12c Real Application Security

Concepts, Techniques, Use Cases

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- Specialized in ORACLE-based Systems
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Real Application Security

Agenda

- Introduction
- Architecture and Basic Concepts
- Use Case: Step-by-Step Configuration
- Running RAS-enabled Applications
- Auditing RAS Actions
- Summary

Introduction

- RAS – Real Application Security
  - introduced under 12c R1
  - building upon/enhancing concepts like VPD, secure application context, lightweight sessions in OCI, application roles, proxy authentication etc.
- Centralizing security models and authorization logic
  - deploying security policies inside Oracle databases instead of implementation in (distributed) application code
  - avoid inconsistencies by multiple entry access points
  - improve maintenance
- Enforce end-to-end security for 3-tier and 2-tier applications
  - independant of entry points,, usable for:
    direct logins, APEX, Java/Middletier application servers
  - enforce least-privilege and preserve client identities

Typical Multitier Access Models

- Application users are not database users
  - authentication and authorization done by application code, bypass(!)
  - connection to database by single (highly-)privileged user
  - identity of end user not known to the database
  - thus intrinsic security features including DB auditing not usable
- Frequent and stateless calls to database
  - connection pool: a cache of database connection objects
    - min and max etc. can be configured, reduce overhead
  - application requests connection from pool – “lightweight sessions”
- Pool implementations
  - JDBC OCI Connection Pool
  - universal Connection Pool (formerly “implicit connection cache”)
  - Database Resident Connection Pool (DRCP)

Typical Database Access Models

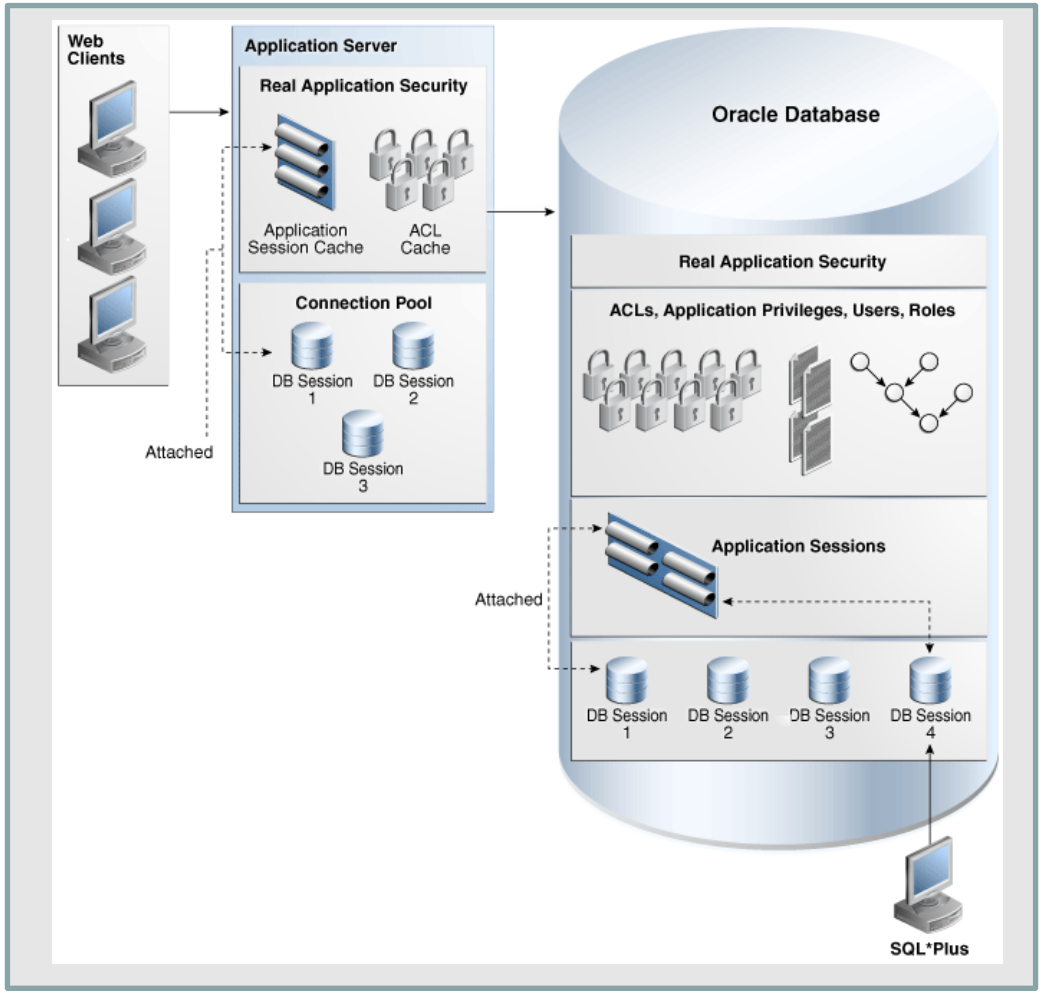
- Usually lesser number of users
- „Heavyweight“, longer lasting sessions bound to schema
- Static Privileges via direct or role grants
  - Exception EUS – Enterprise and Global Roles
- Some improvements in former releases
  - client identifier to tag enduser identity by utilizing application context
    - do not confuse with client_info!
  - dynamically enabling privileges through secure application roles
    - enabled through associated PL/SQL Code
  - Enable users to connect through proxy users
    - both have to be configured in the database
  - Use shared schemas and enterprise roles to attach users and privileges
    - involves OID/OUD infrastructure

Real Application Security

- Fills the gap by utilizing basic techniques like VPD etc. and by adding an enhanced security framework
- Implemented in 12c Enterprise Edition – no options required
  - 32 dictionary tables under SYS named **XS$%**
  - Views: 30 **DBA_XS%** and 13 **USER_XS%**
  - 4 predefined database roles named **XS_%**
  - PL/SQL Packages: 18 **XS_%** and 17 **DBMS_XS_%**
  - predefined application user and application roles
  - Java Packages **oracle.security.xs** and **oracle.security.xs.ee.session**
  - Apex application **rasadm** and demo scripts for testing
- Adds new concepts
  - application user, application role, application sessions, ACL, security class, security policy

RAS Architecture

- Connect as
  - direct login application user
  - attach application user
  - switch application user
- Connect from
  - middle tier/connection pool
  - tool such as SQL*Plus



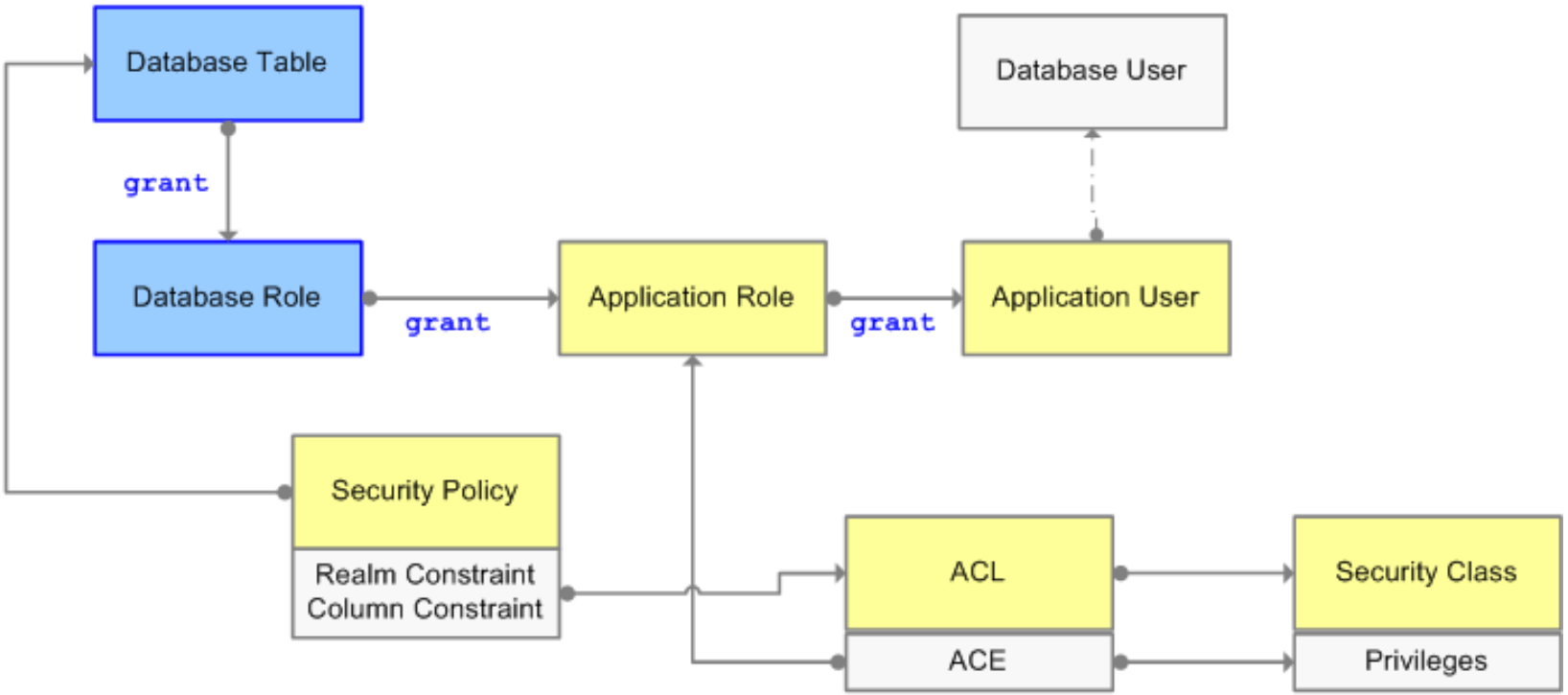
Basic Concepts

- Schema-less application users (AU)
  - do not own any database objects or resources
  - can be but must not be tied to a database schema for name resolution only
  - passwords possible including password rules (profiles)
  - other features like start- and enddates, proxy rules etc.
- Application roles (AR) – group application privileges (AP)
  - are mapped via access control entries (ACE) to application privileges
  - can be granted to AU but not to database roles or users
  - but: database roles can be granted to AR
- Access control lists (ACL)
  - contain ACEs which bind AP to AR
- Data realms (DR) – a logical set of rows in a table used in Sec. Pol.

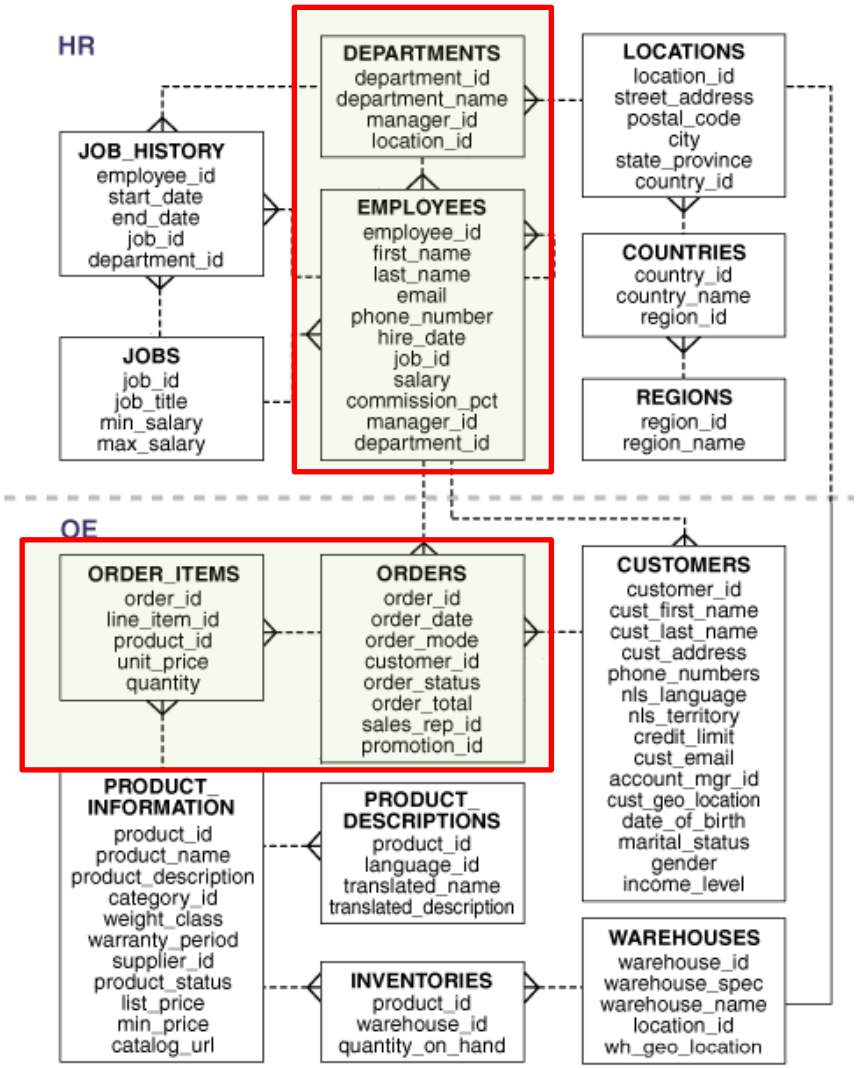
Basic Concepts

- Application Privileges (AP)
  - control application-level operations on specific business-objects
  - are defined in the context of security classes (SC)
  - can be freely named, predefined AP and SC are available
- Security Policies (SP)
  - SP contain data realms and and associate them with ACLs
  - also support column-level authorization to mask column values, in combination with realms they offer cell-level protection
  - once applied on a database table or view, the SP is enforced on all SQL statements/all access paths to the object (2-tier or 3-tier applications)
- Application Session (AS)
  - lightweight, maintain only the security-relevant state for the use
  - multiplexed on heavyweight database sessions among many end-users
  - 3-tier: session acquired from pool and RAS sessionn is attached to connection

Relations (Example)



Building a RAS environment



- Demo Description
  - Employee Oliver Tuvault works in Sales Department and can view:
    - all employees of sales exept salary and commision
    - his own record including salary and commistion
    - his own orders and order items
  - Manager John Russel is manager of Sales
    - can view all employee data and all order data

Step 1: Create RAS Administrator


```
-- e.g. create a database user as RAS administrator
GRANT dba, xs_session_admin TO rasadm
   IDENTIFIED BY rasadm;
```

- Predefined database role XS_SESSION_ADMIN
  - granted to application role XSSESSIONADMIN which has
  - the ADMINISTER_SESSION application privilege of acl SESSIONACL of security class SESSION_SC
  - contains execute on DBMS_XS_SIDP predefined RAS package
- Check via dictionary views DBA_ROLES, DBA_TAB_PRIVS, DBA_XS_ACES, DBA_XS_ACLS, DBA_XS_ROLE_GRANTS

Step 2: Create Database Roles


```
-- e.g. under new RAS administrator
-- DATABASE Role
CREATE ROLE db_rasdemo;
GRANT SELECT, INSERT, UPDATE, DELETE
   ON hr.employees TO db_rasdemo;
GRANT SELECT, INSERT, UPDATE, DELETE
   ON hr.departments TO db_rasdemo;
GRANT SELECT, INSERT, UPDATE, DELETE
   ON oe.orders TO db_rasdemo;
GRANT SELECT, INSERT, UPDATE, DELETE
   ON oe.order_items TO db_rasdemo;
```

- role contains maximum object privileges but is not granted to (database) user(s)
- schema OE has synonyms for HR objects

Step 3: Create Application Roles


```
-- Create an application role sales_emp for employees of sales dep.
exec xs_principal.create_role(name => 'sales_emp', enabled
=> true, description => 'for employees of sales');

-- Create an application role sales_mgr for managers of sales deptartment
exec xs_principal.create_role(name => 'sales_mgr', enabled
=> true, description => 'for managers of sales');

-- grant database role to application roles
GRANT db_rasdemo TO sales_emp;
GRANT db_rasdemo TO sales_mgr;
```

- Check via views DBA_XS_ROLES and DBA_XS_ROLE_GRANTS
- Application roles are not granted to database users

Step 4: Create Application Users


```
-- Create application user OTUVAULT (Oliver Tuvault, sales rep.)
exec xs_principal.create_user(name => 'otuvault',
  schema => 'oe');
exec xs_principal.set_password('otuvault', 'welcome1');
exec xs_principal.grant_roles('otuvault', 'sales_emp');
-- Create application user JRUSSEL (John Russell, sales mgr.)
exec xs_principal.create_user(name => 'jrussel',
   schema => 'oe');
exec xs_principal.set_password('jrussel', 'welcome1');
exec xs_principal.grant_roles('jrussel', 'sales_mgr');
```

- Application user do not own database schemas
- `CURRENT_SCHEMA` set to OE
- Users can „attach“ session or directly connect to database
- If required password profile and start-/enddates can be set

Step 4: Application Users

```
SQL> conn otuvault/welcome1
Connected.
SQL> sho user
USER is "OTUVAULT"
SQL> select user from dual;
USER
------------------------------
XS$NULL
select sys_context('userenv','current_schema') cs
  ,  sys_context('userenv','current_user') cu
  ,  xs_sys_context('xs$session','username') xsu from dual;
CS           CU           XSU
---------- ---------- ----------
OE           XS$NULL    OTUVAULT
select role from session_roles;
ROLE
------
DB_RASDEMO
```

Step 4: Application Users


```
SQL> select 'AppRole' origin, role_name role
from v$xs_session_roles union
select 'DbRole' origin, role from session_roles order by 1;

ORIGIN  ROLE
------- ---------------
AppRole DBMS_AUTH
AppRole DBMS_PASSWD
AppRole SALES_EMP
AppRole XSAUTHENTICATED
AppRole XSPUBLIC
DbRole  DB_RASDEMO
```

Step 5: Create 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$NAME_LIST
        ('"UPDATE"', '"DELETE"', '"INSERT"')));
  xs_security_class.create_security_class(
    name => 'sales_privileges',
    parent_list => xs$name_list('sys.dml'),
    priv_list => pr_list);
END;
```

- Define a set of application privileges for use in ACLs

Step 6: Create ACLs


```
-- create ACLs referring privileges and application roles
DECLARE
  aces xs$ace_list := xs$ace_list();
Begin
  aces.extend(1);
  aces(1) := xs$ace_type(privilege_list =>
xs$name_list('select','VIEW_SENSITIVE_INFO'),
    principal_name => 'sales_emp');
xs_acl.create_acl(name => 'emp_acl'
 , ace_list  => aces
 , sec_class => 'sales_privileges');
END;
```

- Binding SELECT and VIEW_SENSITIVE_INFO application privileges to application role SALES_EMP by means of ACL named EMP_ACL
- ... more ACLs are necessary for our demo ...
- Check via `DBA_XS_ACLS` and `DBA_XS_ACES` views

Step 7: Realms and Data Security Policies


```
declare
  realms   xs$realm_constraint_list := xs$realm_constraint_list();
  cols     xs$column_constraint_list := xs$column_constraint_list();
begin
 realms.extend(1);
 realms(1) := xs$realm_constraint_type(
 realm => 'email = xs_sys_context(''xs$session'',''username'')',
    acl_list => xs$name_list('emp_acl'));

cols.extend(1);
 cols(1) := xs$column_constraint_type(
   column_list => xs$list('salary','commission_pct')
   , privilege   => 'VIEW_SENSITIVE_INFO');

 xs_data_security.create_policy(
   name                   => 'salesemp_ds',
   realm_constraint_list  => realms, column_constraint_list => cols);
end;
```

- Row constraint (data realm) – view only ones own record
- Column constraint – exclude sensitive columns when no privilege granted

Step 7: Using ACL Parameter


```
...
realms(2) := xs$realm_constraint_type(
   realm => 'manager_id = &' || 'MGR');
...
xs_data_security.create_policy( ...
xs_data_security.create_acl_parameter( policy =>
'salesemp_ds', parameter => 'MGR',
    param_type => XS_ACL.TYPE_NUMBER);
...
BEGIN
 sys.xs_acl.add_acl_parameter(acl => 'mgr_acl',
 policy => 'salesemp_ds', parameter => 'MGR',
 value => 145);
END;
```

Step 8: Apply Security Policy

```
begin
  xs_data_security.apply_object_policy(
    policy => 'salesemp_ds',
    schema => 'hr',
    object =>'employees',
    owner_bypass => true);
end;
```

- Bind policy to datbase table or view
- Once applied enabled for ALL accesses except for
  - **`owner_bypass => true`** (default is false(!))
  - system privilege **`EXEMPT ACCESS POLICY`**

Validation

- The complex structure makes it necessary to validate thoroughly
- **`VALIDATE_PRINCIPAL`** Function
- **`VALIDATE_SECURITY_CLASS`** Function
- **`VALIDATE_ACL`** Function
- **`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

Work with RAS

- Direct login with application user
  - password has to be provided, usual syntax
- Attach application user to existing session
  - starting from low privilege user/session

```
EXEC SYS.XS_ADMIN_UTIL.GRANT_SYSTEM_PRIVILEGE(
'ADMINISTER_SESSION','RASDUMMY', XS_ADMIN_UTIL.PTYPE_DB);

-- db user with only create session and administer session privs
connect rasdummy/rasdummy
-- attach
DECLARE
 SESSIONID RAW(16);
 BEGIN
 SYS.DBMS_XS_SESSIONS.CREATE_SESSION('JRUSSEL', sessionid);
 SYS.DBMS_XS_SESSIONS.ATTACH_SESSION(sessionid);
END;
/

select xs_sys_context('XS$SESSION','CURRENT_XS_USER') from dual;
```

Middle Tier

- Mid-Tier connections in dispatcher mode, e.g.
  - Special application user **`dispatcher`** with session and cache privileges
  - dispatcher handles connection (pool) as direct login user (trusted)
  - application user without session and cache privileges
- **`XSSessionManager`** class manages the life cycle of the session.
  - methods to create, attach, assign, detach, and destroy sessions
  - e.g. method **`getSessionManager`** gets an instance of Session M.
- Application Session handling
  - create session (**`XSSessionManager`** method **`createSession`**)
  - attach session (with app user) to traditional db session (method **`attachSession`**)
  - assign application user to attached anonymous (XSGUEST) application session
  - switch security context of current application session for another app.u.

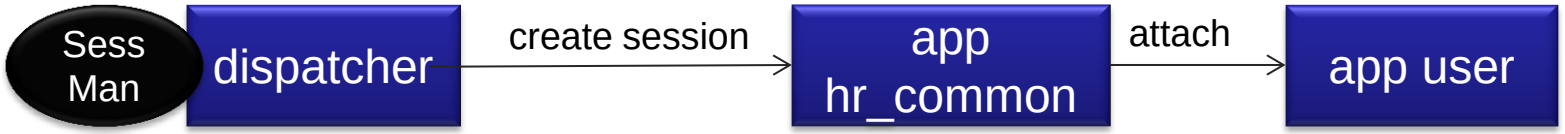
Middle Tier (Code Snippets)


```
// 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");
```

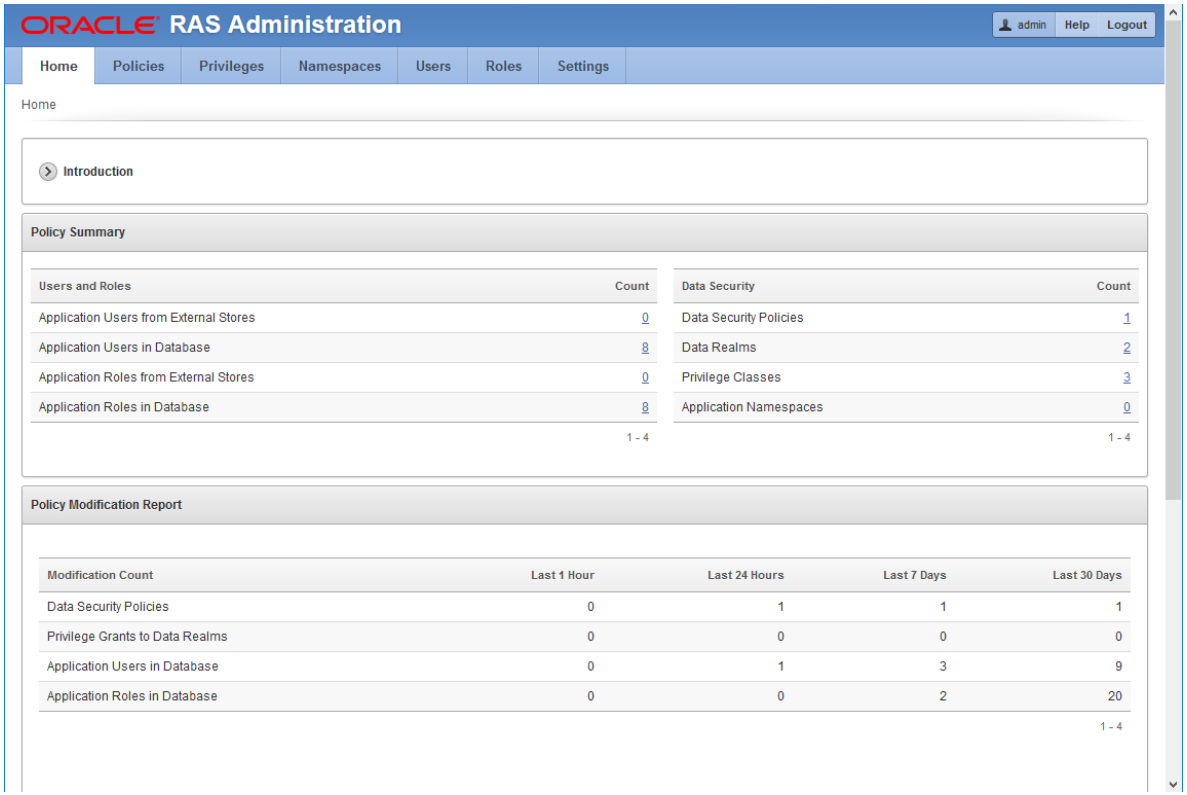
```
private void queryAsUser(String user) throws SQLException ...

Session lws = manager.createSession(appConnection, user, null,null);

manager.attachSession(appConnection, lws, null, null, null, null, null);
```



RAS Admin



- Apex 5.0 Application, free download
- Basic Admin Pages for viewing, adding and deleteing elements

Auditing

- RAS actions audited only by unified audit policies
  - Standard Audit sees only connect under generic XS$NULL, no RAS actions
- Predefined unified audit policies available (COMPONENT=XS)
  - ORA_RAS_POLICY_MGMT
    - administrative actions on application users, roles, and policies
  - ORA_RAS_SESSION_MGMT
    - run-time Oracle Real Application Security session actions and namespace actions
- Particular View fro XS-Actions
  - DBA_XS_AUDIT_POLICY_OPTIONS
  - DBA_XS_ENB_AUDIT_POLICIES – enabled policies
  - DBA_XS_AUDIT_TRAIL – aucit actions

Summary

- Meant for high level applications with (serious) security concerns and manyfold user polulation
- Many options to centralize security policies for applications
- (Very) complex confguration, allow learning curve
- detailed documentation, many examples
  - external user deployment badly documented
  - so far no erxport/import mechanisms
- Partly new technology, just a few if any blogs so far
  - interesting for APEX applications
- No experiences as far as stability in the long run is concerned
- Gather experience in test cases

Thank you for listening

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