WELCOME

Oracle Database 12 New Security Features

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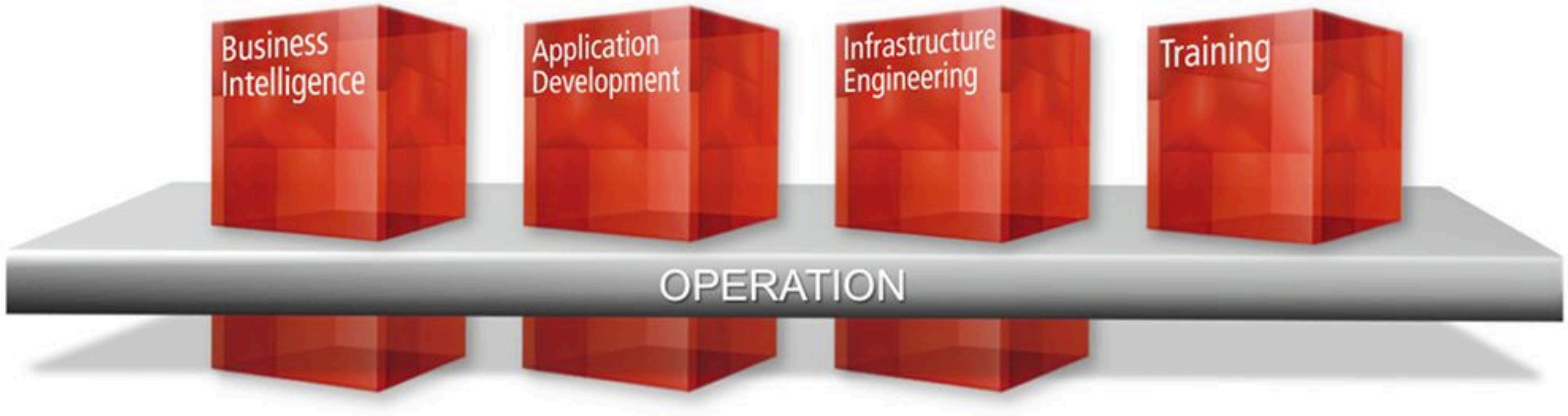

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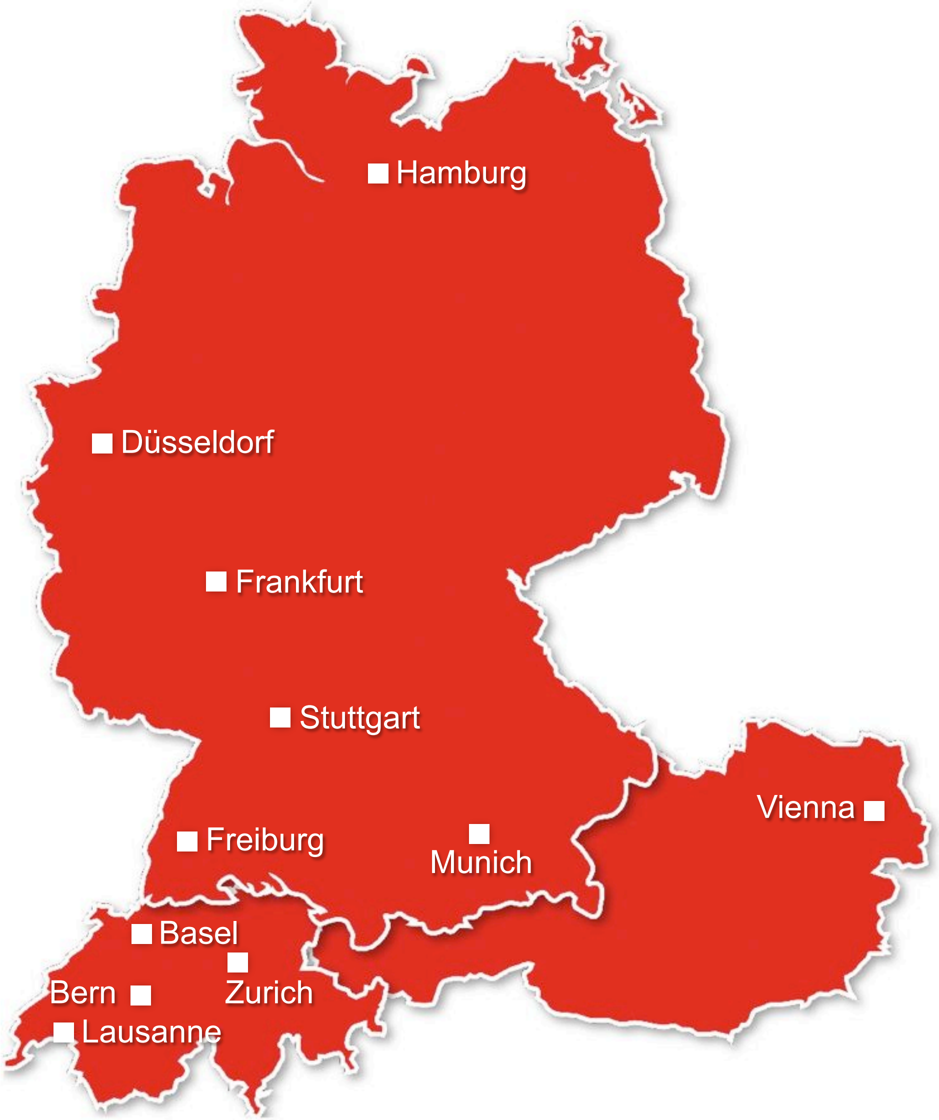

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Agenda

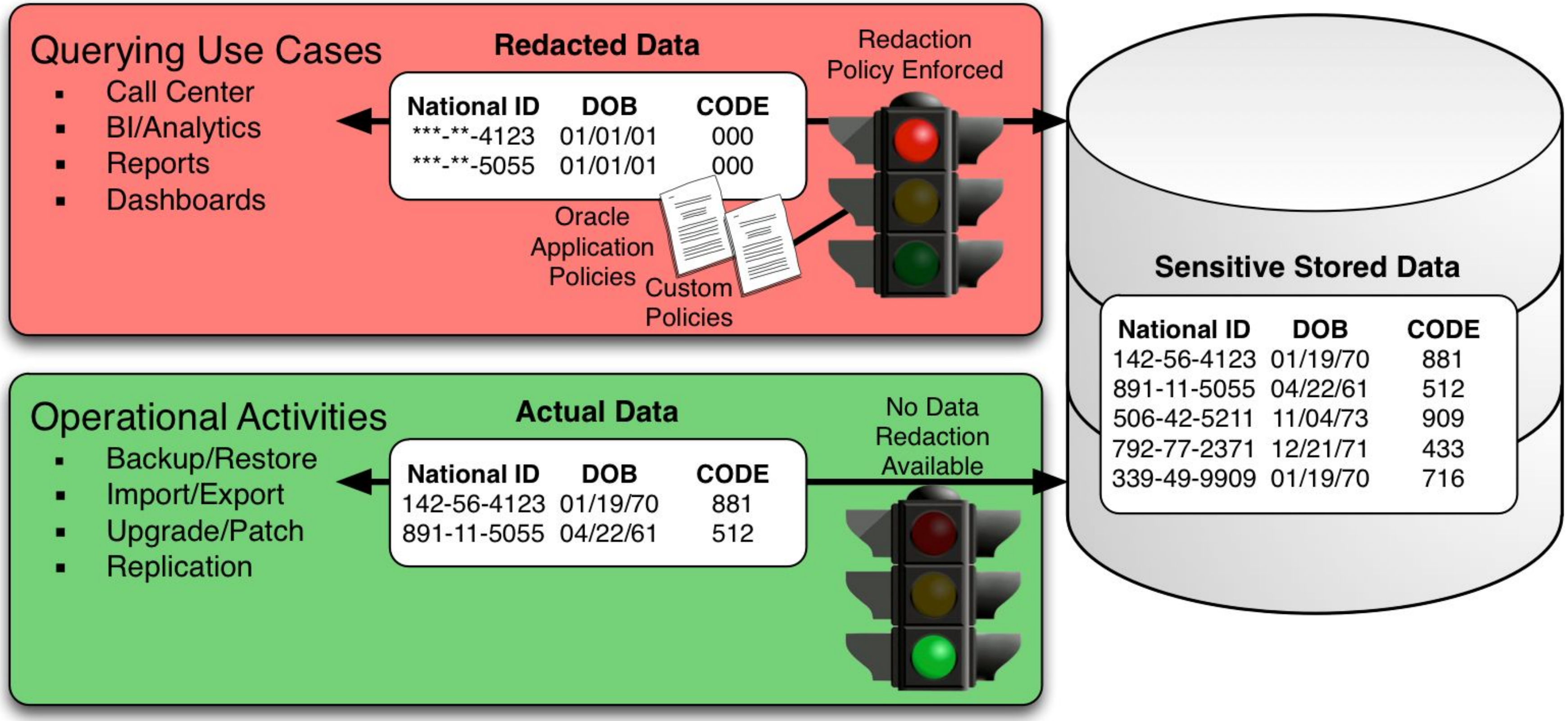
1. Data Redaction
2. Role and Privilege Analysis
3. Unified Auditing
4. Audit Roles and Policies
5. Database Vault
6. Other Enhancements

Data Redaction – The old days

- Traditional masking solutions are targeted for DEV / TEST systems
- So far Oracle does not provide any masking functionality when sensitive data is accessed / displayed
  - credit card number, addresses, social security number
- Any masking functionality must be implemented within the application
  - Partial mask credit card number
- Oracle does address this issue with data redaction (DBMS_REDACT)
- Typical use cases
  - Hide credit card Numbers
  - Partially hide social security numbers

Data Redaction – Overview

Overview



Querying Use Cases

- Call Center
- BI/Analytics
- Reports
- Dashboards

Redacted Data

National ID	DOB	CODE
***-**-4123	01/01/01	000
***-**-5055	01/01/01	000

Redaction Policy Enforced

Oracle Application Policies

Custom Policies

Operational Activities

- Backup/Restore
- Import/Export
- Upgrade/Patch
- Replication

Actual Data

National ID	DOB	CODE
142-56-4123	01/19/70	881
891-11-5055	04/22/61	512

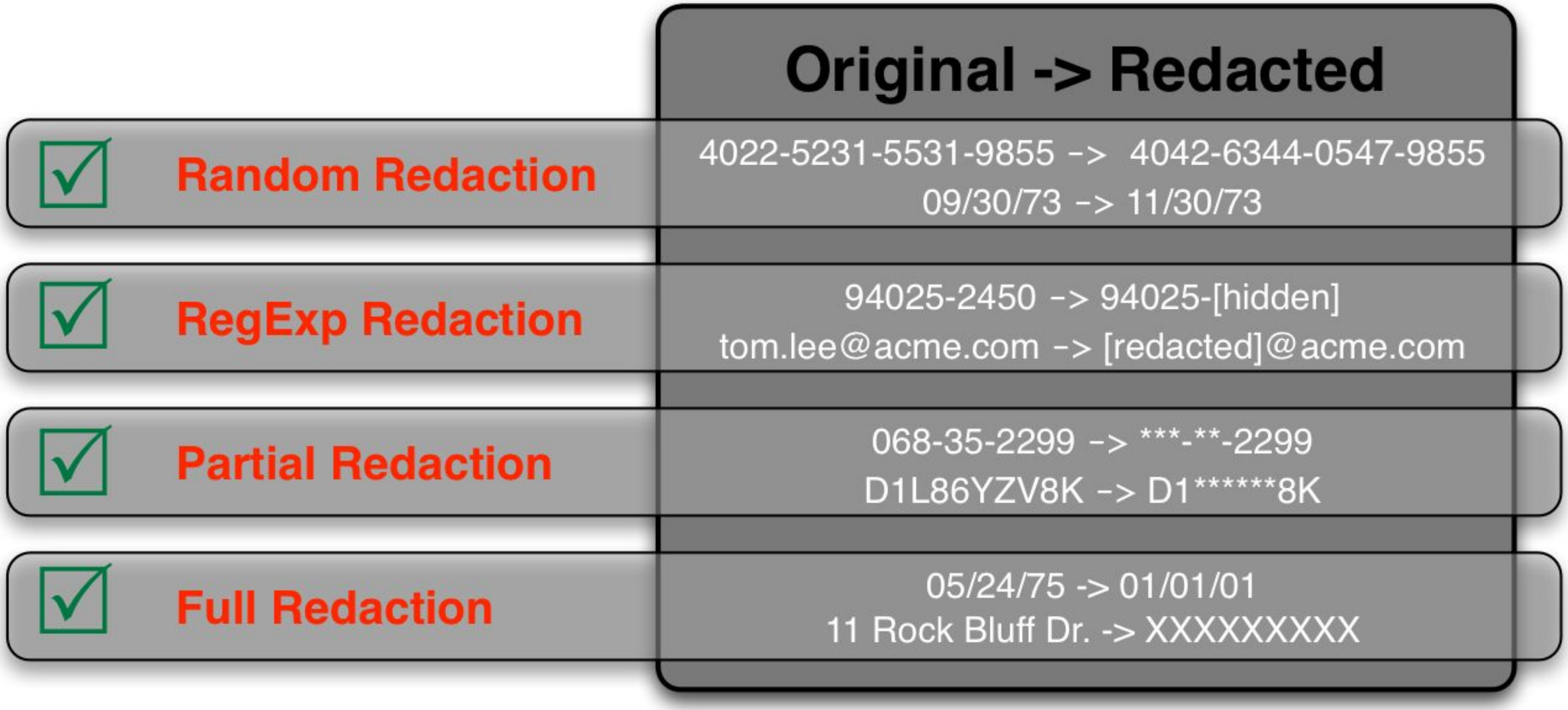
No Data Redaction Available

Sensitive Stored Data

National ID	DOB	CODE
142-56-4123	01/19/70	881
891-11-5055	04/22/61	512
506-42-5211	11/04/73	909
792-77-2371	12/21/71	433
339-49-9909	01/19/70	716

Data Redaction – Features

Feature summary



	Original -> Redacted
☑ Random Redaction	4022-5231-5531-9855 -> 4042-6344-0547-9855 09/30/73 -> 11/30/73
☑ RegExp Redaction	94025-2450 -> 94025-[hidden] tom.lee@acme.com -> [redacted]@acme.com
☑ Partial Redaction	068-35-2299 -> ***-**-2299 D1L86YZV8K -> D1******8K
☑ Full Redaction	05/24/75 -> 01/01/01 11 Rock Bluff Dr. -> XXXXXXXXX

Data Redaction – Example

- Data redact is done based on a condition
  - Using SYS_CONTEXT to get database user/role, IP address, client identifier,...
  - App user/role or other information passed in by the application
  - Supported Functions: SYS_CONTEXT(), V(), NV() or DOMINATES ()
    => *no custom PL/SQL*

```
BEGIN
  DBMS_REDACT.ADD_POLICY(
    object_schema => 'HR',
    object_name   => 'EMPLOYEES',
    column_name   => 'SALARY',
    policy_name   => 'HR_redact_salary',
    function_type => DBMS_REDACT.FULL,
    expression    => 'SYS_CONTEXT(''USERENV'',''SESSION_USER'')!=,''EUGEN''');
END;
/
```

- List of existing redaction policies in REDACTION_POLICIES

Data Redaction – Restrictions

- Create table as select on redacted table does not work

```
create table hr.emp as select first_name,last_name,salary from hr.employees
where department_id=30
                                                   *
ERROR at line 1:
ORA-28081: Insufficient privileges - the command references a redacted
object.
```

- Export of redacted data with Data Pump is limited

```
ORA-31693: Table data object "HR"."EMPLOYEES" failed to load/unload and is
being skipped due to error:
ORA-28081: Insufficient privileges - the command references a redacted
object.
```

- New system privilege are required to bypass redaction policies
  - EXEMPT REDACTION POLICY
  - EXEMPT DML REDACTION POLICY
  - EXEMPT DDL REDACTION POLICY

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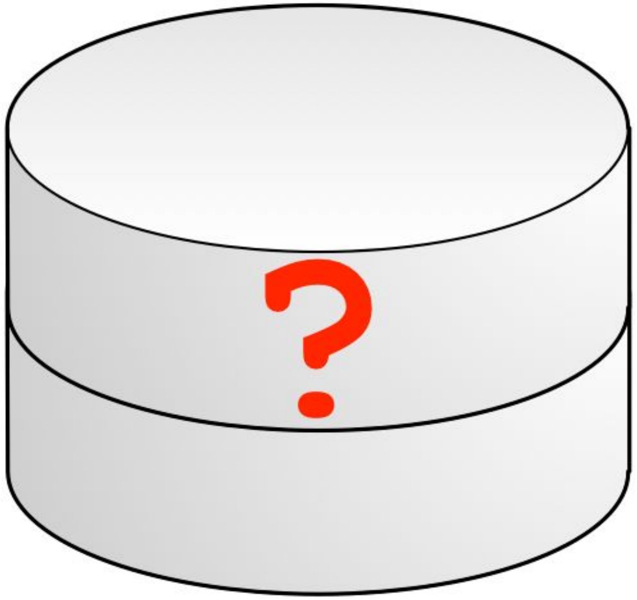
Role and Privilege Analysis – Challenges

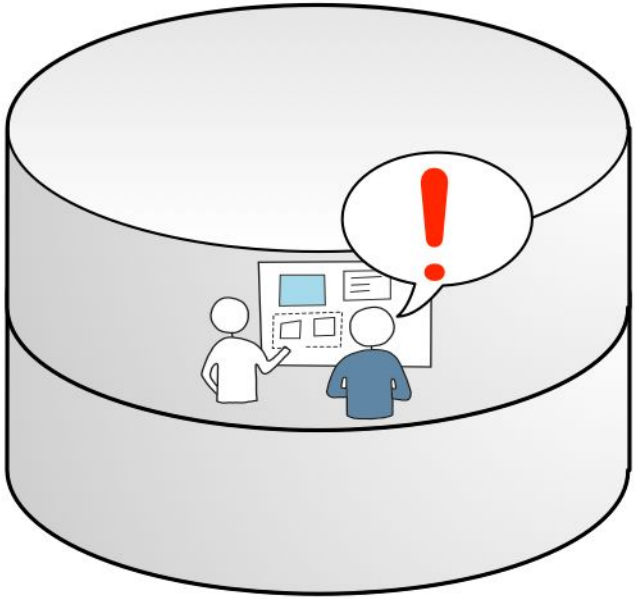
Challenges with database roles and privileges

- Most applications run with high privileges similar to DBA
- Privilege analysis was not performed during the design phase
- Focus was on finalizing the application, rather than on defining a minimum set of privileges eg. Least privileges
- Security simply wasn't a focus for many legacy applications

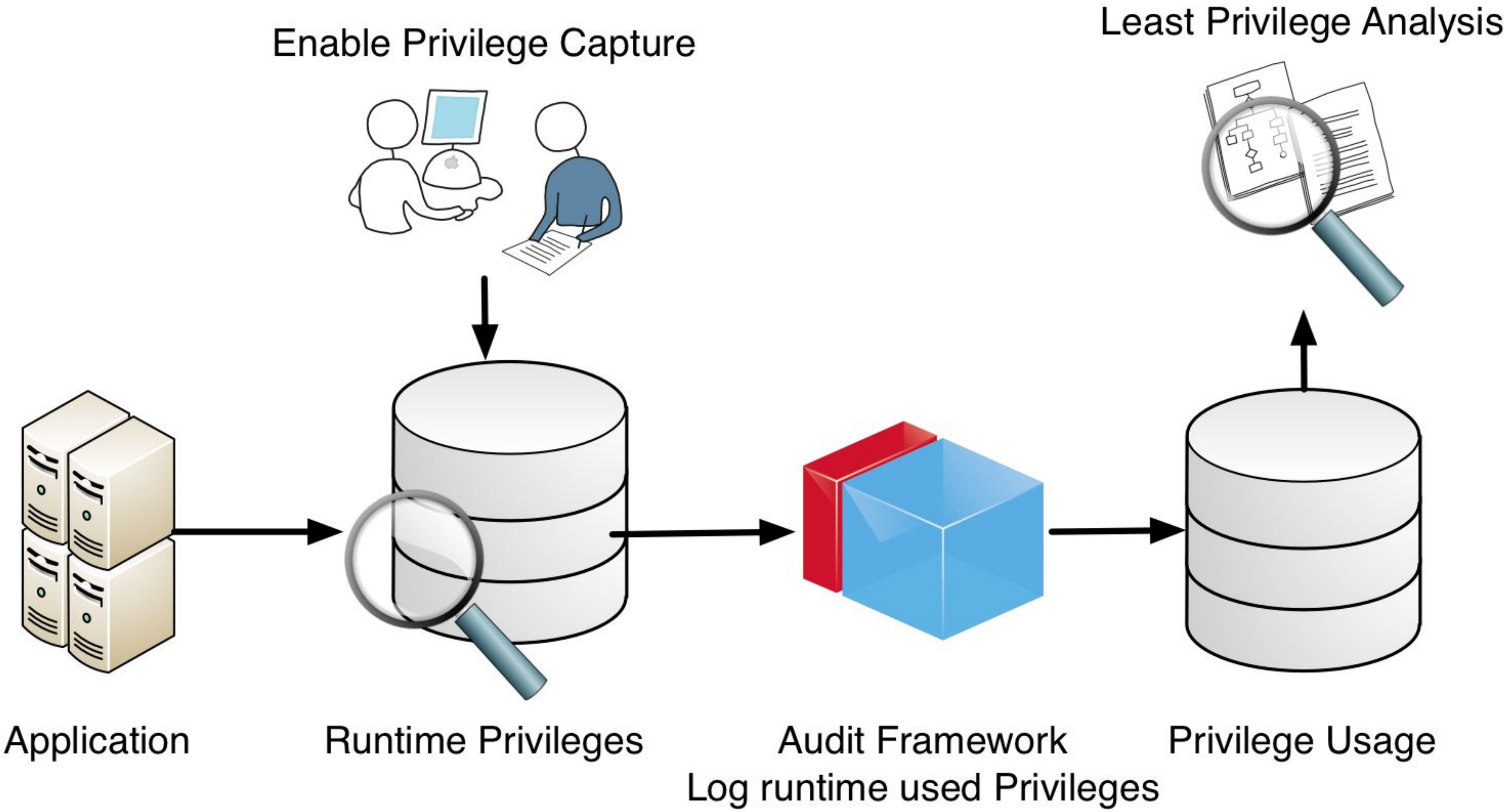


Role and Privilege Analysis – The Solution

- Capture and report on database privilege usage at runtime
  - For users, sessions, roles, PUBLIC
  - Show used system, object, and PUBLIC privileges
  - Show how the user got the privilege
- Show unused privileges:
  - System and object
- Achieve least privilege model
  - Make the database and applications more secure



Role and Privilege Analysis – Architecture



Enable Privilege Capture

Least Privilege Analysis

Application

Runtime Privileges

Audit Framework

Log runtime used Privileges

Privilege Usage

Role and Privilege Analysis - Precondition

- New Role CAPTURE_ADMIN

```
select ROLE,PRIVILEGE,TABLE_NAME from ROLE_TAB_PRIVS
where ROLE='CAPTURE_ADMIN‘;

ROLE              PRIVILEGE   TABLE_NAME
--------------- ---------- -------------------------
CAPTURE_ADMIN   SELECT      DBA_PRIV_CAPTURES
CAPTURE_ADMIN   SELECT      DBA_UNUSED_OBJPRIVS
CAPTURE_ADMIN   SELECT      DBA_UNUSED_OBJPRIVS_PATH
CAPTURE_ADMIN   SELECT      DBA_UNUSED_PRIVS
CAPTURE_ADMIN   SELECT      DBA_UNUSED_SYSPRIVS
CAPTURE_ADMIN   SELECT      DBA_UNUSED_SYSPRIVS_PATH
CAPTURE_ADMIN   SELECT      DBA_UNUSED_USERPRIVS
CAPTURE_ADMIN   SELECT      DBA_UNUSED_USERPRIVS_PATH
CAPTURE_ADMIN   SELECT      DBA_USED_OBJPRIVS
...
CAPTURE_ADMIN   SELECT      DBA_USED_USERPRIVS_PATH
CAPTURE_ADMIN   EXECUTE     DBMS_PRIVILEGE_CAPTURE
```

Role and Privilege Analysis – Initiate capture

- Create the Capture Policy

```
EXEC DBMS_PRIVILEGE_CAPTURE.CREATE_CAPTURE(
NAME      =>'scott_dba_analysis',
TYPE      =>DBMS_PRIVILEGE_CAPTURE.G_CONTEXT,
CONDITION =>'SYS_CONTEXT(''USERENV'',''SESSION_USER'')=''SCOTT''');
```

- Enable the Capture Policy

```
EXEC DBMS_PRIVILEGE_CAPTURE.ENABLE_CAPTURE('scott_dba_analysis');
```

- Run Job, Task etc which has to be analyzed

Role and Privilege Analysis – Analysis capture

- Disable the Capture Policy

```
EXEC DBMS_PRIVILEGE_CAPTURE.DISABLE_CAPTURE('scott_dba_analysis');
```

- Generate Report

```
EXEC DBMS_PRIVILEG_CAPTURE.GENERATE_RESULT('scott_dba_analysis');
```

- Review Views DBA_USED_% and DBA_UNUSED_%

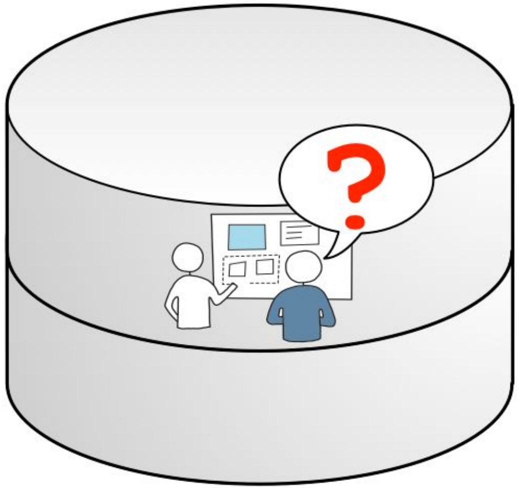
```
select CAPTURE, USERNAME,USED_ROLE,SYS_PRIV,PATH
from DBA_USED_SYSPRIVS_PATH where CAPTURE='scott_dba_analysis';

CAPTURE            USER  USED_ROLE   SYS_PRIV         PATH
------------------ ----  ---------   --------------   ----------------------
scott_dba_analysis SCOTT CONNECT     CREATE SESSION   GRANT_PATH('SCOTT‘,'CONNECT')
scott_dba_analysis SCOTT VERY_SECRET SELECT ANY TABLE GRANT_PATH('SCOTT‘,'SECRET',
                                                                      'VERY_SECRET‘)
```

Role and Privilege Analysis – Solution

Pin down the privileges

- Setup Privilege Analysis to …
  - … Identify unused privileges
  - … Identify the source of the unused privileges
  - … analyze PUBLIC privileges
  - … different use cases eg. report user vs power user
- Application owner can decide whether the unused privileges could be revoked
- Re-test your application



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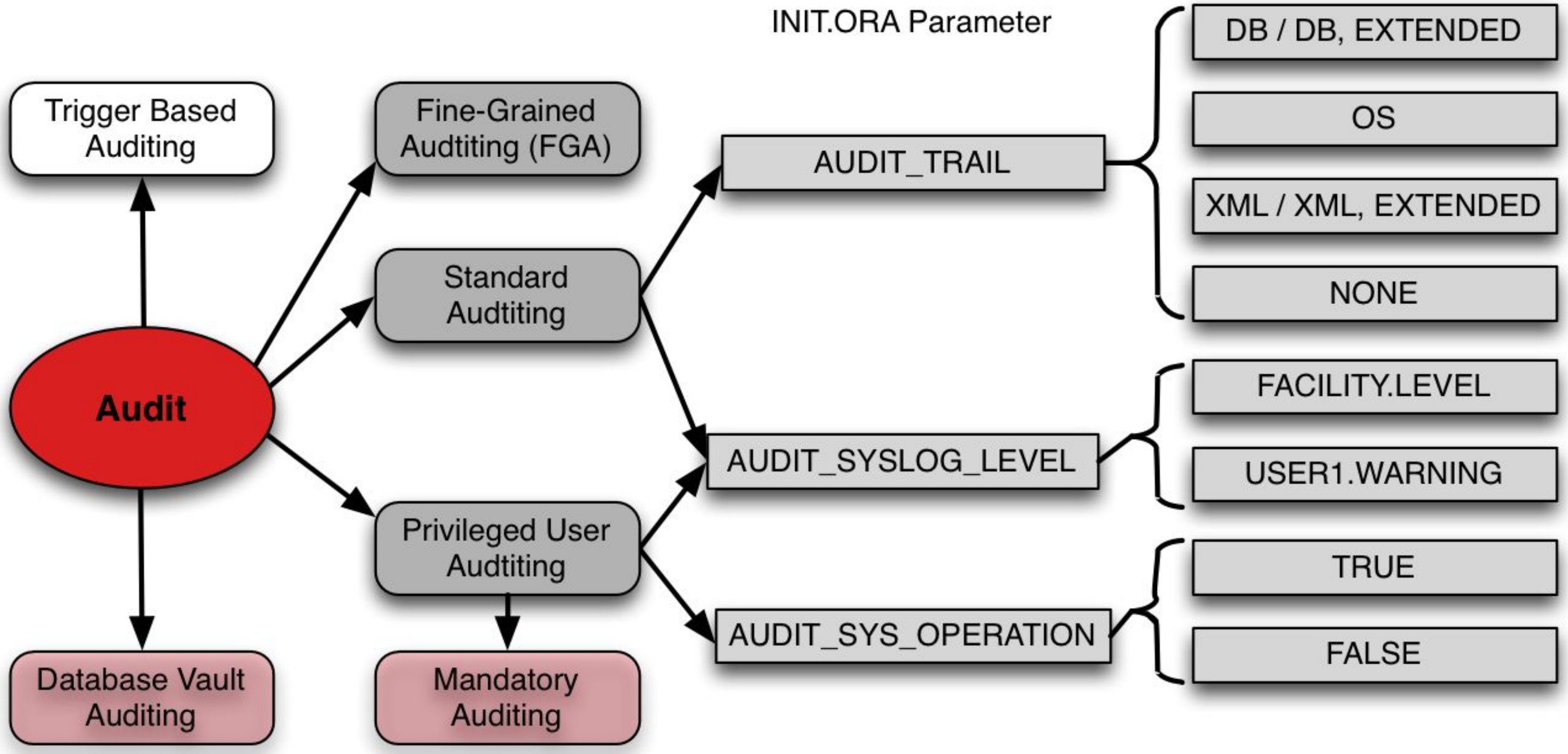
Database Auditing – The challenges

- Defining complex audit scenarios could become quite cumbersome
  - Ending with a lot of `audit xyz` statements
  - Can not easily be switched off/on
  - Having to much audit data
- Performance impact depending on what is audited
  - Audit highly used objects could lead to a lot of audit records / redo
- No strait forward solution to limit access to audit data
- Different data stores of audit information
  - Mandatory Audit
  - SYS Audit
  - Standard database audit
  - Fine grained auditing

Database Auditing – The old days

- Auditing until Oracle 11g R2 (and a little bit beyond)



Database Auditing – The UNIFIED AUDIT

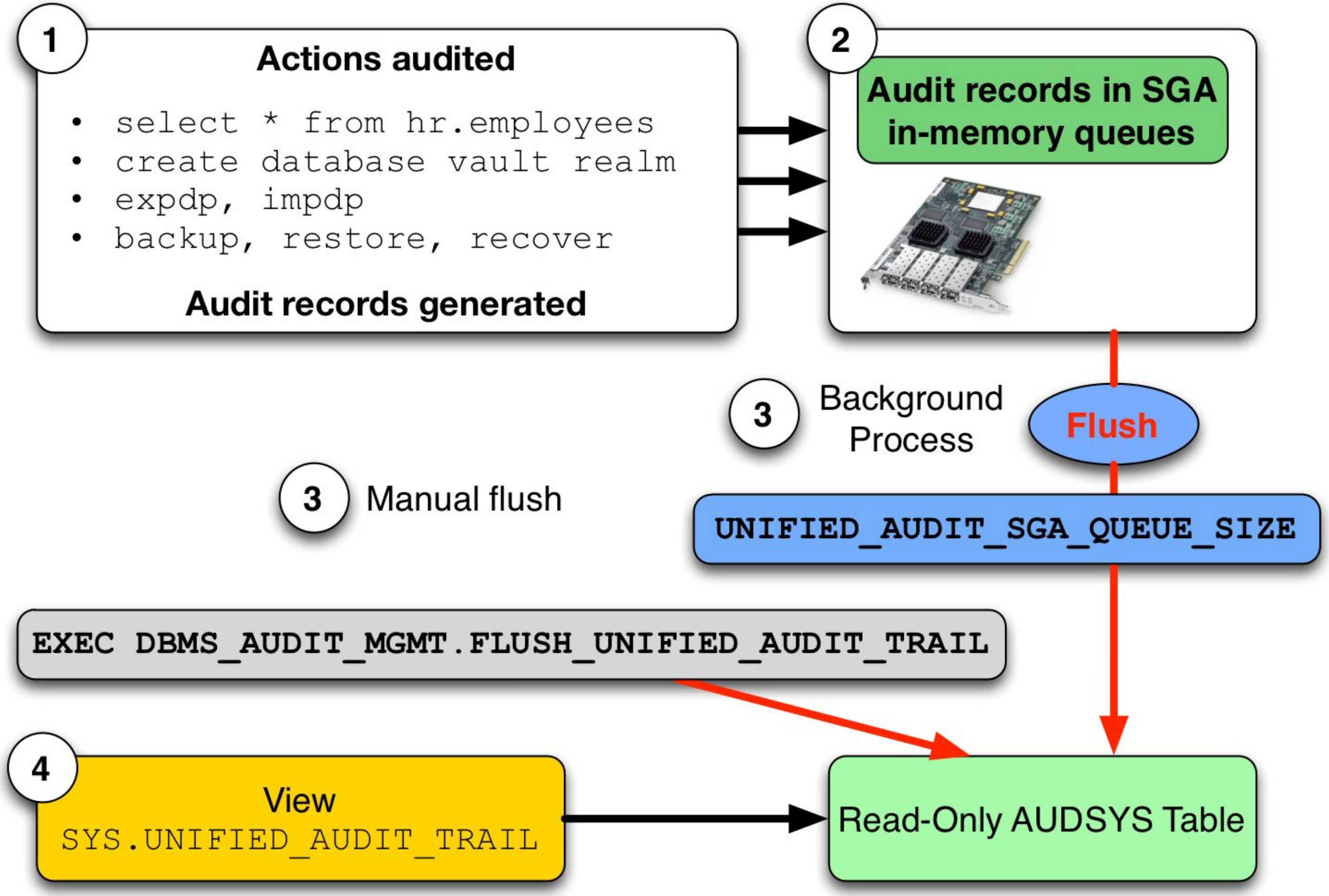
- Oracle introduces the new UNIFIED AUDIT TRAIL
  - All audit data stored in Oracle secure files
  - unified_audit_trail view replaces AUD$, FGA$
  - Security with new AUDITOR and AUDIT_ADMIN accounts
- Always ON Auditing
  - No initialization parameters required to enable auditing
  - No need to bounce the database (ehm. At least once... ☺ to link it)
- Audit the audit configuration by default
  - Records every event that modifies the audit configuration
  - Records every modification to audit trail and its settings

Database Auditing – The UNIFIED AUDIT

- Fast audit engine, easier access control to DB, increased performance
  - Low processing overhead (records are stored in proprietary format)
  - Low transactional overhead (audit records are buffered)
  - Dynamic views to query audit data stored in proprietary format
- Queued Mode
  - Default mode
  - Audit records stored in SGA and periodically flushed
  - Configured with UNIFIED_AUDIT_SGA_QUEUE_SIZE (1MB to 30MB)
- Immediate Mode
  - Audit records written immediately
- Manual flush queue to disk
  - Connect as user with AUDIT_ADMIN role

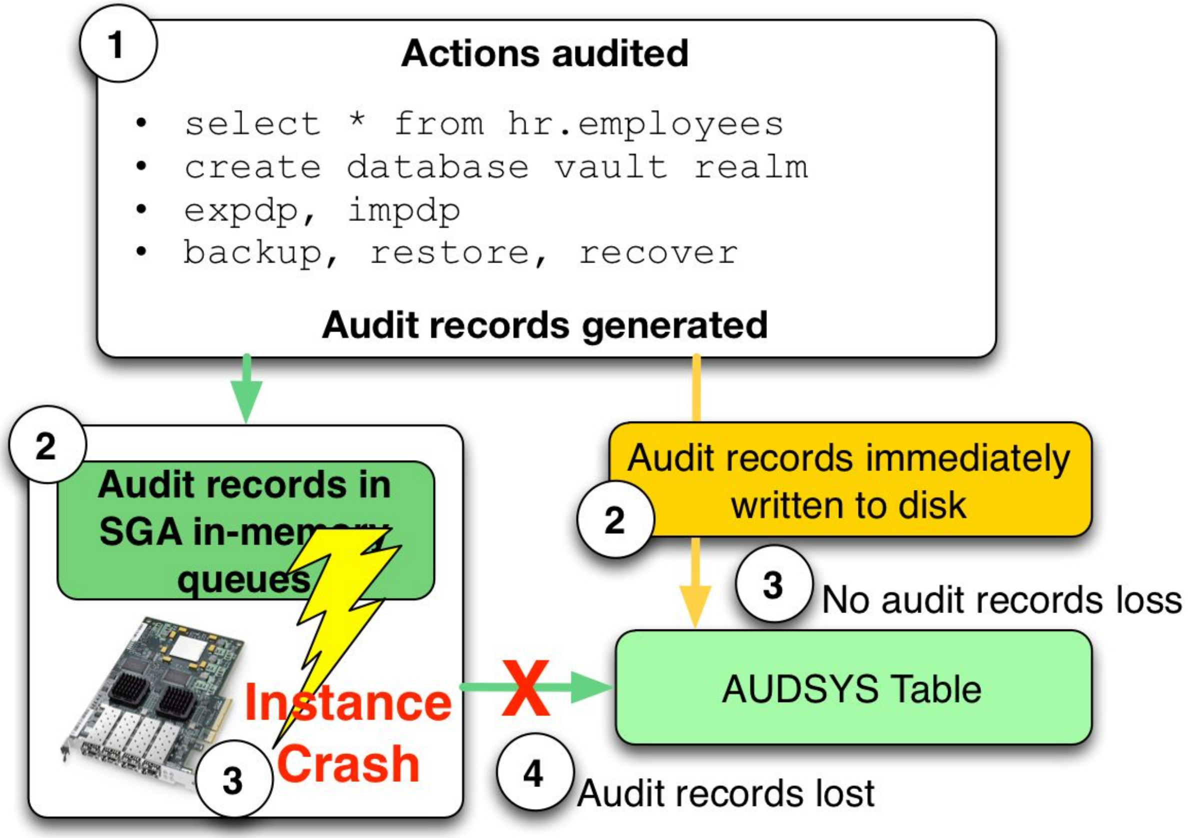
```
EXEC DBMS_AUDIT_MGMT.FLUSH_UNIFIED_AUDIT_TRAIL;
```

Database Auditing – Fast audit engine



1
Actions audited
• select * from hr.employees
• create database vault realm
• expdp, impdp
• backup, restore, recover
Audit records generated
2
Audit records in SGA in-memory queues
3
Background Process
Flush
UNIFIED_AUDIT_SGA_QUEUE_SIZE
3
Manual flush
EXEC DBMS_AUDIT_MGMT.FLUSH_UNIFIED_AUDIT_TRAIL
4
View
SYS.UNIFIED_AUDIT_TRAIL
Read-Only AUDSYS Table

Database Auditing – Ups…



1 **Actions audited**

- `select * from hr.employees`
- `create database vault realm`
- `expdp, impdp`
- `backup, restore, recover`

Audit records generated

2 **Audit records in SGA in-memory queues**

3 **Instance Crash**

X

4 Audit records lost

2 Audit records immediately written to disk

3 No audit records loss

AUDSYS Table

```
DBMS_AUDIT_MGMT.SET_AUDIT_TRAIL_PROPERTY

AUDIT_TRAIL_IMMEDIATE_WRITE
AUDIT_TRAIL_QUEUED_WRITE
```

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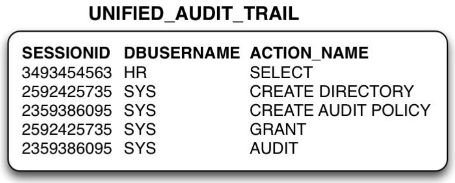
Database Auditing – Audit Roles

- DBA
  - Create tablespace to store the audit table
- AUDIT_ADMIN role to …
  - Manages audit policies eg. define auditing
  - Maintain audit data retention and initiate housekeeping
- AUDIT_VIEWER role to …
  - View and report on audit data
- Best Practice
  - Create dedicated users and grant appropriate roles

```
create audit policy ...;
exec DBMS_FGA ...
exec DBMS_AUDIT_MGMT.MOVE_DBAUDIT_TABLES
exec DBMS_AUDIT_MGMT.INIT_CLEANUP
```



UNIFIED_AUDIT_TRAIL

SESSIONID	DBUSERNAME	ACTION_NAME
3493454563	HR	SELECT
2592425735	SYS	CREATE DIRECTORY
2359386095	SYS	CREATE AUDIT POLICY
2592425735	SYS	GRANT
2359386095	SYS	AUDIT

```
grant audit_admin to AUDITOR_OEHRLI;
grant audit_viewer to AUDITOR_MEIER;
```

Database Auditing – Audit policies

- Audit policies
  - Named containers for audit settings
- Audit policies …
  - … is used to audit ACTIONS, PRIVILEGES, OBJECTS
  - … based on system wide or object-specific audit options
  - … can contain a role
  - … can contain conditions / exceptions
  - … are enabled / disabled with audit and noaudit statement
- Condition limited to Oracle Functions ➔ no custom PL/SQL functions

Database Auditing – Audit policies

- Create audit policy with conditions and exceptions

```
CREATE AUDIT POLICY dba_pol ROLE DBA;

CREATE AUDIT POLICY hr_employees_pol
    PRIVILEGES CREATE TABLE
    ACTIONS UPDATE ON HR.EMPLOYEES
    WHEN 'SYS_CONTEXT(''USERENV'', ''IDENTIFICATION_TYPE'') =
''EXTERNAL''' EVALUATE PER STATEMENT;

AUDIT POLICY hr_employees_pol EXCEPT HR;
```

- Enabled audit policies

```
select * from audit_unified_enabled_policies;

USER_NAME   POLICY_NAME       ENABLED_ SUC FAI
----------- ----------------- -------- --- ---
SCOTT_DBA   ORA_ACCOUNT_MGMT  BY       YES YES
ALL USERS   ORA_SECURECONFIG  BY       YES YES
```

Database Auditing – Default policies

- ORA_SECURECONFIG
  - Audit configuration and trail
  - enabled by default
- ORA_ACCOUNT_MGMT
  - Create user, role and privilege grants
- ORA_DATABASE_PARAMETER
  - Database initialization file (spfile) changes

Database Auditing – More on “unified”

- Unified Auditing does / can as well audit…
  - Fine Grained Audit (FGA)
  - Data Pump
  - Oracle RMAN
  - Oracle Label Security (OLS)
  - Oracle Database Vault (DV)
  - Real Application Security (RAS)
- Component auditing do use dedicated columns
  - RMAN_OPERATION, RMAN_OBJECT_TYPE, RMAN_DEVICE_TYPE
  - DP_TEXT_PARAMETERS1, DP_BOOLEAN_PARAMETERS1
- Can be specified as well in an audit policy

```
CREATE AUDIT POLICY audit_dp
ACTIONS COMPONENT=DATAPUMP ALL;
```

Database Auditing – More on “unified”

- Auditing for Oracle Database Vault (DV)
  - Is defined by the DV Framework
  - DV Configuration changes are tracked by default
  - DV Violations are tracked as defined in DV realms etc.
- RMAN is audited by default and it audit…
  - … successful rman backup’s
  - … successful rman restores
  - … some list and report statements
  - but not everthing…

```
SELECT event_timestamp, dbusername,
  rman_operation, rman_object_type,rman_device_type
  FROM unified_audit_trail WHERE action_name='RMAN ACTION'
  ORDER BY event_timestamp;
```

Database Auditing – What else…

It does get harder to tamper audit

- UNIFIED AUDIT is part of the oracle kernel
  - switch off require relink / restart
  - Using different binaries at runtime eg. for sqlplus lead to errors / ORA-00600
  - Auditing is partially available even if relinked with **uniaud_off**
- Memory could be manipulated before it has been flushed
  - Use immediate mode to minimize the risk
- ORADEBUG itself is audited by default

Database Auditing – What else…

Backward compatibility and Migration

- Traditional and UNIFIED mode (mixed mode)
  - Traditional auditing (Pre 12c) still works in 12c
  - All traditional auditing settings configured in 11g R2 continue to work
- Pure UNIFIED mode
  - Customers should migrate over time to new UNIFIED mode
  - Traditional auditing feature will be disabled in future release
  - Running in pure unified mode ➔ Relink Oracle binary unified flag **uniaud_on**

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Database Vault – Improvements in 12c

- Manageability
  - Streamline controls enforcement via Enterprise Manager 12c (☺☹)
  - One command enablement, no special installation required
- New Mandatory Realms Feature
  - Block all privileges from accessing data – even owner
  - Patching, maintenance, highly sensitive information
- Performance
  - Pushing overhead to near zero
- Installation
  - Installed by default but not configured ➔ Removes reliance on OS for linking
  - Protection is always on no matter where you restore DB backup
- Database Vault is using the UNIFIED AUDIT TRAIL

Database Vault – Configuration

- Create a security admin user as DBA

```
CREATE USER SEC_ADMIN;
GRANT CREATE SESSION TO SEC_ADMIN;
```

- Create an accounts admin

```
CREATE USER ACCTS_ADMIN;
GRANT CREATE SESSION TO ACCTS_ADMIN;
```

- One command to configure as SYS

```
EXEC DVSYS.CONFIGURE_DV(dvowner_uname => 'SEC_ADMIN', dvacctmgr_uname =>
'ACCTS_ADMIN');
```

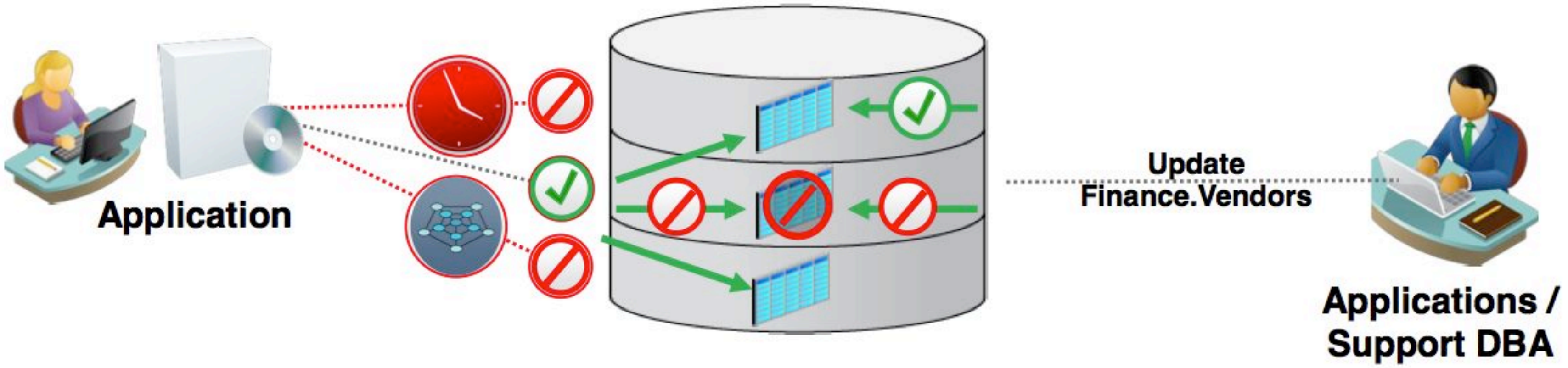
- Then enable as security admin SEC_ADMIN

```
EXEC DVSYS.DBMS_MACADM.ENABLE_DV;
```

- Restart the database as SYSDBA

Database Vault – Realm and Other Enhancements

- Protect highly sensitive information from all users, even table owner
- Enable application DBA to patch application but prevent access to highly sensitive tables
- Block access to sensitive information by support analysts who need temporary access to application schema



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Other Enhancements

- Separation of Duty, reduce dependency on SYSDBA
  - SYSBACKUP → used by RMAN
  - SYSDG → used by DataGuard
  - SYSKM → used for Key Mgmt
- Full Support for SHA-2
  - Stored password verifiers – Oracle Advanced Security – DBMS_CRYPTO
  - Oracle Database 12c Password Authentication
  - By default will only accept SHA-2 verifiers
  - Connections from earlier releases - Set compatibility parameter to earlier release
- Hardware acceleration support extended beyond TDE
  - Now supported for Network Encryption and DBMS_CRYPTO

Other Enhancements

- Sensitive Database Tables
  - The SELECT ANY DICTIONARY privilege no longer permits access to security sensitive data dictionary tables DEFAULT_PWD$, ENC$, LINK$, USER$, USER_HISTORY$, and XS$VERIFIERS.
- UNLIMITED TABLESPACE
  - removed from Resource Role
  - Upgrading to 12c ➔ No change for existing users during upgrade
  - New 12c installations ➔ Grants of resource role in 12c will not give “unlimited”
- Multiple authentication support
  - Database will fall back to password authentication
- Last login time
  - Displayed on SQL*Plus login & recorded in dictionary

Other Enhancements

- Access control mechanism based on application code
  - Restricts exercise of privileges within specific code units
  - Minimizes privileges granted to runtime user
- Runtime privilege elevation in PL/SQL program units – Allows owner’s roles to be granted to his program units
  - Functions, procedures and packages
  - Invoker rights and definer rights
  - Granted roles enabled during execution of the code
- New Kerberos stack
  - Replaced old Kerberos implementation

Conclusion:

So many security improvements as long gone

Interesting improvements to make existing feature more reliable, faster, easier

Oracle Security is on track

Privilege Analysis a a simple but useful features ☺

There will be more…

Technology on its own won't help you.
You need to know how to use it properly.
Trivadis makes IT easier.

THANK YOU.

Trivadis AG

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