameter	Description
`role`	The name of the dynamic application role.
`duration`	The duration of the dynamic application role in minutes. This cannot be a negative value.

Examples

The following example sets the duration of the `reprole` dynamic application role to 60 minutes.

```
BEGIN
  SYS.XS_PRINCIPAL.SET_DYNAMIC_ROLE_DURATION('reprole',60);
END;
```

SET_DYNAMIC_ROLE_SCOPE Procedure

The `SET_DYNAMIC_ROLE_SCOPE` procedure sets or modifies the scope of a dynamic application role. The session (`SESSION_SCOPE`) or request (`REQUEST_SCOPE`) scopes can be chosen.

You need the `ALTER ANY ROLE` system privilege to modify a role.

Syntax

```
SET_DYNAMIC_ROLE_SCOPE (
  role      IN VARCHAR2,
  scope     IN PLS_INTEGER);
```

Parameters

Parameter	Description
`role`	The name of the dynamic application role.
`scope`	The scope of the dynamic application role to be set. The allowed values are `XS_PRINCIPAL.REQUEST_SCOPE` and `XS_PRINCIPAL.SESSION_SCOPE`.

Examples

The following example sets the scope of the `reprole` dynamic application role to request scope:

```
begin
  SYS.XS_PRINCIPAL.SET_DYNAMIC_ROLE_SCOPE('reprole',XS_PRINCIPAL.REQUEST_SCOPE);
end;
```

ENABLE_BY_DEFAULT Procedure

The `ENABLE_BY_DEFAULT` procedure enables or disables a regular application role.

If enabled, then the application role is automatically enabled for the principal to which it is granted. If disabled, then the privileges associated with the application role are not enabled even if the application role is granted to a principal.

You need the `ALTER ANY ROLE` system privilege to modify an application role.

Syntax

```
ENABLE_BY_DEFAULT (
  role       IN VARCHAR2,
  enabled    IN BOOLEAN := TRUE);
```

Parameters

Parameter	Description
`role`	The name of the regular application role.
`enabled`	The `enabled` attribute of the application role. Setting this to `TRUE` marks the application role as being enabled by default. The default value is `TRUE`.

Examples

The following example sets the `enabled` attribute for the `HRREP` application role to `TRUE`:

```
BEGIN
  SYS.XS_PRINCIPAL.ENABLE_BY_DEFAULT('HRREP',TRUE);
END;
```

ENABLE_ROLES_BY_DEFAULT Procedure

The `ENABLE_ROLES_BY_DEFAULT` procedure enables or disables all application roles that have been directly granted to an application user.

You need the `ALTER USER` system privilege to run this procedure for an application user.

Syntax

```
ENABLE_ROLES_BY_DEFAULT (
  user       IN VARCHAR2,
  enabled    IN BOOLEAN := TRUE);
```

Parameters

Parameter	Description
user	The name of the application user.
enabled	The enabled attribute for all application roles that have been directly granted to the application user. Setting the enabled attribute to TRUE enables all directly granted application roles for the application user. The default value is TRUE. Setting the enabled attribute to FALSE disables all directly granted application roles for the application user.

Examples

The following example enables all directly granted roles for application user SMAVRIS:

```
BEGIN
  SYS.XS_PRINCIPAL.ENABLE_ROLES_BY_DEFAULT('SMAVRIS',TRUE);
END;
```

SET_USER_SCHEMA Procedure

The SET_USER_SCHEMA procedure sets the database schema for an application user.

You need the ALTER USER system privilege to run this procedure for an application user.

Syntax

```
SET_USER_SCHEMA (
  user        IN VARCHAR2,
  schema      IN VARCHAR2);
```

Parameters

Parameter	Description
user	The name of the application user.
schema	The name of the database schema to be associated with the user. Setting this to NULL removes any schema association.

Examples

The following example associates the HR schema with user DJONES.

```
BEGIN
  SYS.XS_PRINCIPAL.SET_USER_SCHEMA('DJONES','HR');
END;
```

SET_GUID Procedure

The SET_GUID procedure sets the GUID for a principal. The principal must be an external user or role, and the current GUID must be NULL.

You need the ALTER USER system privilege to run this procedure for an application user. You need the ALTER ANY ROLE system privilege to run this procedure for an application role.

> **Note:**
>
> The external_source attribute for the user must have been set for SET_GUID to work.

Syntax

```
SET_GUID (
  principal IN VARCHAR2,
  guid      IN RAW);
```

Parameters

Parameter	Description
principal	The name of the external user or role.
guid	The GUID for the external user or role.

Examples

The following example sets a GUID for user Alex:

```
BEGIN
  SYS.XS_PRINCIPAL.SET_GUID('ALEX','7b6cb3a98f8a4e20ac31a37419cc7fa3');
END;
```

SET_ACL Procedure

Purpose

The SET_ACL procedure sets an ACL on the specified application user or dynamic role.

This procedure requires the caller to have the Real Application Security PROVISION privilege as the least privilege. Users with database ALTER USER privilege can also call the procedure if the principal is an application user. Users with the database role ALTER ROLE privilege can also call this procedure if the principal is a dynamic role.

Syntax

```
SET_ACL(principal IN VARCHAR2,
        acl IN VARCHAR2);
```

Parameters

Parameter	Description
principal	The application user or dynamic role to which the ACL is to be set.

Parameter	Description
acl	The Real Application Security session privilege.

Usage Notes

The ACLs must be created in the SYS schema.

An ACL set on an application user or dynamic role overrides a system-wide ACL.

The session privilege will be enforced as per the ACL set on Real Application Security application user or dynamic role involved in the session operation. For example, a create session operation requires the caller to have the CREATE_SESSION privilege in the ACL set on the Real Application Security application user or the attach operation with dynamic role requires the ENABLE_DYNAMIC_ROLE privilege in the ACLs to be set on the dynamic roles.

Principal-specific ACL grants take precedence over existing system-level session privilege grants. A privilege check is first done in the ACL associated with the principal and if it succeeds, the operation proceeds. If the privilege check finds deny, the operation fails with an insufficient privilege error. If neither grant nor deny is found, the check is done in the system ACL associated with the SESSION_SC security class and the operation succeeds or fails based on this privilege check result.

Examples

Example 11-1 Set the ACL Privilege CREATE_SESSION on Application User TEST1

The following example sets the ACL privilege CREATE_SESSION on the specified application user test1.

```
BEGIN
  SYS.XS_PRINCIPAL.SET_ACL('test1','CREATE_SESSION');
END;
```

SET_PROFILE Procedure

The SET_PROFILE procedure sets the application user's profile. The profile is a set of resource limits and password parameters that restrict database usage and database instance resources for a Real Application Security application user. Both the application user and the profile must be existing entities.

The user executing this procedure must have the ALTER_USER privilege.

If a profile that is assigned to an application user is dropped using the cascade option, then the default profile would automatically become activated for that user.

Syntax

```
SET_PROFILE (
  user     IN VARCHAR2,
  profile  IN VARCHAR2);
```

Parameters

Parameter	Description
user	The name of the Real Application Security application user. This must be an existing application user.
profile	The name of the profile.

Examples

The following example creates a profile named prof and then sets the profile named prof to an application user named xsuser.

```
CREATE PROFILE prof LIMIT PASSWORD_REUSE_TIME 1/1440 PASSWORD_REUSE_MAX 3
PASSWORD_VERIFY_FUNCTION Verify_Pass;

BEGIN
  SYS.XS_PRINCIPAL.SET_PROFILE('xsuser','prof');
END;
```

SET_USER_STATUS Procedure

The SET_USER_STATUS procedure sets or modifies the status of an application user account.

You need the ALTER_USER privilege to run this procedure for an application user.

Syntax

```
SET_USER_STATUS (
  user        IN VARCHAR2,
  status      IN PLS_INTEGER);
```

Parameters

Parameter	Description
user	The name of the user account whose status needs to be set or updated.

Parameter	Description
status	The new status of the Real Application Security user account. The status values can be divided into several classes: • ACTIVE and INACTIVE - These two account status values will affect the user account's ability to create and attach to an application session. When set to ACTIVE, it allows the application user to use a direct login account to log into the database with a valid password. The application user is allowed to create and attach to an application session if the account has the required application privileges. When set to INACTIVE, the application user cannot use a direct login account to log into the database even with a valid password and can not create and attach to an application session. • UNLOCK, LOCKED, or EXPIRED - These status values will be checked only for the direct login Real Application Security application user. When set to UNLOCK, it opens the application user account when the account is LOCKED and allows the application user to use a direct login account to log into the database with a valid password. When set to LOCKED, it locks the account of the application user. This means user connections using a direct login account will not be allowed even with a valid password. Provided that the user account is ACTIVE, a direct login will not succeed when the account is locked, but the user can create and attach to an application session. When set to EXPIRED, it expires the account of the application user. This means user connections using a direct login account will be allowed for valid passwords; however, the password must be changed at the time of logon. • PASSWORDEXPIRED (Deprecated) - This status value is deprecated beginning with Release 1 (12.1.0.2). If you try to pass any other value for the parameter status, an ORA-46152: XS Security - invalid user status specified error is returned.

Examples

The following example sets the user status to LOCKED for user DJONES.

```
BEGIN
  SYS.XS_PRINCIPAL.SET_USER_STATUS('DJONES',XS_PRINCIPAL.LOCKED);
END;
```

SET_PASSWORD Procedure

The SET_PASSWORD procedure sets or modifies the password for an application user account. When you use the SET_PASSWORD procedure, it creates a verifier for you based on the password and the type parameter and then inserts the verifier and the value of the type parameter into the dictionary table.

A direct login Real Application Security user can change his or her own password by providing its value using the oldpass parameter. If value of the old password is incorrect, then the failed login count is incremented with each attempt, returning an

ORA-28008: invalid old password error. The new password is not set until the old supplied password is correct.

You need the ALTER_USER privilege to run this procedure for an application user or if you are changing the password of other Real Application Security users.

Native Real Application Security users synchronized from external ID stores are not allowed to change their own password. These users must change their password in the originating ID store. For example, if the Oracle Internet Directory 11*g* Release 1 (11.1.1) is the external store, for end-user self-service use the Oracle Identity Self Service interface provided by Oracle Identity Manager to manage your passwords. See Fusion Middleware Performing Self Service Tasks with Oracle Identity Manager for more information. You should contact your security administrator to determine if native Real Application Security users are synchronized from an external ID store, and if so, whether password management is provided in your directory server environment for end-user self-service.

The SET_PASSWORD operation and the SQL*Plus PASSWORD command are both blocked on the logical standby database.

Syntax

```
SET_PASSWORD (
  user      IN VARCHAR2,
  password  IN VARCHAR2,
  type      IN PLS_INTEGER := XS_SHA512,
  opassword IN VARCHAR2 :=NULL);
```

Parameters

Parameter	Description
user	The name of the application user account for which the password is to be set.
password	The password to be set.
type	The verifier type to be used for the password. The default value is XS_SHA512. The verifier type must be one of the following types: XS_SHA512, XS_SALTED_SHA1
opassword	The old password. This parameter is required if the Real Application Security user is changing his or her own password. If not provided, then the user must have the required privilege to change his or her own password.

Examples

The following example sets a password for application user SMAVRIS. It also specifies the XS_SHA512 verifier type for the password.

```
BEGIN
  SYS.XS_PRINCIPAL.SET_PASSWORD('SMAVRIS','2Hrd2Guess',XS_PRINCIPAL.XS_SHA512);
END;
```

SET_VERIFIER Procedure

The SET_VERIFIER procedure sets or modifies the verifier for an application user account. When you use the SET_VERIFIER procedure, the procedure directly inserts

the verifier and the value of the type parameter into the dictionary table, XS$VERIFIERS. This enables administrators to migrate users into Real Application Security with knowledge of the verifier and not the password.

You need the ALTER_USER privilege to run this procedure for an application user.

The SET_VERIFIER operation and the SQL*Plus PASSWORD command are both blocked on the logical standby database.

Syntax

```
set_verifier (
  user      IN VARCHAR2,
  verifier  IN VARCHAR2,
  type      IN PLS_INTEGER := XS_SHA512);
```

Parameters

Parameter	Description
user	The name of the application user for whom the verifier is set.
verifier	A character string to be used as the verifier.
type	The verifier type to be used. This can be one of the following: XS_SHA512, XS_SALTED_SHA1

Examples

Assume that a user by the name LWUSER3 is created and the password is set with a verifier type of XS_SALTED_SHA1.

Next, query the view DBA_XS_OBJECTS to obtain the ID value for user LWUSER3.

```
SQL> column name format A10;
SQL> column owner format A6;
SQL> select NAME, OWNER, ID, TYPE, STATUS from  DBA_XS_OBJECTS where NAME
= 'LWUSER3';

NAME       OWNER          ID TYPE                STATUS
---------- ------ ---------- ------------------ --------
LWUSER3    SYS    2147493770 PRINCIPAL          VALID
```

Next, query the XS$VERIFIERS dictionary table for user LWUSER3 whose ID is 2147493770.

```
SQL> column user# format 9999999999;
SQL> column type# format 99;
SQL> column verifier format A62;
SQL> select USER#, VERIFIER, TYPE# from XS$VERIFIERS where USER# =
'2147493770';

      USER# VERIFIER
TYPE#
----------- --------------------------------------------------------------
-----
```

```
 2147493770 S:
14DC0F5ABB72FC869549B1F845C548E0BEF7B863A116DB24DFAE22F0501E      1
```

The value of the verifier includes its type as value “S” followed by a colon (:) to denote that it is a verifier type of XS_SALTED_SHA1, which is also indicated as being of type# 1.

Using the entire verifier value including “S:”, set the verifier for user LWUSER3.

```
BEGIN
SYS.XS_PRINCIPAL.SET_VERIFIER('lwuser3','S:
14DC0F5ABB72FC869549B1F845C548E0BEF7B863A116DB24DFAE22F0501E',
XS_PRINCIPAL.XS_SALTED_SHA1);
END;
/  2    3    4    5

PL/SQL procedure successfully completed.
```

For this procedure to complete successfully, both the verifier value and its type must match the information in the VERIFIER column of the XS$VERIFIERS dictionary table for the user whose verifier is being set. Note that when you change the password for an application user, it automatically changes its verifier value with the option of changing its verifier type.

The previous example set the verifier to its same exact value to show the steps involved. You have the option to set the verifier for a password to any verifier value that displays for an application user when you query the XS$VERIFIERS dictionary table as long as the verifier value matches the verifier type that you set. For example, if you wanted to change the verifier value and the verifier type to XS_SHA512, do the following.

```
SQL> BEGIN
SYS.XS_PRINCIPAL.SET_VERIFIER('lwuser3','T:
9BA95FEF2C2630A2BAACF2E7C5E41B0D50CDC7B0B6
0C88AD4FE81F8155D002F99EEAF9D95477E4749870C67FDE870E154ED17809C359777F979E2
69010823FB
981B2A998915EB1439FE3C6C1542A239C',
XS_PRINCIPAL.XS_SHA512);
END;
/  2    3    4

PL/SQL procedure successfully completed.
```

Note that this is the same verifier value and verifier type that was set for application user LWUSER1 as shown in Setting a Password Verifier for Direct Application User Accounts.

SET_DESCRIPTION Procedure

The SET_DESCRIPTION procedure is used to set the description for an application principal.

You need the ALTER USER system privilege to run this procedure for an application user. You need the ALTER ANY ROLE system privilege to run this procedure for an application role.

Syntax

```
SET_DESCRIPTION (  principal   IN VARCHAR2,  description IN VARCHAR2);
```

Parameters

Parameter	Description
principal	The name of the principal for which the description is set.
description	A descriptive string about the principal.

Examples

The following example sets a description for the application role HRREP:

```
BEGIN
  SYS.XS_PRINCIPAL.SET_DESCRIPTION('HRREP','HR Representative role');
END;
```

DELETE_PRINCIPAL Procedure

The DELETE_PRINCIPAL procedure drops an application user or application role.

You need the DROP USER system privilege to run this procedure for an application user. You need the DROP ANY ROLE system privilege to run this procedure for an application role.

Syntax

```
delete_principal (
  principal     IN VARCHAR2,
  delete_option IN PLS_INTEGER:=XS_ADMIN_UTIL.DEFAULT_OPTION);
```

Parameters

Parameter	Description
principal	The name of the application user or application role that is to be deleted.
delete_option	The delete option to use. The following options are available: • DEFAULT_OPTION: The default option allows deleting a principal only if it is not referenced elsewhere. If there are other entities that reference the principal, then the principal cannot be deleted. For example, the delete operation fails if you try to delete an application role that is granted to a principal. • CASCADE_OPTION: The cascade option deletes the application user or application role together with any references to it.The user deleting the application user or application role must have privileges to delete these references as well. • ALLOW_INCONSISTENCIES_OPTION: The allow inconsistencies option lets you delete the entity even if other entities have late binding references to it. If the entity is part of an early dependency, then the delete fails and an error is raised.

Examples

The following example deletes the user SMAVRIS using the DEFAULT_OPTION:

```
BEGIN
  SYS.XS_PRINCIPAL.DELETE_PRINCIPAL('SMAVRIS');
END;
```

XS_SECURITY_CLASS Package

The XS_SECURITY_CLASS package includes procedures to create, manage, and delete security classes and their privileges. The package also includes procedures for managing security class inheritance.

This section includes the following topics:

- Security Model for the XS_SECURITY_CLASS Package
- Summary of XS_SECURITY_CLASS Subprograms

Security Model for the XS_SECURITY_CLASS Package

The XS_SECURITY_CLASS package is created under the SYS schema. The DBA role is granted the ADMIN_ANY_SEC_POLICY, which allows it to administer schema objects like ACLs, security classes, and security policies across all schemas.

Users can administer schema objects in their own schema if they have been granted the RESOURCE role for the schema. The RESOURCE role and the XS_RESOURCE application role include the ADMIN_SEC_POLICY privilege, required to administer schema objects in the schema as well as administering the policy artifacts within the granted schema to achieve policy management within an application.

Users can administer policy enforcement on the schema if they have been granted the APPLY_SEC_POLICY privilege. With this privilege, the user can administer policy enforcement within granted schemas to achieve policy management within an application.

Summary of XS_SECURITY_CLASS Subprograms

Table 11-11 Summary of XS_SECURITY_CLASS Subprograms

Subprogram	Description
CREATE_SECURITY_CLASS Procedure	Creates a new security class.
ADD_PARENTS Procedure	Adds one or more parent security classes for the specified security class.
REMOVE_PARENTS Procedure	Removes one or more parent security classes for the specified security class.
ADD_PRIVILEGES Procedure	Adds one or more privileges to the specified security class.
REMOVE_PRIVILEGES Procedure	Removes one or more privileges for the specified security class.
ADD_IMPLIED_PRIVILEGES Procedure	Adds one or more implied privileges for the specified aggregate privilege.

Table 11-11 (Cont.) Summary of XS_SECURITY_CLASS Subprograms

Subprogram	Description
REMOVE_IMPLIED_PRIVILEGES Procedure	Removes one or more implied privileges from an aggregate privilege.
SET_DESCRIPTION Procedure	Sets a description string for the specified security class.
DELETE_SECURITY_CLASS Procedure	Deletes the specified security class.

This section describes the following XS_SECURITY_CLASS subprograms:

CREATE_SECURITY_CLASS Procedure

The CREATE_SECURITY_CLASS creates a new security class.

Syntax

```
XS_SECURITY_CLASS.CREATE_SECURITY_CLASS (
  name         IN VARCHAR2,
  priv_list    IN XS$PRIVILEGE_LIST,
  parent_list  IN XS$NAME_LIST := NULL,
  description  IN VARCHAR2 := NULL);
```

Parameters

Parameter	Description
name	The name of the security class to be created. The name is schema qualified, for example, SCOTT.SC1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as SC1, and the current schema is SCOTT, it would resolve to SCOTT.SC1.
priv_list	The list of privileges to include in the security class.
parent_list	The list of parent security classes from which the security class is inherited. This is optional.
description	An optional description for the security class.

Examples

The following example creates a security class called HRPRIVS. The security class includes a set of privileges defined in priv_list. The security class uses the DML class as its parent security class.

```
DECLARE
  pr_list  XS$PRIVILEGE_LIST;
BEGIN
  pr_list :=XS$PRIVILEGE_LIST(
     XS$PRIVILEGE(name=>'VIEW_SENSITIVE_INFO'),
     XS$PRIVILEGE(name=>'UPDATE_INFO',
                  implied_priv_list=>XS$NAME_LIST
                  ('"UPDATE"', '"DELETE"', '"INSERT"')));

  SYS.XS_SECURITY_CLASS.CREATE_SECURITY_CLASS(
     name=>'HRPRIVS',
```

```
    priv_list=>pr_list,
    parent_list=>XS$NAME_LIST('DML'));
END;
```

ADD_PARENTS Procedure

The ADD_PARENTS procedure adds one or more parent security classes for the specified security class.

Syntax

```
XS_SECURITY_CLASS.ADD_PARENTS (
  sec_class   IN VARCHAR2,
  parent      IN VARCHAR2);

XS_SECURITY_CLASS.ADD_PARENTS (
  sec_class   IN VARCHAR2,
  parent_list IN XS$NAME_LIST);
```

Parameters

Parameter	Description
sec_class	The name of the security class for which parent classes are to be added. The name is schema qualified, for example, SCOTT.SC1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as SC1, and the current schema is SCOTT, it would resolve to SCOTT.SC1.
parent	The name of the parent security class to be added.
parent_list	The list of parent classes to be added.

Examples

The following example adds the parent security class GENPRIVS to the HRPRIVS security class.

```
BEGIN
  SYS.XS_SECURITY_CLASS.ADD_PARENTS('HRPRIVS','GENPRIVS');
END;
```

REMOVE_PARENTS Procedure

The REMOVE_PARENTS procedure removes one or more parent classes for the specified security class.

Syntax

```
XS_SECURITY_CLASS.REMOVE_PARENTS (
  sec_class IN VARCHAR2);

XS_SECURITY_CLASS.REMOVE_PARENTS (
  sec_class IN VARCHAR2,
  parent    IN VARCHAR2);

XS_SECURITY_CLASS.REMOVE_PARENTS (
  sec_class   IN VARCHAR2,
  parent_list IN XS$NAME_LIST);
```

Parameters

Parameter	Description
sec_class	The name of the security class whose parent classes are to be removed. The name is schema qualified, for example, SCOTT.SC1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as SC1, and the current schema is SCOTT, it would resolve to SCOTT.SC1.
parent	The parent security class that is to be removed.
parent_list	The list of parent security classes that are to be removed.

Examples

The following example removes the parent security class GENPRIVS from the HRPRIVS security class.

```
BEGIN
  SYS.XS_SECURITY_CLASS.REMOVE_PARENTS('HRPRIVS','GENPRIVS');
END;
```

ADD_PRIVILEGES Procedure

The ADD_PRIVILEGES procedure adds one or more privileges to a security class.

Syntax

```
XS_SECURITY_CLASS.ADD_PRIVILEGES (
  sec_class         IN VARCHAR2,
  priv              IN VARCHAR2,
  implied_priv_list IN XS$NAME_LIST := NULL,
  description       IN VARCHAR2 := NULL);

XS_SECURITY_CLASS.ADD_PRIVILEGES (
  sec_class  IN VARCHAR2,
  priv_list  IN XS$PRIVILEGE_LIST);
```

Parameters

Parameter	Description
sec_class	The name of the security class to which the privileges are to be added. The name is schema qualified, for example, SCOTT.SC1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as SC1, and the current schema is SCOTT, it would resolve to SCOTT.SC1.
priv	The name of the privilege to be added.
priv_list	The list of privileges to be added.
implied_priv_list	An optional list of implied privileges to be added.
description	An optional description of the privilege being added.

Examples

The following example adds an aggregate privilege called UPDATE_INFO to the HRPRIVS security class. The aggregate privilege contains the implied privileges, UPDATE, DELETE, and INSERT.

```
BEGIN
  SYS.XS_SECURITY_CLASS.ADD_PRIVILEGES(sec_class=>'HRPRIVS',priv=>'UPDATE_INFO',
                                       implied_priv_list=>XS$NAME_LIST('"UPDATE"',
                                                   '"DELETE"', '"INSERT"'));
END;
```

REMOVE_PRIVILEGES Procedure

The REMOVE_PRIVILEGES procedure removes one or more privileges from the specified security class. If no privilege name or list is specified, then all privileges are removed from the specified security class.

Syntax

```
XS_SECURITY_CLASS.REMOVE_PRIVILEGES (
  sec_class   IN VARCHAR2,
  priv        IN VARCHAR2);

XS_SECURITY_CLASS.REMOVE_PRIVILEGES (
  sec_class    IN VARCHAR2,
  priv_list    IN XS$NAME_LIST);

XS_SECURITY_CLASS.REMOVE_PRIVILEGES (
  sec_class IN VARCHAR2);
```

Parameters

Parameter	Description
sec_class	The name of the security class for which the privileges are to be removed. The name is schema qualified, for example, SCOTT.SC1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as SC1, and the current schema is SCOTT, it would resolve to SCOTT.SC1.
priv	The name of the privilege to be removed.
priv_list	The list of privileges to be removed.

Examples

The following example removes the UPDATE_INFO privilege from the HRPRIVS security class.

```
BEGIN
  SYS.XS_SECURITY_CLASS.REMOVE_PRIVILEGES('HRPRIVS','UPDATE_INFO');
END;
```

The following example removes all privileges from the HRPRIVS security class.

```
BEGIN
  SYS.XS_SECURITY_CLASS.REMOVE_PRIVILEGES('HRPRIVS');
END;
```

ADD_IMPLIED_PRIVILEGES Procedure

The ADD_IMPLIED_PRIVILEGES procedure adds one or more implied privileges to an aggregate privilege.

Syntax

```
XS_SECURITY_CLASS.ADD_IMPLIED_PRIVILEGES (
  sec_class    IN VARCHAR2,
  priv         IN VARCHAR2,
  implied_priv IN VARCHAR2);

XS_SECURITY_CLASS.ADD_IMPLIED_PRIVILEGES (
  sec_class         IN VARCHAR2,
  priv              IN VARCHAR2,
  implied_priv_list IN XS$NAME_LIST);
```

Parameters

Parameter	Description
sec_class	The name of the security class to which the privileges are to be added. The name is schema qualified, for example, SCOTT.SC1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as SC1, and the current schema is SCOTT, it would resolve to SCOTT.SC1.
priv	Name of the aggregate privilege for which the implied privileges are to be added.
implied_priv	The implied privilege to be added.
implied_priv_list	A list of implied privileges to be added for the aggregate privilege.

Examples

The following example adds a list of implied privileges for the aggregate privilege UPDATE_INFO to the HRPRIVS security class:

```
BEGIN
  SYS.XS_SECURITY_CLASS.ADD_IMPLIED_PRIVILEGES(sec_class=>'HRPRIVS',
priv=>'UPDATE_INFO', implied_priv_list=>XS$NAME_LIST('"UPDATE"', '"DELETE"',
'"INSERT"'));
END;
```

REMOVE_IMPLIED_PRIVILEGES Procedure

The REMOVE_IMPLIED_PRIVILEGES procedure removes the specified implied privileges from an aggregate privilege. If no implied privileges are specified, then all implied privileges are removed from the aggregate privilege.

Syntax

```
XS_SECURITY_CLASS.REMOVE_IMPLIED_PRIVILEGES (
  sec_class    IN VARCHAR2,
  priv         IN VARCHAR2,
  implied_priv IN VARCHAR2);

XS_SECURITY_CLASS.REMOVE_IMPLIED_PRIVILEGES (
  sec_class         IN VARCHAR2,
  priv              IN VARCHAR2,
  implied_priv_list IN XS$NAME_LIST);

XS_SECURITY_CLASS.REMOVE_IMPLIED_PRIVILEGES (
  sec_class   IN VARCHAR2,
  priv        IN VARCHAR2);
```

Parameters

Parameter	Description
`sec_class`	The name of the security class for which the privileges are to be removed. The name is schema qualified, for example, `SCOTT.SC1`. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as `SC1`, and the current schema is `SCOTT`, it would resolve to `SCOTT.SC1`.
`priv`	The name of the aggregate privilege from which the implied privileges are to be removed.
`implied_priv`	The implied privilege to be removed from the aggregate privilege.
`implied_priv_list`	The list of implied privileges to be removed from the aggregate privilege.

Examples

The following example removes the implicit privilege `DELETE` from the aggregate privilege `UPDATE_INFO` from the `HRPRIVS` security class:

```
BEGIN

SYS.XS_SECURITY_CLASS.REMOVE_IMPLIED_PRIVILEGES('HRPRIVS','UPDATE_INFO','"DELETE"');
END;
```

The following example removes all implicit privileges from the aggregate privilege `UPDATE_INFO` from the `HRPRIVS` security class.

```
BEGIN
  SYS.XS_SECURITY_CLASS.REMOVE_IMPLIED_PRIVILEGES('HRPRIVS','UPDATE_INFO');
END;
```

SET_DESCRIPTION Procedure

The `SET_DESCRIPTION` procedure sets a description string for the specified security class.

Syntax

```
XS_SECURITY_CLASS.SET_DESCRIPTION (
  sec_class   IN VARCHAR2,
  description IN VARCHAR2);
```

Parameters

Parameter	Description
sec_class	The name of the security class for which the description is to be set. The name is schema qualified, for example, SCOTT.SC1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as SC1, and the current schema is SCOTT, it would resolve to SCOTT.SC1.
description	A description string for the specified security class.

Examples

The following example sets a description string for the HRPRIVS security class:

```
BEGIN
  SYS.XS_SECURITY_CLASS.SET_DESCRIPTION(
    'HRPRIVS','Contains privileges required to manage HR data');
END;
```

DELETE_SECURITY_CLASS Procedure

The DELETE_SECURITY_CLASS procedure deletes the specified security class.

Syntax

```
XS_SECURITY_CLASS.DELETE_SECURITY_CLASS (
  sec_class     IN VARCHAR2,
  delete_option IN NUMBER:=XS_ADMIN_UTIL.DEFAULT_OPTION);
```

Parameters

Parameter	Description
sec_class	The name of the security class to be deleted. The name is schema qualified, for example, SCOTT.SC1. When the schema part of the name is missing, the current session schema is assumed. For example, in this same example, if the name is specified as SC1, and the current schema is SCOTT, it would resolve to SCOTT.SC1.

Parameter	Description
delete_option	The delete option to use. The following options are available: • DEFAULT_OPTION: The default option allows deleting a security class only if it is not referenced elsewhere. If there are other entities that reference the security class, then the security class cannot be deleted. • CASCADE_OPTION: The cascade option deletes the security class together with any references to it.The user deleting the security class must have privileges to delete these references as well. • ALLOW_INCONSISTENCIES_OPTION: The allow inconsistencies option lets you delete the entity even if other entities have late binding references to it.

Examples

The following example deletes the HRPRIVS security class using the default option:

```
BEGIN

SYS.XS_SECURITY_CLASS.DELETE_SECURITY_CLASS('HRPRIVS',XS_ADMIN_UTIL.DEFAULT_OPTION);
END;
```

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Real Application Security HR Demo

This chapter describes the following topics:

- Overview of the Security HR Demo
- What Each Script Does
- Setting Up the Security HR Demo Components
- Running the Security HR Demo Using Direct Logon
- Running the Security HR Demo Attached to a Real Application Security Session
- Running the Security HR Demo Cleanup Script
- Running the Security HR Demo in the Java Interface
- About Using RASADM to Run the Security HR Demo

Overview of the Security HR Demo

This Human Resources (HR) Demonstration shows how to use basic Real Application Security (RAS) features. This tutorial is an end-to-end use case scenario. PL/SQL scripts, a Java program source file, and log files can be found in Real Application Security HR Demo Files.

The HR demo secures the `HR.EMPLOYEE` table by applying a data security policy that has three realms:

1. An employee's own record realm. The ACL, `EMP_ACL` controls this realm, which grants application role `employee` privileges to access the realm, including the `SALARY` column.
2. All the records in the IT department realm. The ACL, `IT_ACL` controls this realm, which grants application role `it_engineer` privileges to access the realm, but excluding the `SALARY` column.
3. All the employee records realm. The ACL, HR_ACL controls this realm, which grants application role `hr_representative` privileges to access the realm, including the `SALARY` column.

The HR Demo defines two application users to demonstrate the effects of the policy:

- `DAUSTIN`, an application user in the IT department. He has application roles `employee` and `it_engineer`. So, he can access realm #1 and realm #2 mentioned previously; that is, he can view employee records in the IT department, but he cannot view the `SALARY` column, except for his own salary record.
- `SMAVRIS`, an application user in HR department. She has application roles `employee` and `hr_representative`. So, she can access realm #1 and realm #3 mentioned previously; that is, she can view and update all the employee records.

The HR Demo scripts show:

- How to create Real Application Security objects: application user, application role, ACL, security class, and data security policy.
- How to use the data security policy to secure rows (using realm constraints) and columns (using a column constraint) of a table.
- How to directly logon to a database with application users (requiring a password), and how to create, attach, detach, and destroy a Real Application Security session.
- How to enable and disable an application role in a Real Application Security session.

What Each Script Does

The Security HR demo use case runs the following set of PL/SQL scripts to set up components and run the demo:

- `hrdemo_setup.sql`: sets up the demo components by:
  - Creating a database user as the Real Application Security Administrator and then connecting as the Real Application Security Administrator to create the components.
  - Creating a database role, `DB_EMP`.
  - Creating an IT application user, `DAUSTIN`.
  - Creating an HR application user, `SMAVRIS`.
  - Creating application roles: `employee`, `it_engineer`, and `hr_representative`, and then granting the database role `DB_EMP` to each of these application roles.
  - Granting application roles `employee` and `it_engineer` to application user `DAUSTIN`.
  - Granting application roles `employee` and `hr_representative` to application user `SMAVRIS`.
  - Creating the `VIEW_SALARY` privilege and creating the `hr_privileges` security class in which to scope the privilege.
  - Creating three ACLs: `EMP_ACL`, `IT_ACL`, and `HR_ACL`, in which:
    - `EMP_ACL` grants the `employee` role the `SELECT` database privilege and `VIEW_SALARY` application privilege to view an employee's own record, including the `SALARY` column.
    - `IT_ACL` grants the `it_engineer` role only the `SELECT` database privilege to view the employee records in the IT department, but it does not grant the `VIEW_SALARY` privilege that is required for access to the `SALARY` column.
    - `HR_ACL` grants the `hr_representative` role `SELECT`, `INSERT`, `UPDATE`, and `DELETE` database privileges to view and update all employee's records, and granting the `VIEW_SALARY` application privilege to view the `SALARY` column.
  - The HR demo secures the `HR.EMPLOYEE` table by creating and applying the data security policy, `EMPLOYEES_DS`, that has the following three realms and column constraint:

        - An employee's own record realm. The ACL, `EMP_ACL` controls this realm, which grants application role `employee` privileges to access the realm, including the `SALARY` column.
        - All the records in the IT department realm. The ACL, `IT_ACL` controls this realm, which grants application role `it_engineer` privileges to access the realm, but excluding the `SALARY` column.
        - All the employee records realm. The ACL, `HR_ACL` controls this realm, which grants application role `hr_representative` privileges to access the realm, including the `SALARY` column.
        - A column constraint that protects the `SALARY` column by requiring the `VIEW_SALARY` privilege to view its sensitive data.
    - Validating all the objects that have been created to ensure that all configurations are correct.
    - Setting up the mid-tier related configuration by creating a `DISPATCHER` user, setting the password for this user, and granting the roles, `XSCONNECT` and `xsdispatcher` to this `DISPATCHER` user.
- `hrdemo.sql`: runs the demo with direct logon, demonstrating:
    - That the IT application user, `DAUSTIN`, can view the records in the IT department, but can only view his own salary record, and cannot update his own record.
    - That the HR application user, `SMAVRIS`, can view all the records, including all salary rows in the `SALARY` column, and can update any record.
- `hrdemo_session.sql`: runs the demo creating and attaching to a Real Application Security session, demonstrating:
    - Connecting as the Real Application Security Administrator and creating an application session for application user `SMAVRIS` and attaching to it.
    - Displaying the current user as `SMAVRIS`.
    - Displaying the enabled database roles as `DB_EMP` and application roles as `employee`, `hr_representative`, and `XSPUBLIC` for the current user `SMAVRIS`.
    - That `SMAVRIS` application user can view all records including all salary rows in the `SALARY` column.
    - Disabling the `hr_representative` and thus limiting application user `SMAVRIS` to viewing only her own employee record.
    - Enabling the `hr_representative`, thus allowing `SMAVRIS` application user to view all records, including all salary rows in the `SALARY` column again.
    - Detaching from the application session.
    - Destroying the application session.
- `hrdemo_clean.sql`: performs a cleanup operation that removes: application roles, application users, ACLs, the data security policy, the database role, the Real Application Security administrative user, and the mid-tier dispatcher user.
- `hrdemo.java`: runs the HR Demo using the Java interface.

"Setting Up the Security HR Demo Components" describes in more detail how each of the Real Application Security components is created along with performing some other important tasks.

Setting Up the Security HR Demo Components

Before you can create Real Application Security components, you must first connect as SYS/ user as SYSDBA.

```
define passwd=&1
connect sys/&passwd as sysdba
```

This sections includes the following topics:

- About Creating Roles and Application Users
- About Creating the Security Class and ACLs
- About Creating the Data Security Policy
- About Validating the Real Application Security Objects
- About Setting Up the Mid-Tier Related Configuration

About Creating Roles and Application Users

Create the application roles EMPLOYEE, IT_ENGINEER, and HR_REPRESENTATIVE, and the database role DB_EMP. The DB_EMP role is used to grant the required object privileges to the two application users that are created, DAUSTIN and SMAVRIS. Finally, grant the HR user the policy administration privilege, ADMIN_ANY_SEC_POLICY.

Connect as SYS/ user as SYSDBA.

```
define passwd=&1
connect sys/&passwd as sysdba
```

Create the application role EMPLOYEE for common employees.

```
exec sys.xs_principal.create_role(name => 'employee', enabled => true);
```

Create an application role IT_ENGINEER for the IT department.

```
exec sys.xs_principal.create_role(name => 'it_engineer', enabled => true);
```

Create an application role HR_REPRESENTATIVE for the HR department.

```
exec sys.xs_principal.create_role(name => 'hr_representative', enabled => true);
```

Create the database role, DB_EMP, for object privilege grants.

```
create role db_emp;
```

Grant the DB_EMP database role to the three application roles, so they each have the required object privilege to access the table.

```
grant db_emp to employee;
grant db_emp to it_engineer;
grant db_emp to hr_representative;
```

Create the application users.

Create application user DAUSTIN (in the IT department) and grant this user application roles EMPLOYEE and IT_ENGINEER.

```
exec  sys.xs_principal.create_user(name => 'daustin', schema => 'hr');
exec  sys.xs_principal.set_password('daustin', 'welcome1');
exec  sys.xs_principal.grant_roles('daustin', 'XSCONNECT');
exec  sys.xs_principal.grant_roles('daustin', 'employee');
exec  sys.xs_principal.grant_roles('daustin', 'it_engineer');
```

Create application user SMAVRIS (in the HR department) and grant this user application roles EMPLOYEE and HR_REPRESENTATIVE.

```
exec  sys.xs_principal.create_user(name => 'smavris', schema => 'hr');
exec  sys.xs_principal.set_password('smavris', 'welcome1');
exec  sys.xs_principal.grant_roles('smavris', 'XSCONNECT');
exec  sys.xs_principal.grant_roles('smavris', 'employee');
exec  sys.xs_principal.grant_roles('smavris', 'hr_representative');
```

Grant the HR user the policy administration privilege, ADMIN_ANY_SEC_POLICY.

```
exec sys.xs_admin_util.grant_system_privilege('ADMIN_ANY_SEC_POLICY','HR');
```

About Creating the Security Class and ACLs

First, grant the necessary table privileges to the DB_EMP role.

Next, create a security class HR_PRIVILEGES based on the predefined DML security class. HR_PRIVILEGES has a new privilege VIEW_SALARY, which controls access to the SALARY column. Finally, create the three ACLs, EMP_ACL, IT_ACL, and HR_ACL.

Connect as the HR user.

```
connect hr/hr;
```

Grant the necessary object privileges to the DB_EMP role. This role is used to grant the required object privileges to application users.

```
grant select, insert, update, delete on hr.employees to db_emp;

declare
begin
  sys.xs_security_class.create_security_class(
    name        => 'hr_privileges',
    parent_list => xs$name_list('sys.dml'),
    priv_list   => xs$privilege_list(xs$privilege('view_salary')));
end;
/
```

Create three ACLs, EMP_ACL, IT_ACL, and HR_ACL to grant privileges for the data security policy to be defined later.

```
declare
  aces xs$ace_list := xs$ace_list();
begin
  aces.extend(1);

  -- EMP_ACL: This ACL grants EMPLOYEE role the privileges to view an employee's
  --          own record including SALARY column.
  aces(1) := xs$ace_type(privilege_list => xs$name_list('select','view_salary'),
                         principal_name => 'employee');

  sys.xs_acl.create_acl(name      => 'emp_acl',
                        ace_list  => aces,
```

```
                    sec_class => 'hr_privileges');

  -- IT_ACL:  This ACL grants IT_ENGINEER role the privilege to view the employee
  --          records in IT department, but it does not grant the VIEW_SALARY
  --          privilege that is required for access to SALARY column.
  aces(1) := xs$ace_type(privilege_list => xs$name_list('select'),
                         principal_name => 'it_engineer');

  sys.xs_acl.create_acl(name      => 'it_acl',
                    ace_list  => aces,
                    sec_class => 'hr_privileges');

  -- HR_ACL:  This ACL grants HR_REPRESENTITIVE role the privileges to view and
update all
  --          employees' records including SALARY column.
  aces(1):= xs$ace_type(privilege_list => xs$name_list('select', 'insert',
                                          'update', 'delete', 'view_salary'),
                        principal_name => 'hr_representative');

  sys.xs_acl.create_acl(name      => 'hr_acl',
                    ace_list  => aces,
                    sec_class => 'hr_privileges');
end;
/
```

About Creating the Data Security Policy

Create the data security policy for the `EMPLOYEE` table. The policy defines three realm constraints and a column constraint that protects the `SALARY` column.

```
declare
  realms   xs$realm_constraint_list := xs$realm_constraint_list();
  cols     xs$column_constraint_list := xs$column_constraint_list();
begin
  realms.extend(3);

  -- Realm #1: Only the employee's own record.
  --           The EMPLOYEE role can view the realm including SALARY column.
  realms(1) := xs$realm_constraint_type(
    realm    => 'email = xs_sys_context(''xs$session'',''username'')',
    acl_list => xs$name_list('emp_acl'));

  -- Realm #2: The records in the IT department.
  --           The IT_ENGINEER role can view the realm excluding SALARY column.
  realms(2) := xs$realm_constraint_type(
    realm    => 'department_id = 60',
    acl_list => xs$name_list('it_acl'));

  -- Realm #3: All the records.
  --           The HR_REPRESENTATIVE role can view and update the realm including
SALARY column.
  realms(3) := xs$realm_constraint_type(
    realm    => '1 = 1',
    acl_list => xs$name_list('hr_acl'));

  -- Column constraint protects SALARY column by requiring VIEW_SALARY
  -- privilege.
  cols.extend(1);
  cols(1) := xs$column_constraint_type(
    column_list => xs$list('salary'),
```

```
    privilege   => 'view_salary');

  sys.xs_data_security.create_policy(
    name                   => 'employees_ds',
    realm_constraint_list  => realms,
    column_constraint_list => cols);
end;
/
```

Apply the data security policy to the EMPLOYEES table.

```
begin
  sys.xs_data_security.apply_object_policy(
    policy => 'employees_ds',
    schema => 'hr',
    object =>'employees');
end;
/
```

About Validating the Real Application Security Objects

After you create these Real Application Security objects, validate them to ensure they are all properly configured.

```
begin
  if (sys.xs_diag.validate_workspace()) then
    dbms_output.put_line('All configurations are correct.');
  else
    dbms_output.put_line('Some configurations are incorrect.');
  end if;
end;
/
-- XS$VALIDATION_TABLE contains validation errors if any.
-- Expect no rows selected.
select * from xs$validation_table order by 1, 2, 3, 4;
```

About Setting Up the Mid-Tier Related Configuration

Set up the mid-tier configuration to be used later. This involves creating a session administrator, hr_session, who only has Real Application Security administrative privileges (XS_SESSION_ADMIN and CREATE SESSION), but no data privileges. The session administrator is responsible for managing the Real Application Security session for each application user. In addition, it involves creating a DISPATCHER user and password and granting this user the XSCONNECT and XSDISPATCHER Real Application Security administrator privileges.

```
grant xs_session_admin, create session to hr_session identified by hr_session;
grant create session to hr_common identified by hr_common;
```

Create a dispatcher user for the Java demo to set up a session for the application user.

```
exec sys.xs_principal.create_user(name=>'dispatcher', schema=>'HR');
exec sys.xs_principal.set_password('dispatcher', 'welcome1');
exec sys.xs_principal.grant_roles('dispatcher', 'XSCONNECT');
exec sys.xs_principal.grant_roles('dispatcher', 'xsdispatcher');
```

Running the Security HR Demo Using Direct Logon

To run the HR Demo, first connect as application user DAUSTIN, who has only the EMPLOYEE and IT_ENGINEER application roles.

```
conn daustin/welcome1;
```

Customize how secured column values are to be displayed in SQL*Plus using the default indicator asterisks (*******) in place of column values.

```
SET SECUREDCOL ON UNAUTH *******
```

Perform a query to show that application user DAUSTIN can view the records in the IT department, but can only view his own SALARY column.

```
select email, first_name, last_name, department_id, manager_id, salary
from employees order by email;

SQL> select email, first_name, last_name, department_id, manager_id, salary
  2  from employees order by email;

EMAIL      FIRST_NAME      LAST_NAME       DEPARTMENT_ID MANAGER_ID  SALARY
---------- --------------- --------------- ------------- ---------- -------
AHUNOLD    Alexander       Hunold                     60        102 *******
BERNST     Bruce           Ernst                      60        103 *******
DAUSTIN    David           Austin                     60        103    4800
DLORENTZ   Diana           Lorentz                    60        103 *******
VPATABAL   Valli           Pataballa                  60        103 *******

5 rows selected.
```

Set to the default display for how secured column values are to be displayed in SQL*Plus by displaying null values in place of column values for application users without authorization, and in place of column values where the security level is unknown.

```
SET SECUREDCOL OFF
```

Perform an update operation to show that application user is not authorized to update the record.

```
update employees set manager_id = 102 where email = 'DAUSTIN';

SQL> update employees set manager_id = 102 where email = 'DAUSTIN';

0 rows updated.
```

Perform a query to show that the record is unchanged.

```
select email, first_name, last_name, department_id, manager_id, salary
from employees where email = 'DAUSTIN';

SQL> select email, first_name, last_name, department_id, manager_id, salary
  2  from employees where email = 'DAUSTIN';

EMAIL      FIRST_NAME      LAST_NAME       DEPARTMENT_ID MANAGER_ID  SALARY
---------- --------------- --------------- ------------- ---------- -------
DAUSTIN    David           Austin                     60        103    4800
```

```
1 row selected.
```

Connect as application user SMAVRIS, who has both EMPLOYEE and HR_REPRESENTATIVE application roles.

```
conn smavris/welcome1;
```

Perform a query to show that application user SMAVRIS can view all the records including SALARY column.

```
select email, first_name, last_name, department_id, manager_id, salary
from employees where department_id = 60 or department_id = 40
order by department_id, email;

SQL> select email, first_name, last_name, department_id, manager_id, salary
  2  from employees where department_id = 60 or department_id = 40
  3  order by department_id, email;

EMAIL      FIRST_NAME      LAST_NAME       DEPARTMENT_ID MANAGER_ID  SALARY
---------- --------------- --------------- ------------- ---------- -------
SMAVRIS    Susan           Mavris                     40        101    6500
AHUNOLD    Alexander       Hunold                     60        102    9000
BERNST     Bruce           Ernst                      60        103    6000
DAUSTIN    David           Austin                     60        103    4800
DLORENTZ   Diana           Lorentz                    60        103    4200
VPATABAL   Valli           Pataballa                  60        103    4800

6 rows selected.
```

Perform a query to show that application user SMAVRIS can access all the records.

```
select count(*) from employees;

SQL> select count(*) from employees;

  COUNT(*)
----------
       107

1 row selected.
```

Perform an update of the record to show that application user SMAVRIS can update the record.

```
update employees set manager_id = 102 where email = 'DAUSTIN';

SQL> update employees set manager_id = 102 where email = 'DAUSTIN';

1 row updated.
```

Perform a query to show that the record is changed.

```
select email, first_name, last_name, department_id, manager_id, salary
from employees where email = 'DAUSTIN';

SQL> select email, first_name, last_name, department_id, manager_id, salary
  2  from employees where email = 'DAUSTIN';

EMAIL      FIRST_NAME      LAST_NAME       DEPARTMENT_ID MANAGER_ID  SALARY
---------- --------------- --------------- ------------- ---------- -------
```

```
DAUSTIN    David          Austin                    60        102    4800

1 row selected.
```

Update the record to change it back to its original state.

```
update employees set manager_id = 103 where email = 'DAUSTIN';

SQL> update employees set manager_id = 103 where email = 'DAUSTIN';

1 row updated.
```

Running the Security HR Demo Attached to a Real Application Security Session

To run the demo attached to a Real Application Security session, the Real Application Security administrator must first create the session for an application user and attach to it. In the process, create a variable to remember the session ID.

```
connect hr_session/hr_session;

var gsessionid varchar2(32);

declare
  sessionid raw(16);
begin
  sys.dbms_xs_sessions.create_session('SMAVRIS', sessionid);
  :gsessionid := rawtohex(sessionid);
  sys.dbms_xs_sessions.attach_session(sessionid, null);
end ;
/
```

Display the current user.

```
select xs_sys_context('xs$session','username') from dual;

SQL> select xs_sys_context('xs$session','username') from dual;

XS_SYS_CONTEXT('XS$SESSION','USERNAME')
--------------------------------------------------------------------------------
SMAVRIS

1 row selected.
```

Display the enabled database and application roles for the current application user.

```
select role_name from v$xs_session_roles union
select role from session_roles order by 1;

SQL> select role_name from v$xs_session_roles union
  2  select role from session_roles order by 1;

ROLE_NAME
--------------------------------------------------------------------------------
DB_EMP
EMPLOYEE
HR_REPRESENTATIVE
XSPUBLIC
```

```
4 rows selected.
```

Perform a query to show that application user SMAVRIS can view all the records including SALARY column.

```
select email, first_name, last_name, department_id, manager_id, salary
from employees where department_id = 60 or department_id = 40
order by department_id, email;

SQL> select email, first_name, last_name, department_id, manager_id, salary
  2  from employees where department_id = 60 or department_id = 40
  3  order by department_id, email;

EMAIL      FIRST_NAME      LAST_NAME       DEPARTMENT_ID MANAGER_ID  SALARY
---------- --------------- --------------- ------------- ---------- -------
SMAVRIS    Susan           Mavris                     40        101    6500
AHUNOLD    Alexander       Hunold                     60        102    9000
BERNST     Bruce           Ernst                      60        103    6000
DAUSTIN    David           Austin                     60        103    4800
DLORENTZ   Diana           Lorentz                    60        103    4200
VPATABAL   Valli           Pataballa                  60        103    4800

6 rows selected.
```

Perform a query to show that application user SMAVRIS can access all the records.

```
select count(*) from employees;

SQL> select count(*) from employees;

  COUNT(*)
----------
       107

1 row selected.
```

Disable the HR_REPRESENTATIVE role. This will limit application user SMAVRIS to only be able to see her own record.

```
exec dbms_xs_sessions.disable_role('hr_representative');
```

Perform a query

```
select email, first_name, last_name, department_id, manager_id, salary
from employees where department_id = 60 or department_id = 40
order by department_id, email;

SQL> select email, first_name, last_name, department_id, manager_id, salary
  2  from employees where department_id = 60 or department_id = 40
  3  order by department_id, email;

EMAIL      FIRST_NAME      LAST_NAME       DEPARTMENT_ID MANAGER_ID  SALARY
---------- --------------- --------------- ------------- ---------- -------
SMAVRIS    Susan           Mavris                     40        101    6500

1 row selected.
```

Enable the HR_REPRESENTATIVE role so the application user can view all the records including SALARY column.

```
exec dbms_xs_sessions.enable_role('hr_representative');
```

Perform a query to show that application user can view all the records including SALARY column.

```
select email, first_name, last_name, department_id, manager_id, salary
from employees where department_id = 60 or department_id = 40
order by department_id, email;

SQL> -- SMAVRIS can view all the records again.
SQL> select email, first_name, last_name, department_id, manager_id, salary
  2  from employees where department_id = 60 or department_id = 40
  3  order by department_id, email;

EMAIL      FIRST_NAME      LAST_NAME       DEPARTMENT_ID MANAGER_ID  SALARY
---------- --------------- --------------- ------------- ---------- -------
SMAVRIS    Susan           Mavris                     40        101    6500
AHUNOLD    Alexander       Hunold                     60        102    9000
BERNST     Bruce           Ernst                      60        103    6000
DAUSTIN    David           Austin                     60        103    4800
DLORENTZ   Diana           Lorentz                    60        103    4200
VPATABAL   Valli           Pataballa                  60        103    4800

6 rows selected.
```

Perform a query to show that application user SMAVRIS can access all the records.

```
select count(*) from employees;

SQL> select count(*) from employees;

  COUNT(*)
----------
       107

1 row selected.
```

Detach and destroy the application session.

```
declare
  sessionid raw(16);
begin
  sessionid := hextoraw(:gsessionid);
  sys.dbms_xs_sessions.detach_session;
  sys.dbms_xs_sessions.destroy_session(sessionid);
end;
/
```

Running the Security HR Demo Cleanup Script

After running the HR demo, you can run the clean up script to remove all of the Real Application Security components.

To start, connect as the Real Application Security Administrator and then begin removing components.

```
define passwd=&1
connect hr/hr;
```

Remove the data security policy from the EMPLOYEES table.

```
begin
  xs_data_security.remove_object_policy(policy=>'employees_ds',
                                        schema=>'hr', object=>'employees');
end;
/
```

Delete the security class and the ACLs.

```
exec sys.xs_security_class.delete_security_class('hrprivs',
xs_admin_util.cascade_option);
exec sys.xs_acl.delete_acl('emp_acl', xs_admin_util.cascade_option);
exec sys.xs_acl.delete_acl('it_acl', xs_admin_util.cascade_option);
exec sys.xs_acl.delete_acl('hr_acl', xs_admin_util.cascade_option);
```

Delete the data security policy.

```
exec sys.xs_data_security.delete_policy('employees_ds',
xs_admin_util.cascade_option);
```

Connect as SYS/ user as SYSDBA.

```
connect sys/&passwd as sysdba
```

Delete the application roles and application users.

```
exec sys.xs_principal.delete_principal('employee', xs_admin_util.cascade_option);
exec sys.xs_principal.delete_principal('hr_representative',
xs_admin_util.cascade_option);
exec sys.xs_principal.delete_principal('it_engineer', xs_admin_util.cascade_option);
exec sys.xs_principal.delete_principal('smavris', xs_admin_util.cascade_option);
exec sys.xs_principal.delete_principal('daustin', xs_admin_util.cascade_option);
```

Delete the database role.

```
drop role db_emp;
```

Delete the Real Application Security session administrator.

```
drop user hr_session;
```

Delete the common user used to connect to the database.

```
drop user hr_common;
```

Delete the DISPATCHER user used by the mid-tier.

```
exec sys.xs_principal.delete_principal('dispatcher', xs_admin_util.cascade_option);
```

Running the Security HR Demo in the Java Interface

See the Output section in "Human Resources Administration Use Case: Implementation in Java" for a description of the two queries that are returned from running the Security HR Demo in the Java interface.

About Using RASADM to Run the Security HR Demo

Describes how to use RASADM to create Real Application Security data security policies using a graphical user interface.

Oracle Database Real Application Security Administration (RASADM) lets you create Real Application Security data security policies using a graphical user interface. For more information on installing and configuring RASADM, see Real Application Security Administration.

This section describes the following topics:

- About Running the RASADM Application
- Design Phase
- Development Flow
- About Using RASADM to Create the HR Demo

About Running the RASADM Application

Describes how to run the RASADM application.

The following URL is just an example and the real URL is based on your current Application Express configuration. Make sure the correct URL is provided. Then log in as the RASADM administrator using the same password given during the installation.

To run the RASADM application, you would enter in your browser a URL like the following: https://www.example.com:8080/apex/f?p=rasadm.

Oracle recommends that you turn on HTTPS.

You can log in as the RASADM `admin` user or any user created after installation using the password given during installation as shown in the following screen shot.

For More Information

See the following resources for more information:

- Real Application Security discussion forum: Database Security — General
- Real Application Security Documentation: see *Oracle Database Real Application Security Administration*

Design Phase

In the design phase, you identify all the tasks an application performs that require application privileges to control data access.

For example, during the design phase, the application policy designer must identify:

1. The set of application-level operations that require access control.
2. The rows and columns of tables and views that can be accessed as part of the application-level operations.
3. The set of actors or principals (users and roles) that can perform these operations.
4. The runtime application session attributes that identity rows of a table or views. These attribute names are used within the predicates that selects the rows to be authorized, and their values are set during the execution of the application.

Development Flow

To develop data security policies using RASADM, you must follow some basic steps.

In the development phase, as the RASADM administrator, you use RASADM to develop your data security policies following these steps:

1. Create the corresponding application users and roles. If using an external directory server, create the application users and roles or user groups in the directory server. Follow this procedure to create these principals natively in the database:
    a. Create the application roles and grant application roles to application roles, if needed. See the topic on creating application roles.
    b. Create the application users and grant application roles to the application users. See the topic on creating application users.
    c. Configure the directory server to fetch the users and role, when principals from external stores are used. See the topic on configuration.
    d. For users and roles in the external Directory Server, manage parameter settings for using RASADM with a Directory Server. See the topic on managing settings.
2. Create each privilege class that you plan to use to develop the security policies for your application. Each privilege class consists of one or more appropriate privileges that you define and can reference in an ACL and also grant them to the application users and application roles. Each privilege class authorizes by means of ACLs the required application-level operations of a data security policy. See the topic on creating application privilege classes.
3. Create one or more session namespaces that can be used across different application sessions. This consists of defining for a session namespace its set of

properties (application attributes) and its associated access control policy or ACL that you can choose from a list or create. See the topic on creating namespaces.

4. Create the data security policy by associating each data realm with an ACL, so as to create both data realm authorization and column authorization as needed. This process consists of four parts:

   a. Policy Information - You choose the object to be protected and the privilege class to protect it as well as specify the policy name and select the policy schema. See Step 3 in the topic on creating data security policies.

   b. Column Level Authorization - You choose the name of the column to be protected and select the privilege to be granted to access the column, which is associated with the privilege class you selected in Step 3a. See Step 4 in the topic on creating data security policies.

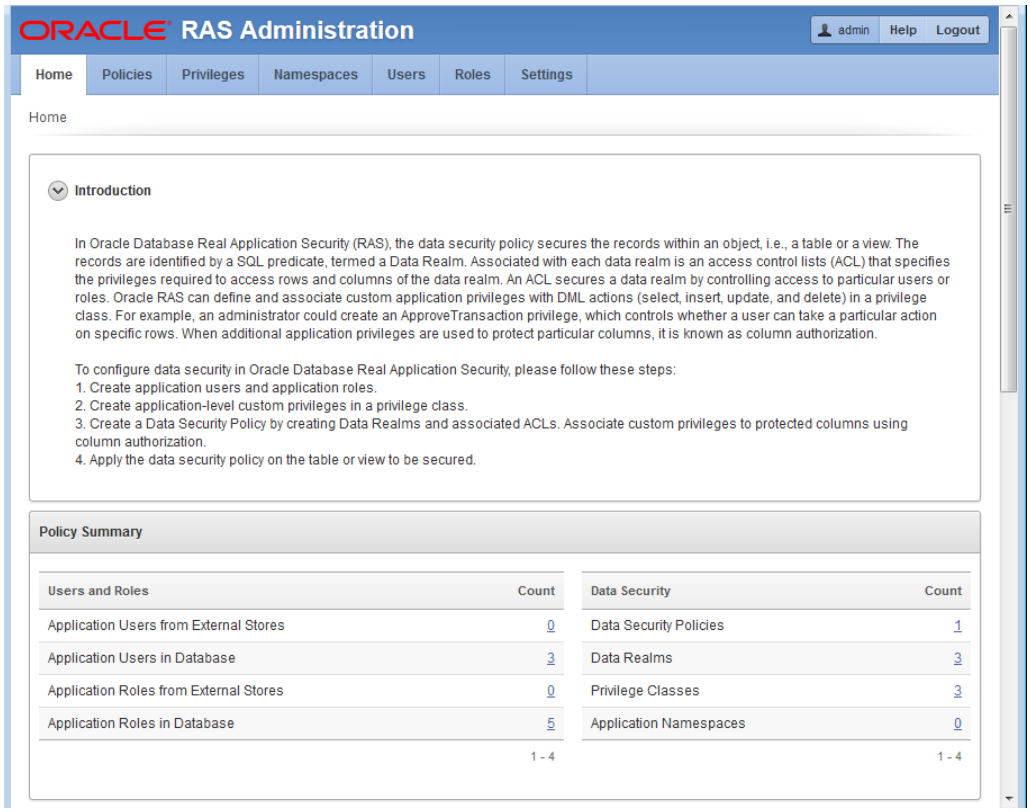
   c. Data Realm Authorization - You create a SQL predicate to represent the data realm to be protected and add each to a data realm grant list. Then you choose or create the ACL to protect the data realm. Next, create privilege grants to be added to a privilege grants list consisting of each principal and whether it is allowed authorization or denied authorization by selecting the appropriate privilege. See Step 5 in the topic on creating data security policies.

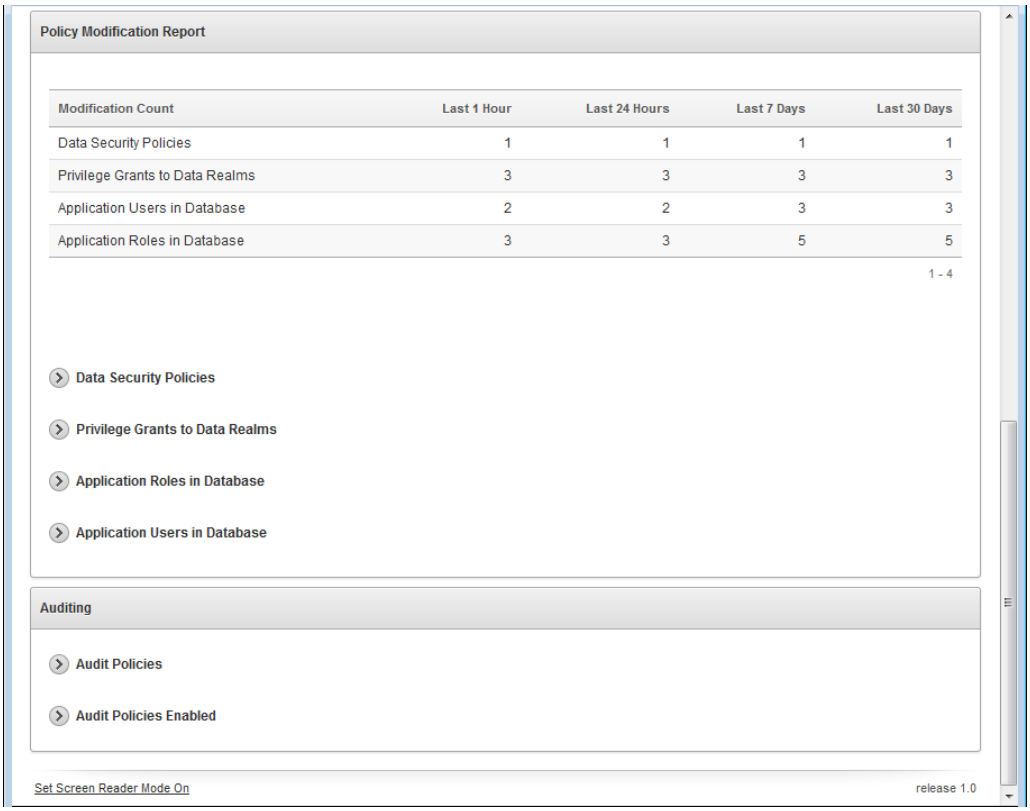
   d. Apply Policy - You can apply, remove, enable, or disable the data security policy you are creating and choose to specify certain apply options, allowing the owner of the table or view to bypass this data security policy, and whether to enforce statement types for this policy. See Step 6 in the topic on creating data security policies.

About Using RASADM to Create the HR Demo

Describes how to use RASADM to create the HR Demo application.

To begin, you should be running the RASADM application and be logged in as the `ADMIN` user as described in About Running the RASADM Application and shown in the following screen shots.


ORACLE RAS Administration
admin
Help
Logout
Home
Policies
Privileges
Namespaces
Users
Roles
Settings
Home
Introduction
In Oracle Database Real Application Security (RAS), the data security policy secures the records within an object, i.e., a table or a view. The records are identified by a SQL predicate, termed a Data Realm. Associated with each data realm is an access control lists (ACL) that specifies the privileges required to access rows and columns of the data realm. An ACL secures a data realm by controlling access to particular users or roles. Oracle RAS can define and associate custom application privileges with DML actions (select, insert, update, and delete) in a privilege class. For example, an administrator could create an ApproveTransaction privilege, which controls whether a user can take a particular action on specific rows. When additional application privileges are used to protect particular columns, it is known as column authorization.
To configure data security in Oracle Database Real Application Security, please follow these steps:
1. Create application users and application roles.
2. Create application-level custom privileges in a privilege class.
3. Create a Data Security Policy by creating Data Realms and associated ACLs. Associate custom privileges to protected columns using column authorization.
4. Apply the data security policy on the table or view to be secured.
Policy Summary
Users and Roles
Count
Application Users from External Stores
0
Application Users in Database
3
Application Roles from External Stores
0
Application Roles in Database
5
1 - 4
Data Security
Count
Data Security Policies
1
Data Realms
3
Privilege Classes
3
Application Namespaces
0
1 - 4


Policy Modification Report
Modification Count
Last 1 Hour
Last 24 Hours
Last 7 Days
Last 30 Days
Data Security Policies
1
1
1
1
Privilege Grants to Data Realms
3
3
3
3
Application Users in Database
2
2
3
3
Application Roles in Database
3
3
5
5
1 - 4
Data Security Policies
Privilege Grants to Data Realms
Application Roles in Database
Application Users in Database
Auditing
Audit Policies
Audit Policies Enabled
Set Screen Reader Mode On
release 1.0

You will be performing the following tasks:

About Creating Application Roles

Describes how to create application roles and specifically the database DB_EMP role.

You must create a database `DB_EMP` role using SQL*Plus and grant this role `SELECT`, `INSERT`, `UPDATE`, and `DELETE` privileges in `HR.EMPLOYEES` as this code snippet indicates.

```
-- Create database role DB_EMP and grant necessary table privileges.
-- This role will be used to grant the required object privileges to
-- application users.
CREATE ROLE DB_EMP;
GRANT SELECT, INSERT, UPDATE, DELETE ON HR.EMPLOYEES TO DB_EMP;
```

See hrdemo_setup.sqlfor more information.

This next task involves creating the following application roles: `EMP_ROLE`, `IT_ROLE`, and `HR_ROLE`, and then enabling each application role.

This task can be performed in one of two ways:

- Using RASADM to create these application roles.
- Using an external directory server to create the application roles in the directory server.

In either case, for the HR Demo, the following application roles will be created:

- `EMP_ROLE`
- `IT_ROLE`
- `HR_ROLE`

Finally, using SQL*Plus, you must grant each of these application roles the database `DB_EMP` role as indicated in the following code snippet.

```
-- Grant DB_EMP to the three application roles, so they have the required
-- object privilege to access the table.
GRANT DB_EMP TO EMP_ROLE;
GRANT DB_EMP TO IT_ROLE;
GRANT DB_EMP TO HR_ROLE;
```

See hrdemo_setup.sqlfor more information.

- See Using RASADM to Create Application Roles

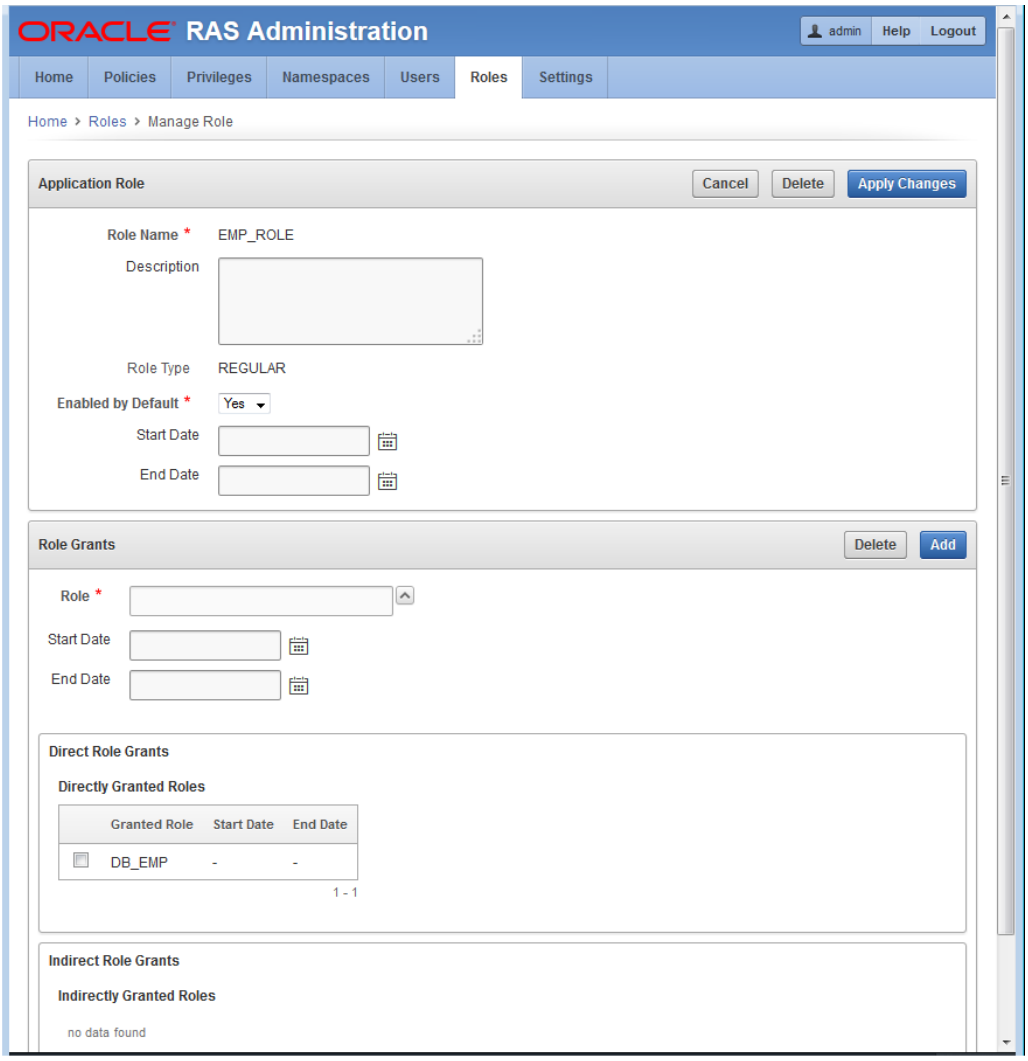
Using RASADM to Create Application Roles

Describes how to create application roles using RASADM.

To get started, click the **Roles** tab, then click **Create Role**.

1. On the `Application Role` page, enter information in the following fields:
   a. **Role Name:** Enter `EMP_ROLE`.
   b. **Description:** Enter a brief description.
   c. **Type of Role:** Select the default, `ROLE`.
   d. **Enabled by Default:** Select `Yes`.

2. In **Roles Grant** section, in the **Roles** field, click **^** and select **DB_EMP** role from the list to add it as a direct role grant.
3. Click **Apply Changes** to create the `EMP_ROLE` application role.
4. Click the role `EMP_ROLE` to see the edit view of this role as shown in the following screen shot.
5. Repeat these steps to create the `IT_ROLE` and `HR_ROLE` application roles. Again, there are no application roles to be granted to either of these application roles.



About Creating Application Users

Describes creating application users and granting them roles.

This task involves creating each application user and granting each application user its respective application role.

This task can be performed in one of two ways:

- Using RASADM to create application users: `DAUSTIN` and `SMAVRIS`.

Next, perform the following grants:

  - Grant application roles `EMP_ROLE` and `IT_ROLE` to `DAUSTIN`.
  - Grant application roles `EMP_ROLE` and `HR_ROLE` to `SMAVRIS`.

- Using an external directory server to create the application users or application user groups in the directory server.

In either case, for this HR Demo, the following application users will be created:

- `DAUSTIN`
- `SMAVRIS`

Next, you will perform the following grants:

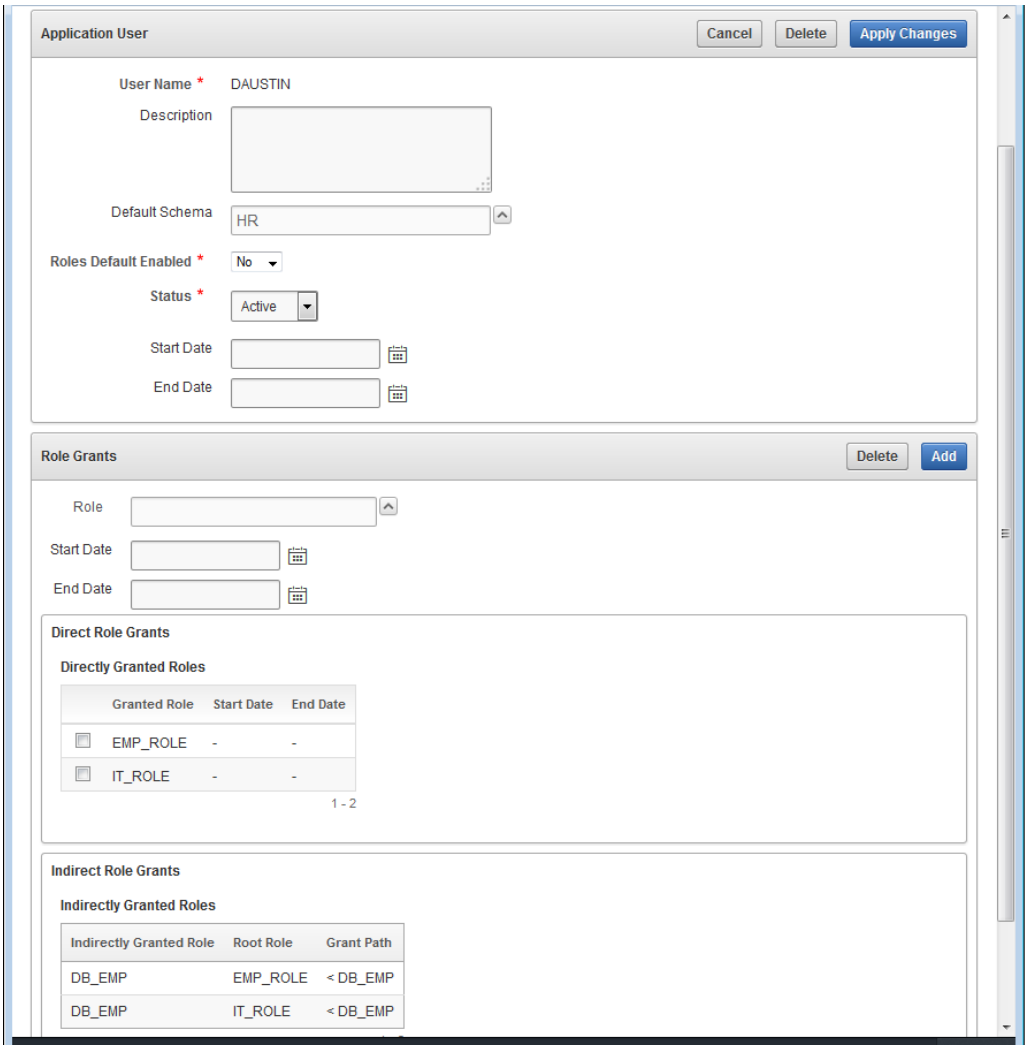
- Grant the application role `EMP_ROLE` to user `DAUSTIN` and `SMAVRIS`.
- Grant the application role `IT_ROLE` to user `DAUSTIN`.
- Grant the application role `HR_ROLE` to user `SMAVRIS`.
- See Using RASADM to Create Application Users.

Using RASADM to Create Application Users

Describes creating application users using RASADM.

To get started, click the **Users** tab, then click **Create User**.

1. On the `Manage User` page in the **Application User** section, enter information in the following fields:
   a. **Name:** Enter `DAUSTIN`.
   b. **Description:** Enter a brief description.
   c. **Default Schema:** Select `HR`.
   d. **Roles Default Enabled:** Select `Yes`.
   e. **Status:** Chose `Active`.
2. In the **Roles Grants** section, select the application roles to be granted to the application user `daustin`. Enter information in the **Role:** field by clicking **^** and selecting `EMP_ROLE`.
3. Click **Add** to grant this role. Repeat this process to grant the `IT_ROLE` to `DAUSTIN`.
4. Click **Apply Changes** to create the application user `DAUSTIN`.
5. Click user `DAUSTIN` to see the edit view of this user as shown in the following screen shot.
6. Repeat these steps to grant the `EMP_ROLE` and `HR_ROLE` to application user `SMAVRIS`.



About Creating the Data Security Policy

Describes the process flow for creating the data security policy.

This task involves creating the HRDEMO data security policy. It includes:

- Entering the policy information.
- Creating the `HRPRIVS` privilege class and its `VIEW_SALARY` privilege.
- Creating the `SALARY` column authorization and selecting the `HRPRIVS` privilege class to be applied to the column.
- Creating the data realm authorization consisting of the three data realms, one for employee access, one for IT access, and one for HR access along with each associated ACL with its respective defined privilege grant for each principal to control its row access.
- Applying the `HRDEMO` data security policy by enabling it.

This section includes the following topics:

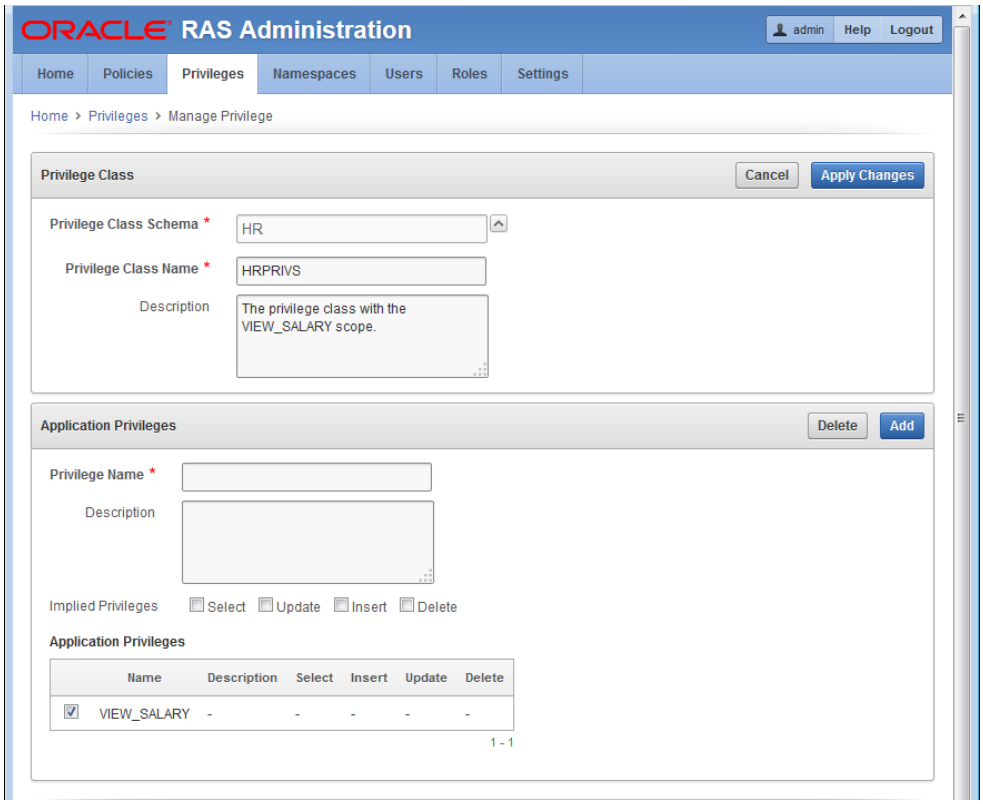
Entering Policy Information

Describes entering data security policy information using the RASADM application.

To create a data security policy, click the **Policies** tab, then click **Create** to display the **Policy Information** page.

1. On the **Policy Information** page, enter the policy information in the following fields:
   a. **Policy Schema:** Click **^** and select `HR`.
   b. **Policy Name:** Enter the name `Employees_DS`.
   c. **Description:** Enter a brief description for this policy.
   d. **Privilege Class:** Click **NEW** to create the `HRPRIVS` privilege class.
2. On the **Privilege Class** page, enter the following information:
   a. For **Privilege Class**. Privilege Class Name: Enter `HRPRIVS`.
   b. For **Privilege Class**. Description: Enter a brief description.
   c. For **Application Privileges**. Privilege Name: Enter the name `VIEW_SALARY`.
   d. For **Application Privileges**. Description: Enter a brief description.
   e. For **Application Privileges**. Implied Privileges: Click `Select`.
   f. Click **Add** to add the `VIEW_SALARY` privilege to the Application Privileges list. See the following figure.
   g. Click **Apply Changes** to save the `HRPRIVS` privilege class.
3. On the same **Privilege Class** page, enter the following information:
   a. **Protected Object's Schema:** Click **^** and select `HR`.
   b. **Protected Object:** Click **^** and select `EMPLOYEES`.

   The following screen shot shows the **Policy Information** page for the `Employees_DS` data security policy.



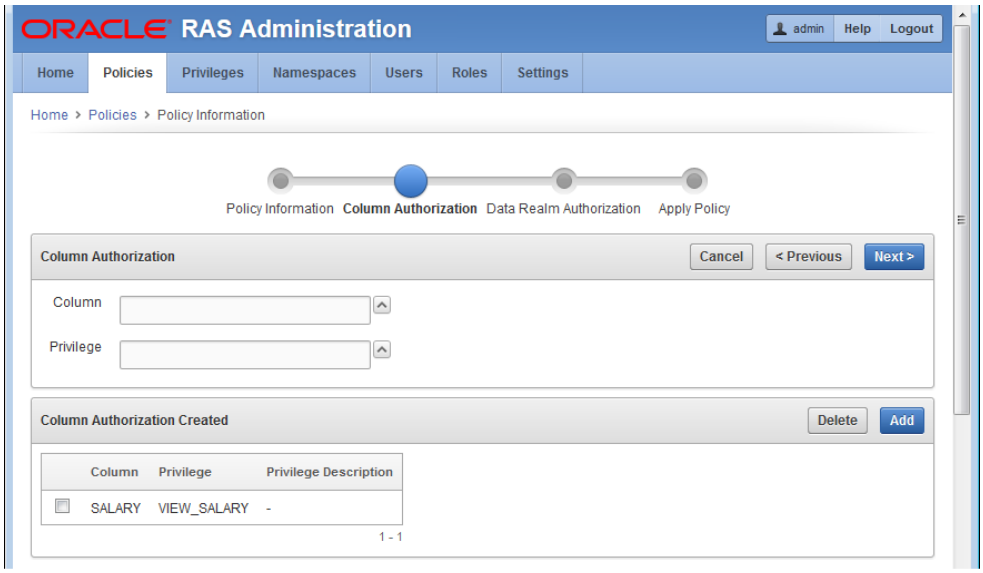
4. Click **Next** to go to the `Column Authorization` page.

Creating the Column Authorization

Describes creating the column authorization part of the data security policy.

1. On the **Column Authorization** page, enter the following information to create a column authorization:
   a. **Column:** Click **^** and select `SALARY`.
   b. **Privilege:** Click **^** and select `VIEW_SALARY`.
2. Click **Add** to add the column authorization to the **Column Constraint** list.

   The following screen shot shows the **Column Authorization** page with the created `SALARY` column authorization protected by the `VIEW_SALARY` privilege.



3. Click **Next** to go to the **Data Realm Authorization** page.

Creating the Data Realm Authorizations

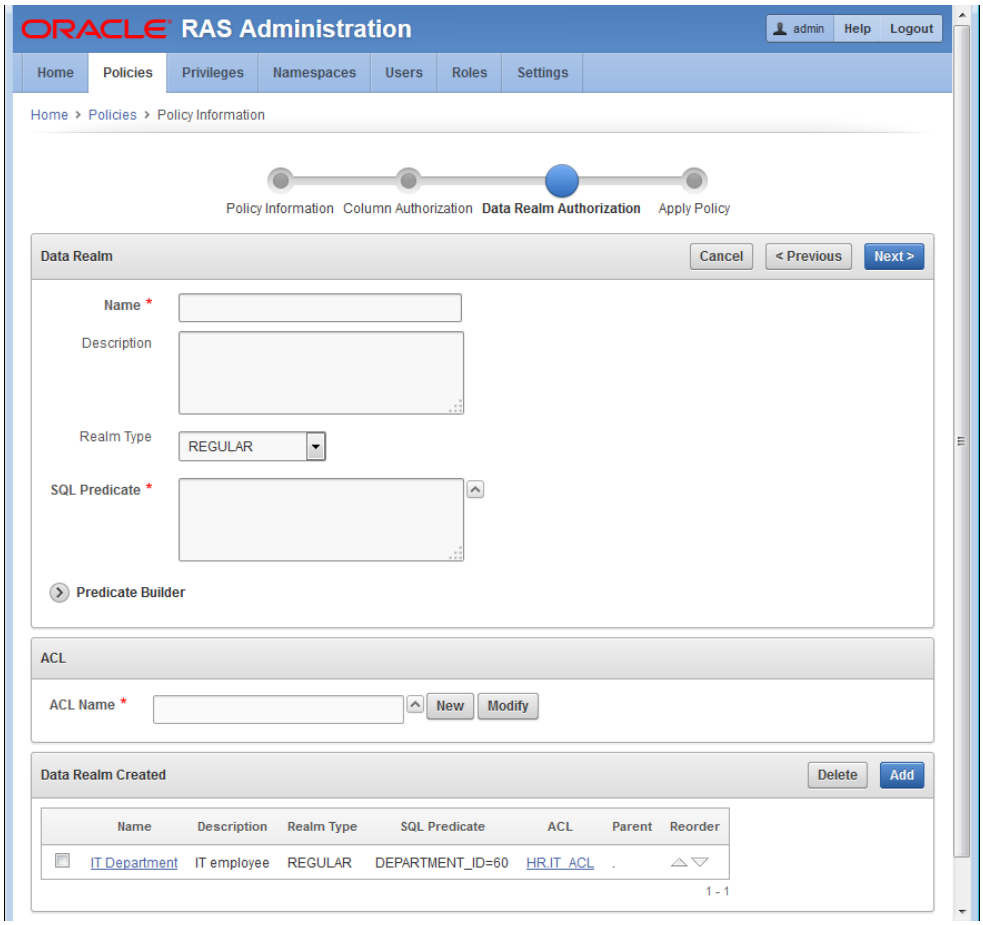
Describes the creating the data realm authorizations part of the data security policy.

Three data realm authorizations will be created that:

- Allows a user granted the `IT_ROLE` to view records in the IT department excluding the `SALARY` column.
- Allows a user granted the `EMP_ROLE` to view their own record including the `SALARY` column
- Allows a user granted the `HR_ROLE` to view and update all records including the `SALARY` column.

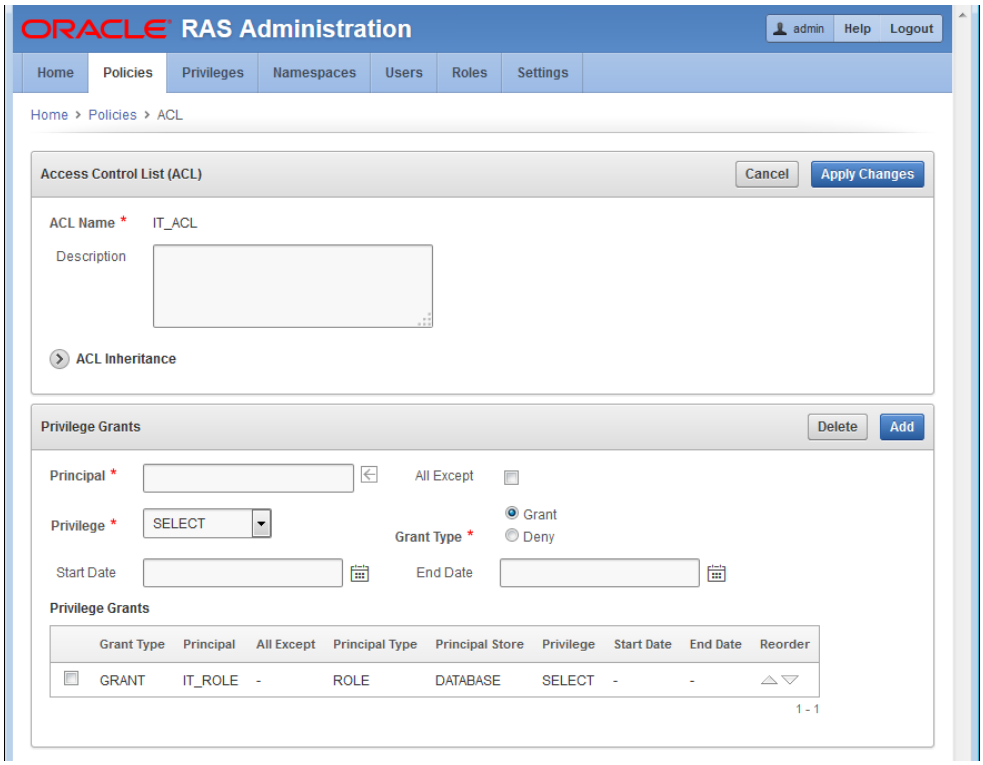
1. On the **Data Realm Authorization** page, enter information in the following fields to create the data realm to allow the IT department member access to their department records, excluding the `SALARY` column:
   a. **Description:** Enter a brief description.
   b. **SQL Predicate:** Click **>** to expand the **Predicate Builder** field. Enter information in the following fields:
   c. **Column Name:** Click **^** to select the `DEPARTMENT` column name.
   d. **Operator:** Click **^** to select the = operator.
   e. **Value:** Enter the value `60`.
   f. **AND/OR:** Ignore this option.
   g. Click **Apply** to create the SQL predicate.

   The following screen shows the completed IT Department data realm authorization..



2. **ACL Name:** Click **+** to create the `IT_ACL`. Enter information in the following fields:
   a. For **ACL Control Lists (ACL)**, **ACL Name:** Enter `IT_ACL`.
   b. For **ACL Control Lists (ACL)**, **Description:** Enter a brief description.
   c. For **ACL Control Lists (ACL)**, **ACL Inheritance:** Ignore this field.
   d. For **Privilege Grants**, Principal: Click **<-** to select a principal.
   e. For **Privilege Grants**, **Principal Type:** Click **User**.
   f. For **Privilege Grants**, **Principal Store:** Click **Database**.
   g. For **Privilege Grants**, **Principal Filter:** Enter `DAUSTIN` and click **Search**. Then click **Select** to select **DAUSTIN** as the principal.
   h. For **Privilege Grants**, **Privilege:** Choose the default option, **SELECT**.
   i. For **Privilege Grants**, **Grant:** Choose the option **Grant**.
   j. Click **Add** to add this privilege grant.

   The following screen shot shows the completed `IT_ACL` ACL and its privilege grant of the SELECT privilege granted to the IT_ROLE role.

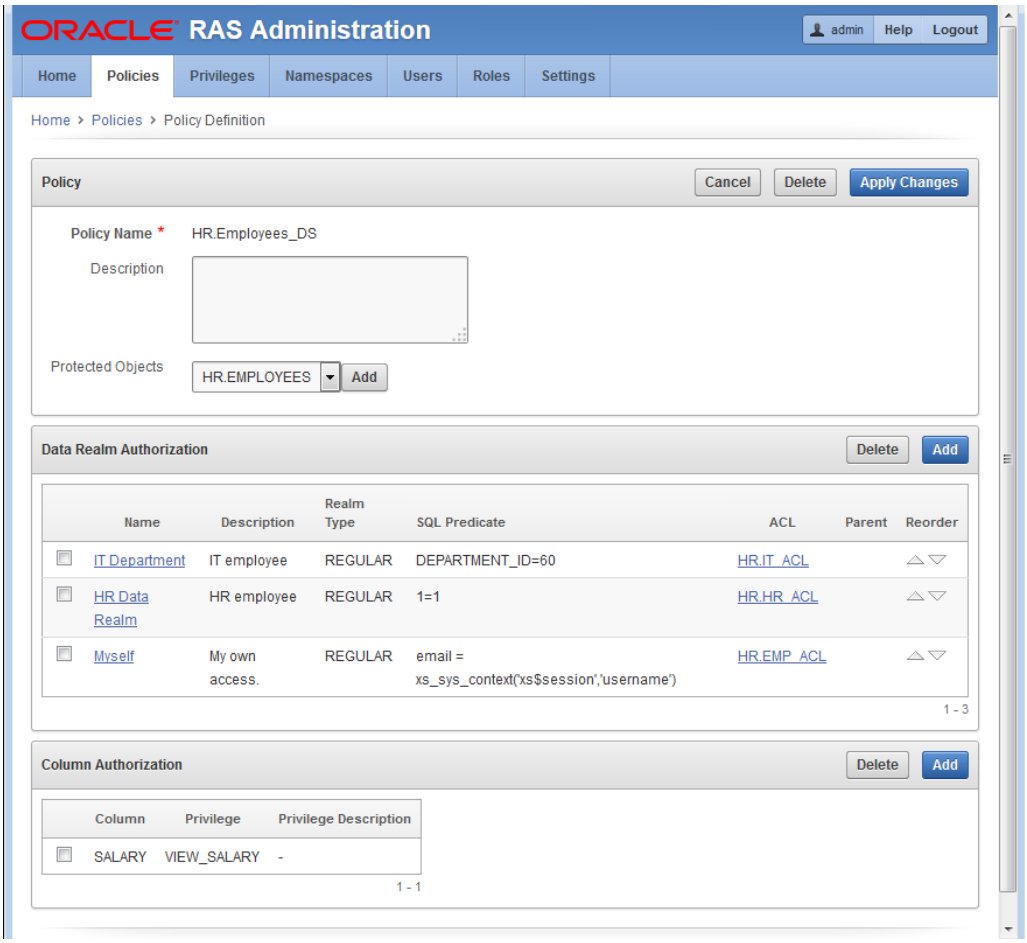


3. **Data Realm Grant:** Click **Add** to grant this data realm.
4. On the **Data Realm Authorization** page, Click **Add** to begin to add the next data realm authorization. Enter information in the following fields to create the data realm to allow the employee access to their own record, including the `SALARY` column.
    a. **Description:** Enter a brief description.
    b. **SQL Predicate:** Enter `UPPER(email) = XS_SYS_CONTEXT('XS$SESSION','USERNAME')`.
    c. Click **Preview** to view the results of the query and see if it is what you expected.
5. **ACL Name:** Click **+** to create the `EMP_ACL`. Enter information in the following fields:
    a. For **ACL Control Lists (ACL)**, **ACL Name:** Enter `EMP_ACL`
    b. For **ACL Control Lists (ACL)**, **Description:** Enter a brief description.
    c. For **ACL Control Lists (ACL)**, **ACL Inheritance:** Ignore this field.
    d. For **Privilege Grants**, Principal: Click **<-** to select a principal.
    e. For **Privilege Grants**, **Principal Type:** Click **User**.
    f. For **Privilege Grants**, **Principal Store:** Click **Database**.
    g. For **Privilege Grants**, **Principal Filter:** Enter `DAUSTIN` and click **Search**. Then click **Select** to select **DAUSTIN** as the principal.
    h. For **Privilege Grants**, **Privilege:** Choose the default option, **SELECT**
    i. For **Privilege Grants**, **Grant:** Choose the option **Grant**.
    j. Click **Add** to add this privilege grant.

k. Repeat these same two grants for user SMAVRIS, so user SMAVRIS is granted SELECT and VIEW_SALARY application privileges.

6. **Data Realm Grant:** Click **Add** to grant this data realm.
7. On the **Data Realm Authorization** page, Click **Add** to begin to add the next data realm authorization. Enter information in the following fields to create the data realm to allow the HR personnel to access and update all employee records, including the SALARY column.
   a. **Description:** Enter a brief description.
   b. **SQL Predicate:** Enter `UPPER(email) = XS_SYS_CONTEXT('XS$SESSION','USERNAME')`.
   c. Click **Preview** to view the results of the query and see if it is what you expected.
8. **ACL Name:** Click **+** to create the HR_ACL. Enter information in the following fields:
   a. For **ACL Control Lists (ACL)**, **ACL Name:** Enter HR_ACL
   b. For **ACL Control Lists (ACL)**, **Description:** Enter a brief description.
   c. For **ACL Control Lists (ACL)**, **ACL Inheritance:** Ignore this field.
   d. For **Privilege Grants**, Principal: Click **<-** to select a principal.
   e. For **Privilege Grants**, **Principal Type:** Click **User**.
   f. For **Privilege Grants**, **Principal Store:** Click **Database**.
   g. For **Privilege Grants**, **Principal Filter:** Enter SMAVRIS and click **Search**. Then click **Select** to select SMAVRIS as the principal.
   h. For **Privilege Grants**, **Privilege:** Choose the default option, **SELECT**
   i. For **Privilege Grants**, **Grant:** Choose the option **Grant**.
   j. Repeat this **Privileges Grants** step to grant UPDATE to SMAVRIS.
   k. For **Privilege Grants**, Principal: Click **<-** to select a principal.
   l. For **Privilege Grants**, **Principal Type:** Click **User**.
   m. For **Privilege Grants**, **Principal Store:** Click **Database**.
   n. For **Privilege Grants**, **Principal Filter:** Enter SMAVRIS and click **Search**. Then click **Select** to select SMAVRIS as the principal.
   o. For **Privilege Grants**, **Privilege:** Choose **UPDATE**
   p. For **Privilege Grants**, **Grant:** Choose the option **Grant**.
   q. Repeat this step two more times to grant INSERT and DELETE to SMAVRIS.
   r. Click **Add** to add this privilege grant.
9. **Data Realm Grant:** Click **Add** to add this data realm authorization to the list of data realm authorizations.

The following screen shot shows the three completed data realm authorizations and the completed column authorization.



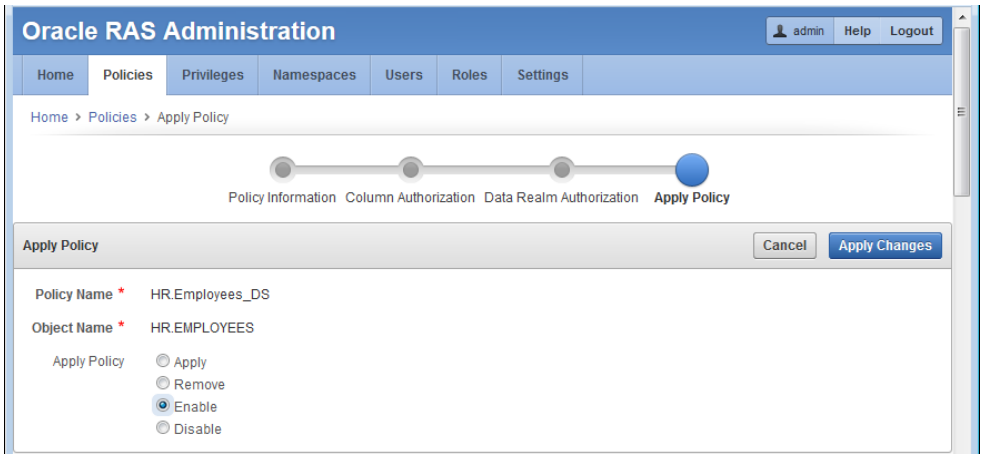
Applying the Policy

Describes applying the data security policy.

To apply the `Employees_DS` data security policy, perform the following steps:

1. On the **Apply Policy** page, enter information in the **Apply Policy** field by selecting `Enable` to enable this data security policy.

   The following screen shot shows the completed `Employees_DS` data security policy on the **Policies** page with the policy already set to be enabled.



2. Click **Apply Changes** to create the `Employees_DS` data security policy.

A

Predefined Objects in Real Application Security

This appendix describes the following predefined objects in Real Application Security:

- Users
- Roles
- Namespaces
- Security Classes
- ACLs

Users

`XSGUEST` - A system-defined Real Application Security user typically reserved for anonymous access.

Roles

Real Application Security provides predefined application roles for regular application roles, dynamic application roles, and database roles.

This section includes the following topics:

- Regular Application Roles
- Dynamic Application Roles
- Database Roles

Regular Application Roles

Real Application Security provides the following predefined regular application roles:

- `XSPUBLIC` - This application role is similar to the `PUBLIC` role in the database. It is granted to all Real Application Security application users.
- `XSBYPASS` - A role used to bypass the restrictions imposed by a system constraining ACL.
- `XSPROVISIONER` - A role used to grant `PROVISION` and `CALLBACK` privileges.
- `XSSESSIONADMIN` - A role used for session administration.
- `XSNAMESPACEADMIN` - A role used for namespace attribute administration.
- `XSCACHEADMIN` - A role used for middle tier cache administration.
- `XSDISPATCHER` - A role used for session administration, namespace administration, and middle tier cache administration by a dispatcher.

- XSCONNECT — A role used to control whether a Real Application Security application user with a password can connect to the database or not.

Dynamic Application Roles

Real Application Security provides the following predefined dynamic application roles:

- DBMS_AUTH

  This application role depends on the authentication state of the application user. It is enabled whenever the application user is authenticated in the Real Application Security system as a direct-logon application user using any of the database authentication methods.

- EXTERNAL_DBMS_AUTH

  This application role depends on the authentication state of the external application user. It is enabled whenever the external application user is authenticated in the Real Application Security system as an external direct-logon application user using any of the database authentication methods.

- DBMS_PASSWD

  This application role depends on the authentication state of the application user. It is enabled whenever the application user is authenticated in the Real Application Security system as a direct-logon application user using a password authentication method.

- MIDTIER_AUTH

  This application role depends on the authentication state of the application user. It is enabled whenever the application user is authenticated in the Real Application Security system through the middle tier. The middle tier explicitly passes this application role to the database indicating that the application user has been authenticated by the middle tier.

- XSAUTHENTICATED

  This application role depends on the authentication state of the application user. It is enabled whenever the application user is authenticated in the Real Application Security system (either directly or through the middle tier).

- XSSWITCH

  This application role depends on the session state of the application user. It is enabled whenever the Real Application Security session for an application user is created as a result of a switch_user operation, that is, if the proxy user in the original Real Application Security session is switched to an application user.

Database Roles

Real Application Security provides the following database roles.

- PROVISIONER - A database role that has the PROVISION and CALLBACK privileges.
- XS_SESSION_ADMIN - A database role that has the ADMINISTER_SESSION privilege.
- XS_NAMESPACE_ADMIN - A database role that has the ADMIN_ANY_NAMESPACE privilege.

- XS_CACHE_ADMIN - A database role that can be used for middle tier cache administration.

Namespaces

Real Application Security provides the following predefined namespaces:

- XS$GLOBAL_VAR - Contains the following NLS Attributes: NLS_LANGUAGE, NLS_TERRITORY, NLS_SORT, NLS_DATE_LANGUAGE, NLS_DATE_FORMAT, NLS_CURRENCY, NLS_NUMERIC_CHARACTERS, NLS_ISO_CURRENCY, NLS_CALENDAR, NLS_TIME_FORMAT, NLS_TIMESTAMP_FORMAT, NLS_TIME_TZ_FORMAT, NLS_TIMESTAMP_TZ_FORMAT, NLS_DUAL_CURRENCY, NLS_COMP, NLS_LENGTH_SEMANTICS, and NLS_NCHAR_CONV_EXCP.

  The XS$GLOBAL_VAR namespace can be loaded in to a Real Application Security session without requiring any privileges.
- XS$SESSION - Contains the following attributes: CREATED_BY, CREATE_TIME, COOKIE, CURRENT_XS_USER, CURRENT_XS_USER_GUID, INACTIVITY_TIMEOUT, LAST_ACCESS_TIME, LAST_AUTHENTICATION_TIME, LAST_UPDATED_BY, PROXY_GUID, SESSION_ID, SESSION_SIZE, SESSION_XS_USER, SESSION_XS_USER_GUID, USERNAME, and USER_ID.

Security Classes

Real Application Security provides the following predefined security classes and application privileges:

- DML - DML Privileges security class. If an ACL does not specify its security class, DML is the default security class for the ACL. See "DML Security Class" for more information. Contains the following common application privileges for object manipulation.
  - SELECT - Privilege to read an object.
  - INSERT - Privilege to insert an object.
  - UPDATE - Privilege to update an object.
  - DELETE - Privilege to delete an object.
- SYSTEM - System security class. Contains the following application privileges:
  - PROVISION - Privilege for updating principal documents from FIDM. The PROVISION privilege is also extended for creating, deleting, and modifying Real Application Security principals (users or roles) beginning in Release 12.2. This Real Application Security system privilege is intended to replace the traditional use of database create user, alter user privileges, and so forth to create and alter Real Application Security application users and roles.
  - CALLBACK - Privilege to register and update global callbacks.
  - ADMIN_ANY_SEC_POLICY - Privilege for any administrative operation.
  - ADMIN_SEC_POLICY - Privilege for administering objects in its own schema.
  - ADMIN_NAMESPACE - Privilege for administering any namespace.
- SESSION_SC - Session security class. Contains the following application privileges:

  - CREATE_SESSION - Privilege to create a Real Application Security user session.
  - TERMINATE_SESSION - Privilege to terminate a Real Application Security user session.
  - ATTACH_SESSION - Privilege to attach to a Real Application Security user session.
  - MODIFY_SESSION - Privilege to modify contents of a Real Application Security user session.
  - ASSIGN_USER - Privilege to assign user to an anonymous Real Application Security user session.
  - ADMINISTER_SESSION - Privilege for Real Application Security user session administration, aggregate of CREATE_SESSION, TERMINATE_SESSION, ATTACH_SESSION, MODIFY_SESSION, and SET_DYNAMIC_ROLES.
  - SET_DYNAMIC_ROLES - Privilege to protect Real Application Security enablement and disablement of a dynamic role as part of the attach session and assign user operations.
- NSTEMPLATE_SC - Namespace template security class. Contains the following application privileges:
  - MODIFY_NAMESPACE - Privilege to modify session namespace.
  - MODIFY_ATTRIBUTE - Privilege to modify session namespace attribute.
  - ADMIN_NAMESPACE - Privilege for namespace administration, aggregate of MODIFY_NAMESPACE and MODIFY_ATTRIBUTE.

ACLs

Real Application Security provides the following predefined ACLs:

- SYSTEMACL - ACL for granting SYSTEM security class privileges.

  Grants PROVISION and CALLBACK privileges to PROVISIONER database role and XSPROVISIONER Real Application Security role.

  Grants ADMIN_ANY_SEC_POLICY privilege to DBA database role.

  Grants ADMIN_SEC_POLICY privilege to RESOURCE and XS_RESOURCE database roles.

  Grants ADMIN_ANY_NAMESPACE privilege to DBA and XS_NAMESPACE_ADMIN database roles and XSNAMESPACEADMIN and MIDTIER_AUTH Real Application Security roles.
- SESSIONACL - ACL for granting SESSION_SC security class privileges.

  Grants ADMINISTER_SESSION privilege to XS_SESSION_ADMIN database role and XSSESSIONADMIN Real Application Security role.
- NS_UNRESTRICTED_ACL - ACL to grant ADMIN_NAMESPACE privilege to PUBLIC database role and XSPUBLIC Real Application Security role.

B

Configuring OCI and JDBC Applications for Column Authorization

This appendix contains:

- About Using OCI to Retrieve Column Authorization Indicators
- About Using JDBC to Retrieve Column Authorization Indicators

About Using OCI to Retrieve Column Authorization Indicators

Oracle Call Interface (OCI) applications can access database tables that have data security policies enabled and then test columns for authorization indicators.

- If the column is determined to be unauthorized to the user, a null column value is returned to the user with indicator "unauthorized".
- If the column authorization cannot be determined, the evaluated column (or column expression) value will be returned to the user along with the indicator "unknown." If any of the underlying table columns involved in the top column expression evaluation is unauthorized, the authorization indicator can be "unknown" and a null value will be used as the underlying column value for expression valuation.
- If the column is determined as authorized to the user, the evaluated column value and indicator will be returned to the user without authorization indicator.

The OCI return code is to communicate column authorization information to the user. To obtain the authorization information for a column, you must provide a return-code buffer when the column buffer is bound or defined. After the column data is returned to the user buffer, you can check the return code associated with the column for authorization information. The column authorization indicator is applicable to define variables or out-bind variables defined by the application. The return code buffer does not have to be provided if the application is not retrieving the column authorization indicator.

This section describes the following topics:

- Example of Obtaining the Return Code
- About Using the Return Code and Indicator with Authorization Indicator
- About the Warning for Unknown Authorization Indicator
- Using OCI Describe for Column Security

Example of Obtaining the Return Code

The following return codes are used to find the column authorizations:

- ORA-24530: column value is unauthorized to the user

- ORA-24531: column value authorization is unknown
- ORA-24536: column authorization unknown

If the unknown value authorization indicator (ORA-24531) is returned for any column, the OCI function status will be `OCI_SUCCESS_WITHINFO` and the error ORA-24536 will be returned in the error handle as warning. To suppress the warning, the application can set attribute, `OCI_ATTR_NO_COLUMN_AUTH_WARNING` to `TRUE` in the statement handle before fetching:

```
no_warning = TRUE;
OCIAttrSet(stmthp, OCI_HTYPE_STMT, (void *)&no_warning, 0,
           OCI_ATTR_NO_COLUMN_AUTH_WARNING, errhp);
```

The default boolean value of `OCI_ATTR_NO_COLUMN_AUTH_WARNING` is `FALSE`.

Example B-1 shows OCI code that retrieves the return codes.

Example B-1 Retrieving Return Codes from OCI for a Column Authorization

```
OCIDefineByPos(stmthp, &dfnhp, errhp,  1, (void *)data_bufp,  (sb4)data_bufl,
               data_typ, (void *)&data_ind, (ub2 *)&data_rlen,
               (ub2 *)&data_rcode, (ub4)OCI_DEFAULT);
status = OCIStmtFetch(stmthp, errhp, 1, OCI_FETCH_NEXT, OCI_DEFAULT);
if (data_rcode == 24530)
    printf("column value not authorized, indicator=%d\n", data_ind);
else if (data_rcode == 24531)
         printf("column value authorization unknown, indicator=%d\n", data_ind);
else  {
       printf("column value authorized, indicator=%d\n", data_ind);
       /* process column data */
       ...
};
```

About Using the Return Code and Indicator with Authorization Indicator

To access tables with column security, you should access the return code at least when the column is bound or defined. If the return code is not accessed, the application needs to know if the column value is authorized with other means so that it can correctly interpret the indicator and the value.

You should also provide the indicator for the bind or define if column security is enabled. If the indicator is not provided and the column value is not authorized or unknown, Oracle Database returns error ORA-1405.

If column value authorization is unknown, the authorization indicator (for ORA-24531) will take precedence over the regular return codes that may otherwise be returned to the user. For example, column null fetch (ORA-1405) and column truncation (ORA-1406) may occur at the same time when a non-null column value is returned along with unknown authorization indicator. In that case, the application gets ORA-24531 as the return code for this column, instead of getting ORA-1405 or ORA-1406. Hence the application should not rely on column return code ORA-1405 or ORA-1406 to find the exact column that is null fetched or truncated.

Table B-1 and Table B-2 summarizes the behavior of the authorization indicator, return code, indicator, and return status.

About the Warning for Unknown Authorization Indicator

If the unknown authorization indicator (ORA-24531) is returned for any column, an OCI warning is returned to the application, that is, the OCI function status will be `OCI_SUCCESS_WITH_INFO`, instead of `OCI_SUCCESS`. At the same time, ORA-24536 will be set in the error handle returned to the application.You must check this warning, examine the SQL being executed, and take appropriate action. The error ORA-24536 takes precedence over the error that is returned when the column is authorized or column security is not enabled.

If a column value is unauthorized or authorized, the OCI function status code will not be changed.

By default the column authorization warning is turned on for unknown authorizations. The application should be designed to handle the error. If the application is prepared for column security and wants to ignore any unknown authorization indicator, the OCI warning can be turned off by setting the OCI attribute, `OCI_ATTR_NO_COLUMN_AUTH_WARNING` to `TRUE` in the OCI statement handle before the column value is fetched.

Table B-1 describes the default authorization behavior for OCI return indicators.

Table B-1 Authorization Indicator Behavior (By Default)

Column Authorization	Column Value	IND Provided RC Provided	IND Not Provided RC Provided	IND Provided RC Not Provided	IND Not Provided RC Not Provided
Unauthorized	Any	OCI_SUCCESS Error = 0 IND = -1 RC = 24530	OCI_SUCCESS Error = 1405 IND = N/A RC = 24530	OCI_SUCCESS Error = 0 IND = -1 RC = N/A	OCI_SUCCESS Error = 1405 IND =-N/A RC = N/A
Unknown	Null	SUCCESS_WITH_INFO Error = 24536 (0) IND = -1 RC = 24531 (0)	SUCCESS_WITH_INFO Error = 24536 (1405) IND = N/A RC = 24531 (1405)	SUCCESS_WITH_INFO Error = 24536 (0) IND = -1 RC = N/A	SUCCESS_WITH_INFO Error = 24536 (1405) IND = N/A RC = N/A
Unknown	Not Null and Not Truncated	SUCCESS_WITH_INFO Error = 24536 (0) IND = 0 RC = 24531 (0)	SUCCESS_WITH_INFO Error = 24536 (0) IND = N/A RC = 24531 (0)	SUCCESS_WITH_INFO Error = 24536 (0) IND = 0 RC = N/A	SUCCESS_WITH_INFO Error = 24536 (0) IND = N/A RC = N/A
Unknown	Not Null and Truncated	SUCCESS_WITH_INFO Error = 24536 (24345) IND = data_len RC = 24531 (1406)	SUCCESS_WITH_INFO Error = 24536 (24345) IND = N/A RC = 24531 (1406)	SUCCESS_WITH_INFO Error = 24536 (1406) IND = data_len RC = N/A	SUCCESS_WITH_INFO Error = 24536 (1406) IND = N/A RC = N/A

> **See Also:**
>
> *Oracle Call Interface Programmer's Guide* Table 2-4 shows the default fetch behavior without column security

Table B-2 describes the default behavior when the `OCI_ATTR_NO_AUTH_WARNING` parameter is set to `TRUE`.

Table B-2 Authorization Indicator Behavior (By Default) - OCI_ATTR_NO_AUTH_WARNING=TRUE

Column Authorization	Column Value	IND Provided RC Provided	IND Not Provided RC Provided	IND Provided RC Not Provided	IND Not Provided RC Not Provided
Unknown	Null	Error = 0 IND = -1 RC = 24531 (0)	Error = 1405 IND = N/A RC = 24531 (1405)	Error = 0 IND = -1 RC = N/A)	Error = 1405 IND = N/A RC = N/A
Unknown	Not Null and Not Truncated	Error = 0 IND = 0 RC = 24531 (0)	Error = 0 IND = N/A RC = 24531 (0)	Error = 0 IND = 0 RC = N/A	Error = 0 IND = N/A RC = N/A
Unknown	Not Null and Truncated	SUCCESS_WITH_INFO Error = 24345 IND = data_len RC = 24531 (1406)	SUCCESS_WITH_INFO Error = 24345 IND = N/A RC = 24531 (1406)	Error = 1406 IND = data_len RC = N/A)	Error = 1406 IND = N/A RC = N/A

Using OCI Describe for Column Security

The `OCIDescribeAny()` function enables an explicit describe of schema objects. Applications sometimes need to know if a column is protected by a column constraint before fetching data. You can use this information to guide the application to process the data and indicators. This is especially useful to applications that handle dynamic SQL. The attribute `OCI_ATTR_XDS_POLICY_STATUS` for the OCI parameter handle is of data type `ub4` and has the following possible values:

- `OCI_XDS_POLICY_NONE`: No XDS policy for the column or the policy is not enabled
- `OCI_XDS_POLICY_ENABLED`: policy is enabled for the column
- `OCI_XDS_POLICY_UNKNOWN`: policy unknown

If the column status is `OCI_XDS_POLICY_NONE`, then the column values will always be "authorized." If the column status is `OCI_XDS_POLICY_ENABLED`, then the column values will be either "authorized" or "unauthorized." If the column status is `OCI_XDS_POLICY_UNKNOWN`, the column value authorization will always be "unknown."

Example B-2 shows how to use the `OCIDescribeAny()` function to perform an explicit describe on a set of schema objects.

> **See Also:**
>
> *Oracle Call Interface Programmer's Guide*

Example B-2 Using the OCIDescribeAny Function to Enable an Explicit Describe

```
void desc_explicit()
{
  const char *table = "col_sec_tab";
  ub4 pos;
  ub2 numcol;
  OCIParam *paramh;
  OCIParam *collst;
  OCIParam *col;
  ub4 colnamelen, colseclen;
  ub1 colname[20];
  ub1 *colnm;
  ub4 colsec;
  ub4 tablen = strlen((char *)table);

  checkerr(errhp, OCIDescribeAny(svchp, errhp, (dvoid *)table, tablen,
                                 OCI_OTYPE_NAME, 0, OCI_PTYPE_TABLE, deschp));

  checkerr(errhp, OCIAttrGet(deschp, OCI_HTYPE_DESCRIBE, &paramh, 0,
                             OCI_ATTR_PARAM, errhp));

  checkerr(errhp, OCIAttrGet(paramh, OCI_DTYPE_PARAM, &numcol, 0,
                             OCI_ATTR_NUM_COLS, errhp));


  checkerr(errhp, OCIAttrGet(paramh, OCI_DTYPE_PARAM, &collst, 0,
                             OCI_ATTR_LIST_COLUMNS, errhp));

  printf("Number of columns = %d\n\n", numcol);

  printf(" Column No   Column Name   Column Security\n");
  printf(" ---------   -----------   ---------------\n\n");


  for (pos = 1; (ub4) pos <= numcol; pos++)
  {
    checkerr(errhp, OCIParamGet (collst, OCI_DTYPE_PARAM, errhp,
                                 (dvoid **)&col, pos));

    checkerr(errhp, OCIAttrGet ((dvoid *)col, (ub4) OCI_DTYPE_PARAM,
                                (dvoid **)&colnm, (ub4 *) &colnamelen,
                                (ub4) OCI_ATTR_NAME, errhp));

    memset (colname, ' ', 20);
    strncpy((char *)colname, (char *)colnm, colnamelen);
    colname[10] = '\0';

    checkerr(errhp, OCIAttrGet ((dvoid *)col, (ub4) OCI_DTYPE_PARAM,
                                (dvoid **)&colsec, (ub4 *) &colseclen,
                                (ub4) OCI_ATTR_XDS_POLICY_STATUS, errhp));

    printf("    %d         %s     %s\n", pos, colname,
```

```
                                ((colsec == OCI_XDS_POLICY_ENABLED) ? "ENABLED" :
                                ((colsec == OCI_XDS_POLICY_NONE)   ?  "NONE"    :
                                ((colsec == OCI_XDS_POLICY_UNKNOWN) ? "UNKNOWN" :
                                                                      "ERROR"))));
  }

  return;
}
```

About Using JDBC to Retrieve Column Authorization Indicators

JDBC applications can access database tables that have data security policies enabled, and test columns for authorization indicators. You can use the JDBC APIs described in this section to check the security attributes and user authorization for a table column.

This section contains:

- About Checking Security Attributes for a Table Column
- About Checking User Authorization for a Table Column
- Example of Checking Security Attributes and User Authorization

About Checking Security Attributes for a Table Column

The `getSecurityAttribute` method of the `oracle.jdbc.OracleResultSetMetaData` interface enables you to check the data security policy attribute for a column. The security attribute has the following definition:

```
public static enum SecurityAttribute
  {
    NONE,
    ENABLED,
    UNKNOWN;
  }
```

`SecurityAttribute` can have the following values:

- `NONE` implies that no column data security policy is enabled for the column. This means that the column either does not have a policy applied to it, or the policy is not enabled.
- `ENABLED` implies that column data security policy is enabled for the column.
- `UNKNOWN` implies that the column data security policy for the column is unknown. This could happen, for example, if the column is a union of two columns but only one of the columns has data security attributes.

The `getSecurityAttribute` method has the following signature:

```
public SecurityAttribute getSecurityAttribute(int indexOfColumnInResultSet) throws
SQLException;
```

The `getSecurityAttribute` method returns the `SecurityAttribute` value for the column.

> **See Also:**
>
> Example B-3 for an example of using the `getSecurityAttribute` method

About Checking User Authorization for a Table Column

The `getAuthorizationIndicator` method of the `oracle.jdbc.OracleResultSet` interface enables you to check the `AuthorizationIndicator` attribute for a column. The `AuthorizationIndicator` attribute has the following definition:

```
public static enum AuthorizationIndicator
  {
    NONE,
    UNAUTHORIZED,
    UNKNOWN;
  }
```

`AuthorizationIndicator` can have the following values:

- `NONE` implies that access to column data is authorized. The user might have explicit authorization or the column could be lacking security attributes.
- `UNAUTHORIZED` implies that access to column data is not authorized.

  When the column value is retrieved, the authorization indicator is evaluated based on the enabled column constraint policy for the column. If the user is not authorized to access the column value, a `NULL` value is returned to the application along with the authentication indicator, `AuthorizationIndicator.UNAUTHORIZED`.

  If there is a column expression involving the unauthorized base column, the evaluated value is returned to the application along with the `AuthorizationIndicator.UNAUTHORIZED` indicator. The application should examine the authorization indicator before interpreting the returned data.
- `UNKNOWN` implies that the authorization indicator cannot be determined.

  Sometimes, the server fails to determine the authorization indicator for a `SELECT` item due to functionality limitations or performance constrains. This can happen if the query involves a column expression, for example, and the server is unable to compute whether the top operator is supposed to be authorized. In such a scenario, the server returns the authorization indicator, `AuthorizationIndicator.UNKNOWN` to the application. The returned value can be `NULL` or not `NULL` depending on how the column expression operates on the underlying column value.

  If the application sees an `UNKNOWN` authorization indictor, it should determine whether or not the returned value should be accessed. If the query and its column expressions are designed to handle unauthorized `NULL` values from the underlying columns, then the application can use the returned value. Otherwise the application may have to take appropriate actions for the returned value.

The `getAuthorizationIndicator` method has the following forms:

```
/**
 * Accepts the column index number as an argument and retrieves the corresponding
column security AuthorizationIndicator value
 */
```

```
public AuthorizationIndicator getAuthorizationIndicator(int columnIndex) throws
SQLException;

/**
 * Accepts the column name as a string and retrieves the column security
AuthorizationIndicator value
 */
public AuthorizationIndicator getAuthorizationIndicator(String columnName)throws
SQLException;
```

Note:

- The preceding methods throw a `SQLException` if the index specified in the argument is invalid.
- If a column is masked, the JDBC user sees it as a NULL value. An exception is not thrown for this.

See Also:

Example B-3 for an example of using the `getAuthorizationIndicator` method

Example of Checking Security Attributes and User Authorization

Example B-3 illustrates the use of the `getSecurityAttribute` and `getAuthorization` methods to check security attributes and user authorization. The program uses the sample `EMP` table to illustrate the procedure.

The `EMP` table is configured as follows:

Column No.	Column Title	Security Attribute
1	EMPNO	No security attribute
2	ENAME	Active security
3	JOB	No security attribute
4	MGR	Active security
5	HIREDATE	Unknown security attribute
6	SAL	Active security
7	COMM	No security attribute
6	DEPTNO	Active security

The program performs the following actions:

1. Selects rows from the `EMP` table

2. Uses the `getSecurityAttribute` method to extract the security setting for each column in the result set. It prints these as column headings
3. Uses the `getAuthorizationIndicator` method to check the user authorization for returned column values. The program prints these values and formats them as follows:

   An unauthorized value that is returned as `NULL` is represented by four asterisk characters (`****`).

Example B-3 Check Security Attributes and User Authorization

```
PreparedStatement pstmt = conn.prepareStatement("SELECT * FROM EMP");
  ResultSet rs = pstmt.executeQuery();
  OracleResultSetMetaData metaData =
   (OracleResultSetMetaData)rs.getMetaData();
  int nbOfColumns = metaData.getColumnCount();
  OracleResultSetMetaData.SecurityAttribute[] columnSecurity
    = new OracleResultSetMetaData.SecurityAttribute[nbOfColumns];
  // display which columns are protected:
  for(int i=0;i<nbOfColumns;i++)
  {
    columnSecurity[i] = metaData.getSecurityAttribute(i+1);
    System.out.print(columnSecurity[i]);
    System.out.print("\t");
  }
  System.out.println();
  System.out.println("-------------------------------------------");
  while(rs.next())
  {
    for(int colIndex=0;colIndex<nbOfColumns;colIndex++)
    {
      OracleResultSet.AuthorizationIndicator visibility
        = ((OracleResultSet)rs).getAuthorizationIndicator(colIndex+1);
      if(visibility == OracleResultSet.AuthorizationIndicator.UNAUTHORIZED)
        System.out.print("****");
      else
        System.out.print(rs.getString(colIndex+1));
      System.out.print("\t");
    }
    System.out.println("");
  }
  rs.close();
  pstmt.close();
```

The program generates the following output:

```
NONE   ENABLED   NONE       ENABLED   UNKNOWN      ENABLED   NONE   ENABLED
-------------------------------------------------------------------------------
7369   SMITH     CLERK      7902      1980-12-17   ****      null   20
7499   ALLEN     SALESMAN   7698      1981-02-20   ****      300    30
7521   WARD      SALESMAN   7698      1981-02-22   ****      500    30
7566   JONES     MANAGER    7839      1981-04-02   ****      null   20
7654   MARTIN    SALESMAN   7698      1981-09-28   ****      1400   30
7698   BLAKE     MANAGER    7839      1981-05-01   ****      null   30
7782   CLARK     MANAGER    7839      1981-06-09   ****      null   10
7788   SCOTT     ANALYST    7566      1987-04-19   ****      null   20
7839   KING      PRESIDENT  null      1981-11-17   ****      null   10
7844   TURNER    SALESMAN   7698      1981-09-08   ****      0      30
7876   ADAMS     CLERK      7788      1987-05-23   ****      null   20
7900   JAMES     CLERK      7698      1981-12-03   ****      null   30
```

```
7902   FORD      ANALYST    7566      1981-12-03   ****      null   20
7934   MILLER    CLERK      7782      1982-01-23   ****      null   10
```

C

Real Application Security HR Demo Files

This appendix contains both the source files and log files. A detailed description of the HR Demo can be found in Real Application Security HR Demo .

This appendix describes the following topics:

- How to Run the Security HR Demo
- Scripts for the Security HR Demo
- Generated Log Files for Each Script

How to Run the Security HR Demo

To run the Security HR demo, run the following scripts in the order shown:

1. Run the setup script `hrdemo_setup.sql`, which creates the log file: `hrdemo_setup.log`.
2. Run the demo script `hrdemo.sql` with direct logon, which creates the log file: `hrdemo.log`.
3. Run the demo script to explicitly create and attach to the Real Application Security session `hrdemo_session.sql`, which creates the log file: `hrdemo_session.log`.
4. Run the Java demo `hrdemo.java` file, which creates the log file: `hrdemo.log`.
5. Run the clean up script `hrdemo_clean.sql`, which creates the log file: `hrdemo_clean.log`.

Scripts for the Security HR Demo

Table C-1 lists the scripts and generated log files with links to the content of each file.

Table C-1 HR Demo Scripts and Log Files

Scripts	Log Files
hrdemo_setup.sql	hrdemo_setup.log
hrdemo.sql	hrdemo.log
hrdemo_session.sql	hrdemo_session.log
hrdemo.java	hrdemo.log
hrdemo_clean.sql	hrdemo_clean.log

This section includes the following script files:

hrdemo_setup.sql

The source file for the set up script `hrdemo_setup.sql`.

```
SET ECHO OFF
SET FEEDBACK 1
SET NUMWIDTH 10
SET LINESIZE 80
SET TRIMSPOOL ON
SET TAB OFF
SET PAGESIZE 100
SET ECHO ON

define passwd=&1

------------------------------------------------------------------------
--  Introduction
------------------------------------------------------------------------
-- The HR Demo shows how to use basic Real Application Security features.
-- The demo secures HR.EMPLOYEES table by creating a data security
-- policy that grants the table access to:
-- Data Security Policy
--
--(1) An employee can view his/her own record including SALARY column.
--(2) An IT engineer can view all employee records in IT department,
--    but cannot view employee's salaries.
--(3) An HR representative can view and update all employee records.
--
--
--Sample Users and Their Role Grants:
-- 1) DAUSTIN, an application user in IT department. He has role employee
--    and it_engineer. He can view employee records in IT department, but he
--    cannot view the salary column except for his own.
-- 2) SMAVRIS, an application user in HR department. She has role employee
--    and hr_representative. She can view and update all the employee records.

------------------------------------------------------------------------
-- 1. SETUP - User and Roles
------------------------------------------------------------------------

connect sys/&passwd as sysdba
-- Create an application role employee for common employees.
exec sys.xs_principal.create_role(name => 'employee', enabled => true);

-- Create an application role it_engineer for IT department.
exec sys.xs_principal.create_role(name => 'it_engineer', enabled => true);

-- Create an application role hr_representative for HR department.
exec sys.xs_principal.create_role(name => 'hr_representative', enabled => true);

-- create a database role for object privilege grants
create role db_emp;

-- Grant DB_EMP to the three application roles, so they have the required
-- object privileges to access the table.
grant db_emp to employee;
grant db_emp to it_engineer;
grant db_emp to hr_representative;

-- Create two application users:
-- DAUSTIN (in IT department), granted employee and it_engineer.
exec  sys.xs_principal.create_user(name => 'daustin', schema => 'hr');
exec  sys.xs_principal.set_password('daustin', 'welcome1');
exec  sys.xs_principal.grant_roles('daustin', 'XSCONNECT');
exec  sys.xs_principal.grant_roles('daustin', 'employee');
```

```
exec  sys.xs_principal.grant_roles('daustin', 'it_engineer');

-- SMAVRIS (in HR department), granted employee and hr_representative.
exec  sys.xs_principal.create_user(name => 'smavris', schema => 'hr');
exec  sys.xs_principal.set_password('smavris', 'welcome1');
exec  sys.xs_principal.grant_roles('daustin', 'XSCONNECT');
exec  sys.xs_principal.grant_roles('smavris', 'employee');
exec  sys.xs_principal.grant_roles('smavris', 'hr_representative');

-- Grant HR user policy adminisration privilege
exec sys.xs_admin_util.grant_system_privilege('ADMIN_ANY_SEC_POLICY','HR');

-----------------------------------------------------------------------
-- 2. SETUP - Security class and ACL
-----------------------------------------------------------------------

-- Connect as HR
connect hr/hr;

-- Grant necessary object privileges to db_emp role
-- This role will be used to grant the required object privileges to
-- application users.

grant select, insert, update, delete on hr.employees to db_emp;

-- Create a security class hr_privileges and include privileges from the predefined
DML security class.
-- hr_privileges has a new privilege VIEW_SALARY, which is used to control the
-- access to SALARY column.
declare
begin
  sys.xs_security_class.create_security_class(
    name        => 'hr_privileges',
    parent_list => xs$name_list('sys.dml'),
    priv_list   => xs$privilege_list(xs$privilege('view_salary')));
end;
/

-- Create three ACLs to grant privileges for the policy defined later.
declare
  aces xs$ace_list := xs$ace_list();
begin
  aces.extend(1);

  -- EMP_ACL: This ACL grants employee the privileges to view an employee's
  --          own record including SALARY column.
  aces(1) := xs$ace_type(privilege_list => xs$name_list('select','view_salary'),
                         principal_name => 'employee');

  sys.xs_acl.create_acl(name      => 'emp_acl',
                   ace_list  => aces,
                   sec_class => 'hr_privileges');

  -- IT_ACL:  This ACL grants it_engineer the privilege to view the employee
  --          records in IT department, but it does not grant the VIEW_SALARY
  --          privilege that is required for access to SALARY column.
  aces(1) := xs$ace_type(privilege_list => xs$name_list('select'),
                         principal_name => 'it_engineer');

  sys.xs_acl.create_acl(name      => 'it_acl',
                   ace_list  => aces,
```

```
                    sec_class => 'hr_privileges');

  -- HR_ACL:  This ACL grants hr_representative the privileges to view and update all
  --          employees' records including SALARY column.
  aces(1):= xs$ace_type(privilege_list => xs$name_list('select', 'insert',
                                          'update', 'delete', 'view_salary'),
                        principal_name => 'hr_representative');

  sys.xs_acl.create_acl(name      => 'hr_acl',
                    ace_list  => aces,
                    sec_class => 'hr_privileges');
end;
/

-------------------------------------------------------------------------
-- 3. SETUP - Data security policy
-------------------------------------------------------------------------
-- Create data security policy for EMPLOYEE table. The policy defines three
-- realm constraints and a column constraint that protects SALARY column.
declare
  realms   xs$realm_constraint_list := xs$realm_constraint_list();
  cols     xs$column_constraint_list := xs$column_constraint_list();
begin
  realms.extend(3);

  -- Realm #1: Only the employee's own record.
  --           employee can view the realm including SALARY column.
  realms(1) := xs$realm_constraint_type(
    realm    => 'email = xs_sys_context(''xs$session'',''username'')',
    acl_list => xs$name_list('emp_acl'));

  -- Realm #2: The records in the IT department.
  --           it_engineer can view the realm excluding SALARY column.
  realms(2) := xs$realm_constraint_type(
    realm    => 'department_id = 60',
    acl_list => xs$name_list('it_acl'));

  -- Realm #3: All the records.
  --           hr_representative can view and update the realm including SALARY
column.
  realms(3) := xs$realm_constraint_type(
    realm    => '1 = 1',
    acl_list => xs$name_list('hr_acl'));

  -- Column constraint protects SALARY column by requiring VIEW_SALARY
  -- privilege.
  cols.extend(1);
  cols(1) := xs$column_constraint_type(
    column_list => xs$list('salary'),
    privilege   => 'view_salary');

  sys.xs_data_security.create_policy(
    name                   => 'employees_ds',
    realm_constraint_list  => realms,
    column_constraint_list => cols);
end;
/

-- Apply the data security policy to the table.
begin
  sys.xs_data_security.apply_object_policy(
```

```
    policy => 'employees_ds',
    schema => 'hr',
    object =>'employees');
end;
/

-----------------------------------------------------------------------
-- 4. SETUP - Validate the objects we have set up.
-----------------------------------------------------------------------
set serveroutput on;
begin
  if (sys.xs_diag.validate_workspace()) then
    dbms_output.put_line('All configurations are correct.');
  else
    dbms_output.put_line('Some configurations are incorrect.');
  end if;
end;
/
-- XS$VALIDATION_TABLE contains validation errors if any.
-- Expect no rows selected.
select * from xs$validation_table order by 1, 2, 3, 4;

-----------------------------------------------------------------------
-- 5. SETUP - Mid-Tier related configuration.
-----------------------------------------------------------------------

connect sys/&passwd as sysdba

-- create a session administrator who has only
-- RAS session administration privilege (no data privilege),
-- and is responsible to manage RAS session for each application user.
grant xs_session_admin, create session to hr_session identified by hr_session;
grant create session to hr_common identified by hr_common;

-- craete a dispatcher user for java demo, to set up session for application user
exec sys.xs_principal.create_user(name=>'dispatcher', schema=>'HR');
exec sys.xs_principal.set_password('dispatcher', 'welcome1');
exec sys.xs_principal.grant_roles('dispatcher', 'XSCONNECT');
exec sys.xs_principal.grant_roles('dispatcher', 'xsdispatcher');

exit
```

hrdemo.sql

The source file for the `hrdemo.sql` script. This script runs the demo with direct logon.

```
SET ECHO OFF
SET FEEDBACK 1
SET NUMWIDTH 10
SET LINESIZE 80
SET TRIMSPOOL ON
SET TAB OFF
SET PAGESIZE 100
COLUMN EMAIL FORMAT A10
COLUMN FIRST_NAME FORMAT A15
COLUMN LAST_NAME FORMAT A15
COLUMN DEPARTMENT_ID FORMAT 9999
COLUMN MANAGER_ID FORMAT 9999
COLUMN SALARY FORMAT 999999
SET ECHO ON
```

```
-----------------------------------------------------------------------
--  HR Demo - PL/SQL with RAS direct logon user
-----------------------------------------------------------------------
-- This demo shows RAS runtime, using RAS direct logon user.
-- Each user directly connects to database and accesses employee table.
-- RAS policy is automatically enforced.
-----------------------------------------------------------------------

-- Connect as DAUSTIN, who has only employee and it_engineer role
conn daustin/welcome1;

SET SECUREDCOL ON UNAUTH *******

-- DAUSTIN can view the records in IT department, but can only view his own
-- SALARY column.
select email, first_name, last_name, department_id, manager_id, salary
from employees order by email;


SET SECUREDCOL OFF

-- DAUSTIN cannot update the record.
update employees set manager_id = 102 where email = 'DAUSTIN';

-- Record is not changed.
select email, first_name, last_name, department_id, manager_id, salary
from employees where email = 'DAUSTIN';


-- Connect as SMAVRIS, who has both employee and hr_representative role.
conn smavris/welcome1;

-- SMAVRIS can view all the records including SALARY column.
select email, first_name, last_name, department_id, manager_id, salary
from employees where department_id = 60 or department_id = 40
order by department_id, email;

-- EMPLOYEES table has 107 rows, we expect to see all of them.
select count(*) from employees;

-- SMAVRIS can update the record.
update employees set manager_id = 102 where email = 'DAUSTIN';

-- Record is changed.
select email, first_name, last_name, department_id, manager_id, salary
from employees where email = 'DAUSTIN';

-- change the record back to the original.
update employees set manager_id = 103 where email = 'DAUSTIN';

exit
```

hrdemo_session.sql

The source file for the `hrdemo_session.sql` script. This script explicitly creates and attaches a Real Application Security session.

```
SET ECHO OFF
SET FEEDBACK 1
SET NUMWIDTH 10
SET LINESIZE 80
SET TRIMSPOOL ON
SET TAB OFF
SET PAGESIZE 100
COLUMN EMAIL FORMAT A10
COLUMN FIRST_NAME FORMAT A15
COLUMN LAST_NAME FORMAT A15
COLUMN DEPARTMENT_ID FORMAT 9999
COLUMN MANAGER_ID FORMAT 9999
COLUMN SALARY FORMAT 999999
SET ECHO ON

----------------------------------------------------------------------
--  HR Demo - PL/SQL with Session API
----------------------------------------------------------------------
-- This demo shows RAS runtime, using RAS user as application user.
-- The user does not logon to database, but a RAS session is created
-- and attached for each user before accessing employee table.
----------------------------------------------------------------------

-- Connect as RAS session administrator.
connect hr_session/hr_session;

-- Variable used to remember the session ID.
var gsessionid varchar2(32);

-- Create an application session for SMARVIS and attach to it.
declare
  sessionid raw(16);
begin
  sys.dbms_xs_sessions.create_session('SMAVRIS', sessionid);
  :gsessionid := rawtohex(sessionid);
  sys.dbms_xs_sessions.attach_session(sessionid, null);
end ;
/

-- Display the current user, it should be SMAVRIS now.
select xs_sys_context('xs$session','username') from dual;

-- Display the enabled application roles and database roles.
select role_name from v$xs_session_roles union
select role from session_roles order by 1;

-- SMAVRIS can view all the records including SALARY column.
select email, first_name, last_name, department_id, manager_id, salary
from employees where department_id = 60 or department_id = 40
order by department_id, email;

-- EMPLOYEES table has 107 rows, we expect to see all of them.
select count(*) from employees;

-- Disable hr_representative role.
exec dbms_xs_sessions.disable_role('hr_representative');

-- SMAVRIS should only be able to see her own record.
select email, first_name, last_name, department_id, manager_id, salary
from employees where department_id = 60 or department_id = 40
order by department_id, email;
```

```
-- Enable hr_representative role.
exec sys.dbms_xs_sessions.enable_role('hr_representative');

-- SMAVRIS can view all the records again.
select email, first_name, last_name, department_id, manager_id, salary
from employees where department_id = 60 or department_id = 40
order by department_id, email;

-- EMPLOYEES table has 107 rows, we expect to see all of them.
select count(*) from employees;

-- Detach and destroy the application session.
declare
  sessionid raw(16);
begin
  sessionid := hextoraw(:gsessionid);
  sys.dbms_xs_sessions.detach_session;
  sys.dbms_xs_sessions.destroy_session(sessionid);
end;
/

exit
```

hrdemo.java

The source file for the Java demo is `hrdemo.java`.

```
import java.security.GeneralSecurityException;
import java.security.InvalidAlgorithmParameterException;
import java.security.InvalidKeyException;
import java.security.NoSuchAlgorithmException;
import java.security.spec.InvalidKeySpecException;

import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.ResultSet;
import java.sql.SQLException;
import java.sql.Statement;

import java.util.ArrayList;
import java.util.List;
import oracle.jdbc.OracleDriver;
import oracle.jdbc.OracleResultSet;
import oracle.jdbc.OracleResultSet.AuthorizationIndicator;

import oracle.security.xs.AccessDeniedException;
import oracle.security.xs.InvalidXSNamespaceException;
import oracle.security.xs.InvalidXSUserException;
import oracle.security.xs.Role;
import oracle.security.xs.Session;
import oracle.security.xs.XSAccessController;
import oracle.security.xs.XSException;
import oracle.security.xs.XSSessionManager;

/**
 * A simple java application implemented using RAS.
 * It shows:
 *  -  How to setup RAS session manager
 *  -  How to manage RAS sessions
```

```
 *  -  How to use Column authorization indicator
 *  -  How to check privileges using "checkAcl" function
*/
public class hrdemo {

  // application connection, should be created with unprivileged user
  // in RAS case, the user only needs DB connection privilege
  private Connection appConnection = null;

  // RAS dispatcher's connection, should be create with a RAS dispatcher user
  private Connection mgrConnection = null;
  // RAS session manager, to manage session for application user
  // Must be instanciated with disptcher's connection
  private XSSessionManager manager = null;

  public static void main(String[] args)  {

    try {
      DriverManager.registerDriver(new OracleDriver());


      if (args.length != 1) {
        System.out.println("Usage hrdemo dbURL");
        System.exit(1);
      }
      hrdemo demo = new hrdemo();
      demo.setupConnection(args[0]);

      demo.queryAsUser("DAUSTIN");
      demo.queryAsUser("SMAVRIS");

      demo.cleanupConnection();

    } catch (Exception e) {
      // we don't handle exception for now
      e.printStackTrace();
    }
  }

  private void queryAsUser(String user) throws SQLException, XSException {

    System.out.println("\nQuery HR.EMPLOYEES table as user \"" + user + "\"");

      Session lws = manager.createSession(appConnection, user, null,null);
      manager.attachSession(appConnection, lws, null, null, null, null, null);

      queryEmployees(lws);

      manager.detachSession(lws);
      manager.destroySession(appConnection, lws);

  }

  public void setupConnection(String url) throws SQLException, XSException,
GeneralSecurityException {
    // dispatcher's connection
    mgrConnection =
        DriverManager.getConnection(url, "dispatcher", "welcome1");

    // RAS session manager
    manager = XSSessionManager.getSessionManager(mgrConnection, 30, 2048000);
```

```
    // connection used for application query
    appConnection = DriverManager.getConnection(url, "hr_common", "hr_common");
  }

  public void cleanupConnection() throws SQLException {
    mgrConnection.close();
    appConnection.close();

  }

  public void queryEmployees(Session lws) throws SQLException, XSException  {
    // using DB connection that has been attached to a RAS session
    Connection conn = lws.getConnection();
    String query = " select email, first_name, last_name, department_id, salary,
ora_get_aclids(emp) from hr.employees emp where department_id in (40, 60, 100) order
by email";

    Statement stmt = null;
    ResultSet rs = null;

    System.out.printf("  EMAIL  | FIRST_NAME | LAST_NAME  | DEPT | SALARY | UPDATE |
VIEW_SALARY\n");

    try {

      stmt = conn.createStatement();
      rs = stmt.executeQuery(query);

      while (rs.next()) {

        String email = rs.getString("EMAIL");
        String first_name = rs.getString("FIRST_NAME");
        String last_name = rs.getString("LAST_NAME");
        String department_id = rs.getString("DEPARTMENT_ID");
        String salary;

        if (((OracleResultSet)rs).getAuthorizationIndicator("SALARY") ==
AuthorizationIndicator.NONE) {
          salary = rs.getString("SALARY");
        }
        else {
          salary = "*****";
        }

        byte[] aclRaw = rs.getBytes(6);
        String update, viewSalary;


    // call checkAcl to determine whether can update the database record
    if (XSAccessController.checkAcl(lws, aclRaw, "UPDATE")) {
          update = "true";
        }
        else {
          update = "false";
        }

        if (XSAccessController.checkAcl(lws, aclRaw, "VIEW_SALARY")) {
          viewSalary = "true";
        }
        else {
```

```
          viewSalary = "false";
        }

        System.out.printf("%9s|%12s|%12s|%6s|%8s|%8s|%8s\n", email,
                          first_name, last_name, department_id,
                          salary, update, viewSalary);
       }
    } finally {
      try { if (rs != null) rs.close(); } catch (Exception e) {};
      try { if (stmt != null) stmt.close(); } catch (Exception e) {};
    }
  }
}
```

hrdemo_clean.sql

The source file for the cleanup script is `hrdemo_clean.sql`.

```
SET ECHO OFF
SET FEEDBACK 1
SET NUMWIDTH 10
SET LINESIZE 80
SET TRIMSPOOL ON
SET TAB OFF
SET PAGESIZE 100
SET ECHO ON

define passwd=&1

connect hr/hr;

-- Remove policy from the table.
begin
  sys.xs_data_security.remove_object_policy(policy=>'employees_ds',
                                            schema=>'hr', object=>'employees');
end;
/
-- Delete security class and ACLs
exec sys.xs_security_class.delete_security_class('hr_privileges',
xs_admin_util.cascade_option);
exec sys.xs_acl.delete_acl('emp_acl', xs_admin_util.cascade_option);
exec sys.xs_acl.delete_acl('it_acl', xs_admin_util.cascade_option);
exec sys.xs_acl.delete_acl('hr_acl', xs_admin_util.cascade_option);

-- Delete data security policy
exec sys.xs_data_security.delete_policy('employees_ds',
xs_admin_util.cascade_option);

connect sys/&passwd as sysdba
-- Delete application users and roles
exec sys.xs_principal.delete_principal('employee', xs_admin_util.cascade_option);
exec sys.xs_principal.delete_principal('hr_representative',
xs_admin_util.cascade_option);
exec sys.xs_principal.delete_principal('it_engineer', xs_admin_util.cascade_option);
exec sys.xs_principal.delete_principal('smavris', xs_admin_util.cascade_option);
exec sys.xs_principal.delete_principal('daustin', xs_admin_util.cascade_option);


-- Delete database role
drop role db_emp;
```

```
-- Delete session administrator
drop user hr_session;
-- Delete the common user used to connect to DB
drop user hr_common;

-- Delete dispatcher user used by mid-tier
exec sys.xs_principal.delete_principal('dispatcher', xs_admin_util.cascade_option);

exit
```

Generated Log Files for Each Script

This section includes the following log files that are generated from running the scripts listed in Table C-1:

- hrdemo_setup.log
- hrdemo.log
- hrdemo_run_sess.log
- hrdemo.log
- hrdemo_clean.log

hrdemo_setup.log

The `hrdemo_setup.log` file.

```
SQL> @hrdemo_setup
SQL>
SQL> define passwd=&1
Enter value for 1: sample
SQL>
SQL> ------------------------------------------------------------------------
SQL> --  Introduction
SQL> ------------------------------------------------------------------------
SQL> -- The HR Demo shows how to use basic Real Application Security
features.
SQL> -- The demo secures HR.EMPLOYEE table by creating a data security
SQL> -- policy that grants the table access to.
SQL> -- Data Security Policy
SQL> --
SQL> --(1) An employee can view his/her own record including SALARY column.
SQL> --(2) An IT engineer can view all employee records in IT department,
SQL> --    but cannot view employee's salaries.
SQL> --(3) An HR representative can view and update all employee records.
SQL> --
SQL> --
SQL> --Sample Users and Their Role Grants:
SQL> --1) DAUSTIN, an application user in IT department. He has role
employee
SQL> --   and it_engineer. He can view employee records in IT department,
but he
SQL> --   cannot view the salary column except for his own.
SQL> --2) SMAVRIS, an application user in HR department. She has role
```

```
employee
SQL> --   and hr_representative. She can view and update all the employee
records
SQL> --
SQL> ------------------------------------------------------------------------
SQL> -- 1. SETUP - User and Roles
SQL> ------------------------------------------------------------------------
SQL>
SQL> connect sys/&passwd as sysdba
Connected.
SQL> -- Create an application role employee for common employees.
SQL> exec xs_principal.create_role(name => 'employee', enabled => true);

PL/SQL procedure successfully completed.

SQL>
SQL> -- Create an application role it_engineer for IT department.
SQL> exec xs_principal.create_role(name => 'it_engineer', enabled => true);

PL/SQL procedure successfully completed.

SQL>
SQL> -- Create an application role hr_representative for HR department.
SQL> exec xs_principal.create_role(name => 'hr_representative', enabled =>
true);

PL/SQL procedure successfully completed.

SQL>
SQL> -- create a database role for object privilege grants
SQL> create role db_emp;

Role created.

SQL>
SQL> -- Grant DB_EMP to the three application roles, so they have the
required
SQL> -- object privileges to access the table.
SQL> grant db_emp to employee;

Grant succeeded.

SQL> grant db_emp to it_engineer;

Grant succeeded.

SQL> grant db_emp to hr_representative;

Grant succeeded.

SQL>
SQL> -- Create two application users:
SQL> -- DAUSTIN (in IT department), granted employee and it_engineer.
SQL> exec  xs_principal.create_user(name => 'daustin', schema => 'hr');
```

```
PL/SQL procedure successfully completed.

SQL> exec  xs_principal.set_password('daustin', 'welcome1');

PL/SQL procedure successfully completed.

SQL> exec  xs_principal.grant_roles('daustin', 'XSCONNECT');

PL/SQL procedure successfully completed.

SQL> exec  xs_principal.grant_roles('daustin', 'employee');

PL/SQL procedure successfully completed.

SQL> exec  xs_principal.grant_roles('daustin', 'it_engineer');

PL/SQL procedure successfully completed.

SQL>
SQL> -- SMAVRIS (in HR department), granted employee and hr_representative.
SQL> exec  xs_principal.create_user(name => 'smavris', schema => 'hr');

PL/SQL procedure successfully completed.

SQL> exec  xs_principal.set_password('smavris', 'welcome1');

PL/SQL procedure successfully completed.

SQL> exec  xs_principal.grant_roles('smavris', 'XSCONNECT');

PL/SQL procedure successfully completed.

SQL> exec  xs_principal.grant_roles('smavris', 'employee');

PL/SQL procedure successfully completed.

SQL> exec  xs_principal.grant_roles('smavris', 'hr_representative');

PL/SQL procedure successfully completed.

SQL>
SQL> -- Grant HR user policy adminisration privilege
SQL> exec
xs_admin_util.grant_system_privilege('ADMIN_ANY_SEC_POLICY','HR');

PL/SQL procedure successfully completed.

SQL>
SQL> ------------------------------------------------------------------------
SQL> -- 2. SETUP - Security class and ACL
SQL> ------------------------------------------------------------------------
SQL>
SQL>
SQL> -- Connect as HR
SQL> connect hr/hr;
```

```
Connected.
SQL>
SQL> -- Grant necessary object privileges to db_emp role
SQL> -- This role will be used to grant the required object privileges to
SQL> -- application users.
SQL>
SQL> grant select, insert, update, delete on hr.employees to db_emp;

Grant succeeded.

SQL>
SQL>
SQL> -- Create a security class hr_privileges and include privileges from
the predefined DML security class.
SQL> -- hr_privileges has a new privilege VIEW_SALARY, which is used to
control the
SQL> -- access to SALARY column.
SQL> declare
  2  begin
  3    xs_security_class.create_security_class(
  4      name        => 'hr_privileges',
  5      parent_list => xs$name_list('sys.dml'),
  6      priv_list   => xs$privilege_list(xs$privilege('view_salary')));
  7  end;
  8  /

PL/SQL procedure successfully completed.

SQL>
SQL>
SQL>
SQL> -- Create three ACLs to grant privileges for the policy defined later.
SQL> declare
  2    aces xs$ace_list := xs$ace_list();
  3  begin
  4    aces.extend(1);
  5
  6    -- EMP_ACL: This ACL grants employee the privileges to view an
employee's
  7    --          own record including SALARY column.
  8    aces(1) := xs$ace_type(privilege_list =>
xs$name_list('select','view_salary'),
  9                           principal_name => 'employee');
 10
 11    xs_acl.create_acl(name      => 'emp_acl',
 12                      ace_list  => aces,
 13                      sec_class => 'hr_privileges');
 14
 15    -- IT_ACL:  This ACL grants it_engineer the privilege to view the
employee
 16    --          records in IT department, but it does not grant the
VIEW_SALARY
 17    --          privilege that is required for access to SALARY column.
 18    aces(1) := xs$ace_type(privilege_list => xs$name_list('select'),
 19                           principal_name => 'it_engineer');
```

```
 20
 21    xs_acl.create_acl(name      => 'it_acl',
 22                      ace_list  => aces,
 23                      sec_class => 'hr_privileges');
 24
 25    -- HR_ACL:  This ACL grants hr_representative the privileges to
view and update all
 26    --          employees' records including SALARY column.
 27    aces(1):= xs$ace_type(privilege_list => xs$name_list('select',
'insert',
 28                                               'update', 'delete',
'view_salary'),
 29                          principal_name => 'hr_representative');
 30
 31    xs_acl.create_acl(name      => 'hr_acl',
 32                      ace_list  => aces,
 33                      sec_class => 'hr_privileges');
 34  end;
 35  /

PL/SQL procedure successfully completed.

SQL>
SQL>
SQL>
SQL> ------------------------------------------------------------------------
SQL> -- 3. SETUP - Data security policy
SQL> ------------------------------------------------------------------------
SQL> -- Create data security policy for EMPLOYEE table. The policy defines
three
SQL> -- realm constraints and a column constraint that protects SALARY
column.
SQL> declare
  2    realms   xs$realm_constraint_list := xs$realm_constraint_list();
  3    cols     xs$column_constraint_list := xs$column_constraint_list();
  4  begin
  5    realms.extend(3);
  6
  7    -- Realm #1: Only the employee's own record.
  8    --           employee can view the realm including SALARY column.
  9    realms(1) := xs$realm_constraint_type(
 10      realm    => 'email = xs_sys_context(''xs$session'',''username'')',
 11      acl_list => xs$name_list('emp_acl'));
 12
 13    -- Realm #2: The records in the IT department.
 14    --           it_engineer can view the realm excluding SALARY column.
 15    realms(2) := xs$realm_constraint_type(
 16      realm    => 'department_id = 60',
 17      acl_list => xs$name_list('it_acl'));
 18
 19    -- Realm #3: All the records.
 20    --           hr_representative can view and update the realm
including SALARY column.
 21    realms(3) := xs$realm_constraint_type(
 22      realm    => '1 = 1',
```

```
 23      acl_list => xs$name_list('hr_acl'));
 24
 25    -- Column constraint protects SALARY column by requiring VIEW_SALARY
 26    -- privilege.
 27    cols.extend(1);
 28    cols(1) := xs$column_constraint_type(
 29      column_list => xs$list('salary'),
 30      privilege   => 'view_salary');
 31
 32    xs_data_security.create_policy(
 33      name                   => 'employees_ds',
 34      realm_constraint_list  => realms,
 35      column_constraint_list => cols);
 36  end;
 37  /

PL/SQL procedure successfully completed.

SQL>
SQL>
SQL>
SQL> -- Apply the data security policy to the table.
SQL> begin
  2    xs_data_security.apply_object_policy(
  3      policy => 'employees_ds',
  4      schema => 'hr',
  5      object =>'employees');
  6  end;
  7  /

PL/SQL procedure successfully completed.

SQL>
SQL>
SQL>
SQL> ------------------------------------------------------------------------
SQL> -- 4. SETUP - Validate the objects we have set up.
SQL> ------------------------------------------------------------------------
SQL> set serveroutput on;
SQL> begin
  2    if (xs_diag.validate_workspace()) then
  3      dbms_output.put_line('All configurations are correct.');
  4    else
  5      dbms_output.put_line('Some configurations are incorrect.');
  6    end if;
  7  end;
  8  /
Some configurations are incorrect.

PL/SQL procedure successfully completed.

SQL> -- XS$VALIDATION_TABLE contains validation errors if any.
SQL> -- Expect no rows selected.
SQL> select * from xs$validation_table order by 1, 2, 3, 4;
```

```
      CODE
----------
DESCRIPTION
--------------------------------------------------------------------------------
-----
OBJECT
--------------------------------------------------------------------------------
-----
NOTE
--------------------------------------------------------------------------------
-----
     -1020
No ACE in the ACL
[ACL "SYS"."NETWORK_ACL_30D45882EF095A86E053B0AAE80AF5F8"]



1 row selected.

SQL>
SQL>
SQL> ------------------------------------------------------------------------
SQL> -- 5. SETUP - additional configuration for Java demo.
SQL> ------------------------------------------------------------------------
SQL>
SQL> connect sys/&passwd as sysdba
Connected.
SQL>
SQL> -- create a session administrator who has only
SQL> -- RAS session administration privilege (no data privilege),
SQL> -- and is responsible to manage RAS session for each application user.
SQL> grant xs_session_admin, create session to hr_session identified by
hr_session;

Grant succeeded.

SQL> grant create session to hr_common identified by hr_common;

Grant succeeded.

SQL>
SQL> -- craete a dispatcher user for java demo, to set up session for
application user
SQL> exec xs_principal.create_user(name=>'dispatcher', schema=>'HR');

PL/SQL procedure successfully completed.

SQL> exec xs_principal.set_password('dispatcher', 'welcome1');

PL/SQL procedure successfully completed.

SQL> exec xs_principal.grant_roles('dispatcher', 'XSCONNECT');

PL/SQL procedure successfully completed.
```

```
SQL> exec xs_principal.grant_roles('dispatcher', 'xsdispatcher');

PL/SQL procedure successfully completed.

SQL>
SQL> exit
```

hrdemo.log

The `hrdemo.log` file.

```
SQL> @hrdemo
SQL>
SQL>
SQL> ------------------------------------------------------------------------
SQL> --  HR Demo - PL/SQL with RAS direct logon user
SQL> ------------------------------------------------------------------------
SQL> -- This demo shows RAS runtime, using RAS direct logon user.
SQL> -- Each user directly connects to database and accesses employee
table.
SQL> -- RAS policy is automaticlly enforced.
SQL> ------------------------------------------------------------------------
SQL>
SQL> -- Connect as DAUSTIN, who has only employee and it_engineer role
SQL> conn daustin/welcome1;
Connected.
SQL>
SQL> SET SECUREDCOL ON UNAUTH *******
SQL>
SQL> -- DAUSTIN can view the records in IT department, but can only view
his own
SQL> -- SALARY column.
SQL> select email, first_name, last_name, department_id, manager_id, salary
  2  from employees order by email;

EMAIL      FIRST_NAME      LAST_NAME       DEPARTMENT_ID MANAGER_ID  SALARY
---------- --------------- --------------- ------------- ---------- -------
AHUNOLD    Alexander       Hunold                     60        102 *******
BERNST     Bruce           Ernst                      60        103 *******
DAUSTIN    David           Austin                     60        103    4800
DLORENTZ   Diana           Lorentz                    60        103 *******
VPATABAL   Valli           Pataballa                  60        103 *******

5 rows selected.

SQL>
SQL>
SQL> SET SECUREDCOL OFF
SQL>
SQL>
SQL> -- DAUSTIN cannot update the record.
SQL> update employees set manager_id = 102 where email = 'DAUSTIN';

0 rows updated.
```

```
SQL>
SQL> -- Record is not changed.
SQL> select email, first_name, last_name, department_id, manager_id, salary
  2  from employees where email = 'DAUSTIN';

EMAIL      FIRST_NAME      LAST_NAME       DEPARTMENT_ID MANAGER_ID  SALARY
---------- -------------- -------------- ------------- ---------- -------
DAUSTIN    David           Austin                     60        103    4800

1 row selected.

SQL>
SQL>
SQL>
SQL> -- Connect as SMAVRIS, who has both employee and hr_representative
role.
SQL> conn smavris/welcome1;
Connected.
SQL>
SQL> -- SMAVRIS can view all the records including SALARY column.
SQL> select email, first_name, last_name, department_id, manager_id, salary
  2  from employees where department_id = 60 or department_id = 40
  3  order by department_id, email;

EMAIL      FIRST_NAME      LAST_NAME       DEPARTMENT_ID MANAGER_ID  SALARY
---------- -------------- -------------- ------------- ---------- -------
SMAVRIS    Susan           Mavris                     40        101    6500
AHUNOLD    Alexander       Hunold                     60        102    9000
BERNST     Bruce           Ernst                      60        103    6000
DAUSTIN    David           Austin                     60        103    4800
DLORENTZ   Diana           Lorentz                    60        103    4200
VPATABAL   Valli           Pataballa                  60        103    4800

6 rows selected.

SQL>
SQL> -- EMPLOYEES table has 107 rows, we expect to see all of them.
SQL> select count(*) from employees;

  COUNT(*)
----------
       107

1 row selected.

SQL>
SQL>
SQL>
SQL> -- SMAVRIS can update the record.
SQL> update employees set manager_id = 102 where email = 'DAUSTIN';

1 row updated.

SQL>
```

```
SQL> -- Record is changed.
SQL> select email, first_name, last_name, department_id, manager_id, salary
  2  from employees where email = 'DAUSTIN';

EMAIL      FIRST_NAME      LAST_NAME       DEPARTMENT_ID MANAGER_ID  SALARY
---------- --------------- --------------- ------------- ---------- -------
DAUSTIN    David           Austin                     60        102    4800

1 row selected.

SQL>
SQL> -- change the record back to the original.
SQL> update employees set manager_id = 103 where email = 'DAUSTIN';

1 row updated.

SQL>
SQL> exit
```

hrdemo_run_sess.log

The `hrdemo_run_sess.log` file.

```
SQL> @hrdemo_session
SQL>
SQL>
SQL> ------------------------------------------------------------------------
SQL> --  HR Demo - PL/SQL with Session API
SQL> ------------------------------------------------------------------------
SQL> -- This demo shows RAS runtime, using RAS user as application user.
SQL> -- The user does not logon to database, but a RAS session is created
SQL> -- and attached for each user before accessing employee table.
SQL> ------------------------------------------------------------------------
SQL>
SQL> -- Connect as RAS session administrator
SQL> connect hr_session/hr_session;
Connected.
SQL>
SQL> -- Variable used to remember the session ID;
SQL> var gsessionid varchar2(32);
SQL>
SQL> -- Create an application session for SMARVIS and attach to it.
SQL> declare
  2    sessionid raw(16);
  3  begin
  4    dbms_xs_sessions.create_session('SMAVRIS', sessionid);
  5    :gsessionid := rawtohex(sessionid);
  6    dbms_xs_sessions.attach_session(sessionid, null);
  7  end ;
  8  /

PL/SQL procedure successfully completed.

SQL>
```

```
SQL> -- Display the current user, it should be SMAVRIS now.
SQL> select xs_sys_context('xs$session','username') from dual;

XS_SYS_CONTEXT('XS$SESSION','USERNAME')
--------------------------------------------------------------------------------
-----
SMAVRIS

1 row selected.

SQL>
SQL> -- Display the enabled application roles and database roles.
SQL> select role_name from v$xs_session_roles union
  2  select role from session_roles order by 1;

ROLE_NAME
--------------------------------------------------------------------------------
-----
DB_EMP
EMPLOYEE
HR_REPRESENTATIVE
XSCONNECT
XSPUBLIC
XS_CONNECT

6 rows selected.

SQL>
SQL> -- SMAVRIS can view all the records including SALARY column.
SQL> select email, first_name, last_name, department_id, manager_id, salary
  2  from employees where department_id = 60 or department_id = 40
  3  order by department_id, email;

EMAIL      FIRST_NAME      LAST_NAME       DEPARTMENT_ID MANAGER_ID  SALARY
---------- --------------- --------------- ------------- ---------- -------
SMAVRIS    Susan           Mavris                     40        101    6500
AHUNOLD    Alexander       Hunold                     60        102    9000
BERNST     Bruce           Ernst                      60        103    6000
DAUSTIN    David           Austin                     60        103    4800
DLORENTZ   Diana           Lorentz                    60        103    4200
VPATABAL   Valli           Pataballa                  60        103    4800

6 rows selected.

SQL>
SQL> -- EMPLOYEES table has 107 rows, we expect to see all of them.
SQL> select count(*) from employees;

  COUNT(*)
----------
       107

1 row selected.

SQL>
```

```
SQL> -- Disable hr_representative role
SQL> exec dbms_xs_sessions.disable_role('hr_representative');

PL/SQL procedure successfully completed.

SQL>
SQL> -- SMAVRIS should only be able to see her own record.
SQL> select email, first_name, last_name, department_id, manager_id, salary
  2  from employees where department_id = 60 or department_id = 40
  3  order by department_id, email;

EMAIL      FIRST_NAME      LAST_NAME       DEPARTMENT_ID MANAGER_ID  SALARY
---------- --------------- --------------- ------------- ---------- -------
SMAVRIS    Susan           Mavris                     40        101    6500

1 row selected.

SQL>
SQL>
SQL> -- Enable HR_ROLE
SQL> exec dbms_xs_sessions.enable_role('hr_representative');

PL/SQL procedure successfully completed.

SQL>
SQL> -- SMAVRIS can view all the records again.
SQL> select email, first_name, last_name, department_id, manager_id, salary
  2  from employees where department_id = 60 or department_id = 40
  3  order by department_id, email;

EMAIL      FIRST_NAME      LAST_NAME       DEPARTMENT_ID MANAGER_ID  SALARY
---------- --------------- --------------- ------------- ---------- -------
SMAVRIS    Susan           Mavris                     40        101    6500
AHUNOLD    Alexander       Hunold                     60        102    9000
BERNST     Bruce           Ernst                      60        103    6000
DAUSTIN    David           Austin                     60        103    4800
DLORENTZ   Diana           Lorentz                    60        103    4200
VPATABAL   Valli           Pataballa                  60        103    4800

6 rows selected.

SQL>
SQL> -- EMPLOYEES table has 107 rows, we expect to see all of them.
SQL> select count(*) from employees;

  COUNT(*)
----------
       107

1 row selected.

SQL>
SQL> -- Detach and destroy the application session.
SQL> declare
  2    sessionid raw(16);
```

```
  3  begin
  4    sessionid := hextoraw(:gsessionid);
  5    dbms_xs_sessions.detach_session;
  6    dbms_xs_sessions.destroy_session(sessionid);
  7  end;
  8  /

PL/SQL procedure successfully completed.

SQL>
SQL> exit
```

hrdemo.log

The Java `hrdemo.log` file.

```
Query HR.EMPLOYEES table as user "DAUSTIN"
  EMAIL  | FIRST_NAME | LAST_NAME  | DEPT | SALARY | UPDATE | VIEW_SALARY
  AHUNOLD|   Alexander|      Hunold|    60|   *****|   false|   false
   BERNST|       Bruce|       Ernst|    60|   *****|   false|   false
  DAUSTIN|       David|      Austin|    60|    4800|   false|    true
 DLORENTZ|       Diana|     Lorentz|    60|   *****|   false|   false
 VPATABAL|       Valli|   Pataballa|    60|   *****|   false|   false

Query HR.EMPLOYEES table as user "SMAVRIS"
  EMAIL  | FIRST_NAME | LAST_NAME  | DEPT | SALARY | UPDATE | VIEW_SALARY
  AHUNOLD|   Alexander|      Hunold|    60|    9000|    true|    true
   BERNST|       Bruce|       Ernst|    60|    6000|    true|    true
  DAUSTIN|       David|      Austin|    60|    4800|    true|    true
  DFAVIET|      Daniel|      Faviet|   100|    9000|    true|    true
 DLORENTZ|       Diana|     Lorentz|    60|    4200|    true|    true
 ISCIARRA|      Ismael|     Sciarra|   100|    7700|    true|    true
    JCHEN|        John|        Chen|   100|    8200|    true|    true
  JMURMAN| Jose Manuel|       Urman|   100|    7800|    true|    true
    LPOPP|        Luis|        Popp|   100|    6900|    true|    true
 NGREENBE|       Nancy|   Greenberg|   100|   12008|    true|    true
  SMAVRIS|       Susan|      Mavris|    40|    6500|    true|    true
 VPATABAL|       Valli|   Pataballa|    60|    4800|    true|    true
```

hrdemo_clean.log

The `hrdemo_clean.log` file.

```
SQL> @hrdemo_clean
SQL>
SQL> define passwd=&1
Enter value for 1: test
SQL>
SQL> connect hr/hr;
Connected.
SQL>
SQL> -- Remove policy from the table.
SQL> begin
  2    xs_data_security.remove_object_policy(policy=>'employees_ds',
  3                                          schema=>'hr',
object=>'employees');
```

```
  4  end;
  5  /

PL/SQL procedure successfully completed.

SQL>
SQL> -- Delete security class and ACLs
SQL> exec xs_security_class.delete_security_class('hr_privileges',
xs_admin_util.cascade_option);

PL/SQL procedure successfully completed.

SQL> exec xs_acl.delete_acl('emp_acl', xs_admin_util.cascade_option);

PL/SQL procedure successfully completed.

SQL> exec xs_acl.delete_acl('it_acl', xs_admin_util.cascade_option);

PL/SQL procedure successfully completed.

SQL> exec xs_acl.delete_acl('hr_acl', xs_admin_util.cascade_option);

PL/SQL procedure successfully completed.

SQL>
SQL> -- Delete data security policy
SQL> exec xs_data_security.delete_policy('employees_ds',
xs_admin_util.cascade_option);

PL/SQL procedure successfully completed.

SQL>
SQL> connect sys/&passwd as sysdba
Connected.
SQL> -- Delete application users and roles
SQL> exec xs_principal.delete_principal('employee',
xs_admin_util.cascade_option);

PL/SQL procedure successfully completed.

SQL> exec xs_principal.delete_principal('hr_representative',
xs_admin_util.cascade_option);

PL/SQL procedure successfully completed.

SQL> exec xs_principal.delete_principal('it_engineer',
xs_admin_util.cascade_option);

PL/SQL procedure successfully completed.

SQL> exec xs_principal.delete_principal('smavris',
xs_admin_util.cascade_option);

PL/SQL procedure successfully completed.
```

```
SQL> exec xs_principal.delete_principal('daustin',
xs_admin_util.cascade_option);

PL/SQL procedure successfully completed.

SQL>
SQL> -- Delete database role
SQL> drop role db_emp;

Role dropped.

SQL>
SQL> -- Delete session administrator
SQL> drop user hr_session;

User dropped.

SQL> -- Delete the common user used to connect to DB
SQL> drop user hr_common;

User dropped.

SQL>
SQL> -- Delete dispatcher
SQL> exec xs_principal.delete_principal('dispatcher',
xs_admin_util.cascade_option);

PL/SQL procedure successfully completed.

SQL>
SQL> exit
```

D

Troubleshooting Oracle Database Real Application Security

This appendix contains:

- About Real Application Security Diagnostics
- About Event-Based Tracing of Real Application Security Components
- About Exception State Dump Information
- About Session Statistics
- Using Middle-Tier Tracing

About Real Application Security Diagnostics

Real Application Security uses an integrated infrastructure that spans across back-end databases, application servers, and application instances. Real Application Security components include diagnostic capabilities that enable you to locate, diagnose, and resolve problems in a Real Application Security system.

Real Application Security diagnostics make use of the database Diagnostic Framework (DFW) available in Oracle Database 12*c* Release 1 (12.1) and later. Functionality diagnostics allow you to track, investigate, and resolve functionality failures. You can use exception state dumps, event-based tracing, or default tracing to study and resolve functionality issues. Performance diagnostics enable you to identify and resolve performance issues.

The following sections discuss functionality and performance diagnostic techniques used in Real Application Security systems:

- About Using Validation APIs
- How to Check Which ACLs Are Associated with a Row for the Current User
- How to Find If a Privilege Is Granted in an ACL to a User
- About Exception State Dumps
- About Event-Based Tracing
- About In-Memory Tracing
- About Statistics

About Using Validation APIs

You should always validate objects after they are created. This includes objects, such as principals, security classes, ACLs, data security policies, and namespaces. You can also validate all these objects that exist in a workspace in a single operation. The `XS_DIAG` package includes subprograms that you can use to diagnose potential problems in any of these created objects. See "XS_DIAG Package" for more

information. These packages are briefly described in the following table with links to each validation subprogram where examples of their usage are shown.

Table D-1 Summary of XS_DIAG Subprograms

Subprogram	Description
VALIDATE_PRINCIPAL Function	Validates the principal.
VALIDATE_SECURITY_CLASS Function	Validates the security class.
VALIDATE_ACL Function	Validates the ACL.
VALIDATE_DATA_SECURITY Function	Validates the data security policy or validates the data security policy against a specific table.
VALIDATE_NAMESPACE_TEMPLATE Function	Validates the namespace template.
VALIDATE_WORKSPACE Function	Validates an entire workspace.

How to Check Which ACLs Are Associated with a Row for the Current User

To find which ACLs are associated with a particular row for the current user, use the `ORA_GET_ACLIDS` function. The `ORA_GET_ACLIDS` function returns a list of ACL IDS associated with a row instance of data security policy enabled tables for the current application user. If access to the current row has been granted, this function captures all ACL identifiers that are associated with the matching data realm constraints. See "ORA_GET_ACLIDS Function" for reference information and "About Checking ACLs for a Privilege" for tutorial information.

How to Find If a Privilege Is Granted in an ACL to a User

To find if a privilege is granted in an ACL, use the `ORA_CHECK_ACL` function. The `ORA_CHECKACL` function checks whether an application user has the queried application privileges according to a list of ACLs. If the specified application privileges have been granted to the application user, `ORA_CHECKACL` returns `1`. If they are not granted to the application user, then it returns `0`. See "ORA_CHECK_ACL Function" for reference information and "About Checking ACLs for a Privilege" for tutorial information.

To list the ACLIDs associated with each row of a table, for example, the `EMPLOYEE` table, the user can use the following query:

```
select ORA_GET_ACLIDS(emp) from EMPLOYEE emp;
```

To list the result if a privilege, for example `SELECT`, is granted for each row of the `EMPLOYEE` table, the user can perform the following query:

```
select ORA_CHECK_ACL(ORA_GET_ACLIDS(emp), 'SELECT') from EMPLOYEE emp;
```

About Exception State Dumps

When an exception occurs, the state information for Real Application Security components is dumped into trace files. Exception state dumps are analogous to crash site evidence for a plane crash.

A failure, like an internal error or server crash, causes a Diagnostic Data Extraction (DDE) routine to be invoked for each component. This dumps the current system, session, and process state information into trace files. You can later analyze the cause of failure using the state information dumped into trace files.

About Event-Based Tracing

Event-based tracing can be used to track events related to specific Real Application Security components. Event-based tracing helps in tracing the events that led up to a failure. For example, event number 46148 is used to trace application session events, such as `createSession` and `attachSession`.

About In-Memory Tracing

In-memory tracing is a proactive tracing mechanism that is used do diagnose intermittent and hard to replicate errors. The in-memory tracing mechanism records component state changes and events in memory buffers. This is dumped to a trace file when a failure occurs. In-memory tracing is analogous to black box data that is used for plane crash investigation.

About Statistics

Real Application Security component statistics help identify performance issues in a Real Application Security system. Statistics include key data like the number of session create operations, principal invalidations, role-enabling operations, and so on.

About Event-Based Tracing of Real Application Security Components

Event-based tracing can be used to track events related to specific Real Application Security components. Table D-2 lists the events assigned to Real Application Security components.

Table D-2 Real Application Security Components and Events

Real Application Security Components	Event (Oracle Error #)
Application Sessions (`XSSESSION`)	46148
Application Principals (`XSPRINCIPAL`)	46150
Security Classes (`XSSECCLASS`)	46149
ACLs (`XSACL`)	46110
Data Security (`XSXDS`)	46049

Table D-2 (Cont.) Real Application Security Components and Events

Real Application Security Components	Event (Oracle Error #)
Mid-Tier Caches (XS_MIDTIER)	46151
Data Security VPD Rewrite (XSVPD)	10730

The following sections describe event-based tracing for individual Real Application Security components:

- About Application Sessions (XSSESSION) Event-Based Tracing
- About Application Principals (XSPRINCIPAL) Event-Based Tracing
- About Security Classes (XSSECCLASS) Event-Based Tracing
- About ACL (XSACL) Event-Based Tracing
- About Data Security (XSXDS and XSVPD) Event-Based Tracing

About Application Sessions (XSSESSION) Event-Based Tracing

Use the following SQL statement to enable event-based tracing for the XSSESSION component:

```
ALTER SESSION SET EVENTS '46148 trace name context forever, level="1", level="2",
level="3"';
```

Here, 46148 is the Oracle Database error number associated with XSSESSION events. You can set a trace level of 1 (low), 2 (medium), or 3 (high). Table D-3 describes the trace levels.

Alternatively, you can use the following statement:

```
ALTER SESSION SET EVENTS 'TRACE [XSSESSION] disk=[low, medium, high]'
```

You can find the location of this trace file by using the following SQL statement:

```
SHOW PARAMETER USER_DUMP_DEST;
```

Table D-3 shows the XSSESSION trace contents for each trace level.

Table D-3 XSSESSION Trace Contents

Event	Trace Level 1 (Low)	Trace Level 2 (Medium)	Trace Level 3 (High)
`createSession`	Includes the following: • User name • Session Id for the session	Includes the following in addition to trace level 1 items: • User GUID • Session attributes such as create time, last authentication time, global variable namespace, and cookie information	Same as level 2
`attachSession`	Includes the following: • User name • Session Id for the session	Includes the following in addition to trace level 1 items: • Roles	Includes the following in addition to trace level 1 and 2 items: • Application namespace with attribute values
`detachSession`	Includes the following: • User name • Session Id for the session before detaching	Same as level 1	Same as levels 1 and 2
`createNamespace`	Includes the following: • User name • Session Id • Application namespace with attribute values	Includes the following in addition to trace level 1 items: • Session attributes such as create time, last authentication time, global variable namespace, and cookie information	Includes the following in addition to trace level 1 and 2 items: • Namespace handler
`switchUser`	Includes the following: • User name • Session Id for the session	Includes the following in addition to trace level 1 items: • Roles	Includes the following in addition to trace level 1 and 2 items: • Application namespace with attribute values

Table D-3 (Cont.) XSSESSION Trace Contents

Event	Trace Level 1 (Low)	Trace Level 2 (Medium)	Trace Level 3 (High)
`assignUser`	Includes the following: • User name • Session Id for the session	Includes the following in addition to trace level 1 items: • Roles	Includes the following in addition to trace level 1 and 2 items: • Application namespace with attribute values
`setAttribute`	Includes the following: • Namespace name • Name and value of the given attribute before and after the `setAttribute` operation	Same as level 1	Same as levels 1 and 2
`deleteAttribute`	Includes the following: • Namespace name and • Name and value of the given attribute before and after the `deleteAttribute` operation	Same as level 1	Same as levels 1 and 2

In addition to the preceding event, you can use the named event, `xs_session_state` to dump the current state of application sessions. Use the following SQL statement to enable tracing for the `xs_session_state` event:

```
ALTER SESSION SET EVENTS 'immediate eventdump(xs_session_state)';
```

The event dump contains information on all session attributes in the User Global Area (UGA) memory, such as session Id, user name, create time, last authentication time, global variable namespace, and so on. The dump does not contain information on secure items such as passwords.

About Application Principals (XSPRINCIPAL) Event-Based Tracing

Use the following `SQL` statement to enable event-based tracing for the `XSPRINCIPAL` component:

```
ALTER SESSION SET EVENTS '46150 trace name context forever, level="1", level="2",
level="3"';
```

Here, `46150` is the Oracle Database error number associated with `XSPRINCIPAL` events. You can set a trace level of `1` (`low`), `2` (`medium`), or `3` (`high`). Table D-4 describes the trace levels.

Alternatively, you can use the following statement:

```
ALTER SESSION SET EVENTS 'TRACE [XSPRINCIPAL] disk=[low, medium, high]';
```

You can find the location of this trace file by using the following SQL statement:

```
SHOW PARAMETER USER_DUMP_DEST;
```

Table D-4 shows the XSPRINCIPAL trace contents for each trace level.

Table D-4 XSPRINCIPAL Trace Contents

Event	Trace Level 1 (Low)	Trace Level 2 (Medium)	Trace Level 3 (High)
Enable Role	Includes the following: • User name • Session Id for the session	Includes the following in addition to trace level 1 items: • If the Enable Role operation fails, then the cause is logged. For example, the operation may fail if the role does not exist or the user has not been granted the role	Same as levels 1 and 2
Disable Role	Includes the following: • All user enabled roles in the session after the role is disabled	Includes the following in addition to trace level 1 items: • If the Disable Role operation fails, then the cause is logged.	Same as levels 1 and 2
Role Graph Traverse	Includes the following: • User name • Session Id for the session	Same as level 1	Same as levels 1 and 2

About Security Classes (XSSECCLASS) Event-Based Tracing

Use the following SQL statement to enable event-based tracing for the XSSECCLASS component:

```
ALTER SESSION SET EVENTS '46149 trace name context forever, level="1", level="2",
level="3"';
```

Here, 46149 is the Oracle Database error number associated with XSSECCLASS events. You can set a trace level of 1 (low), 2 (medium), or 3 (high).

Alternatively, you can use the following statement:

```
ALTER SESSION SET EVENTS 'TRACE [XSSECCLASS] disk=[low, medium, high]';
```

You can find the location of this trace file by using the following SQL statement:

```
SHOW PARAMETER USER_DUMP_DEST;
```

The trace information includes the following:

- Content from the Security Class document, such as parent classes, child classes, privileges, and aggregate privileges
- For security class deletions, it includes information on parent classes that require invalidation from the cache
- Exception related information, such as security class validation errors

About ACL (XSACL) Event-Based Tracing

Use the following SQL statement to enable event-based tracing for the XSACL component:

```
ALTER SESSION SET EVENTS '46110 trace name context forever, level="1", level="2",
level="3"';
```

Here, 46110 is the Oracle Database error number associated with XSACL events. You can set a trace level of 1 (low), 2 (medium), or 3 (high).

Alternatively, you can use the following statement:

```
ALTER SESSION SET EVENTS 'TRACE [XSACL] disk=[low, medium, high]';
```

You can find the location of this trace file by using the following SQL statement:

```
SHOW PARAMETER USER_DUMP_DEST;
```

Table D-5 shows the XSACL trace contents for each trace level.

Table D-5 XSACL Trace Contents

Event	Trace Level 1 (Low)	Trace Level 2 (Medium)	Trace Level 3 (High)
Check privilege against ACLs	Includes the following: • ACL results during cursor sharing	Includes the following in addition to trace level 1 items: • ACL evaluation including ACL loading	Same as levels 1 and 2

About Data Security (XSXDS and XSVPD) Event-Based Tracing

Use the following SQL statement to enable event-based tracing for the XSXDS component:

```
ALTER SESSION SET EVENTS '46049 trace name context forever, level="1", level="2",
level="3"';
```

Here, 46049 is the Oracle Database error number associated with XSXDS events. You can set a trace level of 1 (low), 2 (medium), or 3 (high). Table D-6 describes the trace levels.

Alternatively, you can use the following statement:

```
ALTER SESSION SET EVENTS 'TRACE [XSXDS] disk=[low, medium, high]';
```

You can find the location of this trace file by using the following SQL statement:

```
SHOW PARAMETER USER_DUMP_DEST;
```

Table D-6 shows the XSXDS trace contents for each trace level.

Table D-6 XSXDS Trace Contents

Event	Trace Level 1 (Low)	Trace Level 2 (Medium)	Trace Level 3 (High)
Data Security Document (DSD) loaded into System Global Area (SGA)	Includes the following: • Security data realm constraint rules with resolved parameter values	Includes the following in addition to trace level 1 items: • Access Control List (ACL) identifiers	Same as levels 1 and 2

Use the following SQL statement to enable event-based tracing for the XSVPD component:

```
ALTER SESSION SET EVENTS '10730 trace name context forever level [1, 2, 3]';
```

Here, 10730 is the Oracle Database error number associated with XSVPD events. You can set a trace level of 1 (low), 2 (medium), or 3 (high). Table D-6 describes the trace levels.

Alternatively, you can use the following statement:

```
ALTER SESSION SET EVENTS 'TRACE [XSVPD] disk=[low, medium, high]';
```

Table D-6 shows the XSVPD trace contents for each trace level.

Table D-7 XSVPD Trace Contents

Event	Trace Level 1 (Low)	Trace Level 2 (Medium)	Trace Level 3 (High)
• Data Security Document (DSD) loaded into System Global Area (SGA) • All subsequent SQL statements issued in the current database session	Includes the following: • VPD view of XDS enabled objects during hard-parse, soft-parse, or SQL statement parsing • Data realm constraint rules with resolved parameter values, their corresponding ACL paths and ACL identifiers	Includes the following in addition to trace level 1 items: • Current application session user name and enabled roles when the SQL statement is parsed or run	Includes the following in addition to trace level 1 items: • Contents of all ACLs associated with data realm constraints, which are associated with the XDS enabled objects in the query

About Exception State Dump Information

When an exception occurs, the state information for Real Application Security components is dumped into trace files. Table D-8 describes the information dumped for individual Real Application Security components:

Table D-8 Real Application Security Components and First-Failure Dump Information

Real Application Security Component	Exception Related Information
XSSESSION	• Application session state information
XSPRINCIPAL	• Application session role lists (all roles, enabled roles, disabled roles, and database roles of the application session) • Role Graph hash table of the system • User hash table with direct roles granted to the users in the system • Principal row cache state

About Session Statistics

Real Application Security component statistics help identify performance issues in a Real Application Security system. Table D-9 describes the statistics collected for individual Real Application Security components.

Table D-9 Real Application Security Components and Performance Statistics

Real Application Security Component	Performance Statistics Collected
XSSESSION	• Number of application sessions created • Number of application sessions attached and detached • Number of namespaces created • Number of user callbacks executed
XSPRINCIPAL	• Number of roles enabled/disabled • Number of principal cache misses • Number of principal invalidations
Mid-tier caches	• Number of session cache synchronizations • Number of principal cache synchronizations • Number of security class cache synchronizations

Using Middle-Tier Tracing

Middle-tier tracing uses the package `oracle.security.xs`. It can be done as follows:

1. Specify logging options in a property file. For example,

```
handlers= java.util.logging.ConsoleHandler
.level= SEVERE
java.util.logging.ConsoleHandler.level = FINEST
```

```
java.util.logging.ConsoleHandler.formatter = java.util.logging.SimpleFormatter
oracle.security.xs.level = FINEST
```

2. Apply the preceding configuration during JVM start up.

   ```
   java -Djava.util.logging.config.file=logging.properties
   ```

   The log output will be generated to the handlers (file, console) specified in the configuration.

Real Application Security user can use mid-tier java API for authentication, authorization, session management, and so forth. In case the user needs to debug on interfacing with mid-tier API, trace can be turned on. The trace can show basic call stacks, function involved, time used, parameters passed, returning value, and so forth.

Glossary

access control entry (ACE)

An entry in the access control list that grants or denies access to a given principal. One or more ACEs are listed within an access control list (ACL), in which the ordering of the ACEs is relevant.

access control list (ACL)

A list of access control entries that determines which principals have access to a given resource or resources. In Oracle Database Real Application Security, you use ACLs to define user privileges.

ACE

See access control entry (ACE).

ACL

See access control list (ACL).

aggregate privilege

A privilege that contains other privileges. When an aggregate privilege has been granted or denied, then all of its child privileges are granted or denied as well.

application role

A role that can only be granted to a application user or to another application role.

application session

A user session that contains information pertinent only to the application. Unlike traditional "heavyweight" database sessions, an application session does not hold its own database resources such as transactions and cursors.

application user

A user account that does not own a schema and can create a application session through the middle tier to the database.

column level security

The ability to apply specific privileges to a table column.

custom privilege

A privilege not predefined by Oracle Database. See also system privilege.

data realm

A set of rows within a database table whose access you control by associating it with an access control list (ACL). It is comprised of one or more object instances. See also dynamic data realm constraint and static data realm constraint.

database role

A role that can only be granted to a database user. It is also called a heavyweight role. See also application role.

database user

A user account that is created within the database and has a schema. It is also called a heavyweight user. See also application user.

dynamic ACL

An access control list that has been associated with a dynamic data realm constraint.

dynamic application role

A role that is enabled only under certain conditions, for example, when a user has logged on using SSL, or during a specified period.

dynamic data realm constraint

An data realm whose `WHERE` predicate is rerun each time the user performs a query on the data realm constraint data. See also static data realm constraint.

function security

The mechanism by which user access to an applications functionality is controlled. For example, for Oracle Database Real Application Security, use the `checkPrivilege()` method to check the privilege on the ACL for a row to determine if a specific privilege on one or more given ACLs is associated with that row. See About the Check Privilege API for more information.

globally unique identifier (GUID)

The external ID that applications can use to manage the user's session information. This identifier is not guaranteed to be unique across all tiers, but the number of unique keys that comprises it is so large that the chances of it being duplicated are small. See also unique identifier (UID).

GUID

See globally unique identifier (GUID).

heavyweight role

A traditional database role.

heavyweight user

A traditional database user account that owns a schema.

namespace

A container consisting of attribute-value pairs that reflects the state of the application session.

object instance

A single relational table row that is part of an data realm. It is identified by its primary key value.

password verifier

A hashed version of a clear text password, which is then encoded as a BASE64 encoded string.

principal

A user or collection of users alternately called a **group** or a **role**. See also application user and application role.

privilege

A right or permission that can be granted or denied to a principal. See also aggregate privilege, custom privilege, and system privilege.

security class

A named collection of privileges that can be associated with an ACL.

static ACL

An access control list that has been associated with a static data realm constraint.

static data realm constraint

An data realm whose `WHERE` predicate is stored in cache, so that it is not rerun each time the user performs a query on the data realm constraint data. See also dynamic data realm constraint.

system privilege

Predefined privilege supplied by Oracle Database. See also custom privilege.

unique identifier (UID)

A unique internal identifier that Oracle Database uses to track the user or role. It is used to manage the user's session information across the database enterprise. See also globally unique identifier (GUID).

UID

See unique identifier (UID).

user switch

The ability of an application user to proxy as another user. The application state (that is, namespaces and attributes) is maintained from the previous user, but the security context reflects that of the new user.

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