DATABASE AUDITING: Oracle 8i/9i

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Agenda

- Intro to Auditing
- Auditing Feature Overview
- Audit Tables/Views
- How to Start and Stop Auditing
- Types of Auditing
- Other Auditing Methods
- Fine Grain Auditing
- Auditing Guidelines
- Questions

Introduction To Auditing

Define Auditing

- **au·dit***
  Pronunciation: 'o-d&t Function: *noun*
  1 a : a formal examination of an organization's or individual's accounts or financial situation **b :** the final report of an audit
  2 : a methodical examination and review
- **audit trail ***
  Function: *noun*
  Date: 1954
  : a record of a sequence of events (as actions performed by a computer) from which a history may be reconstructed
- Tracking and monitoring of selected database activity.

* From Merriam-Webster's Collegiate Dictionary

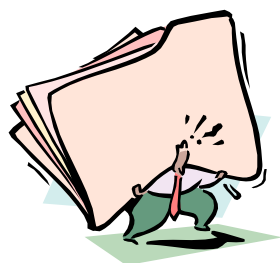
Why Audit?

- Company policies on auditing and logging information
- Log access to sensitive information
- Investigate suspicious or malicious activity
- Track schema changes

Auditing Feature Overview

Auditing Features

- Auditing Levels
  - Session auditing
  - Privilege auditing
  - Statement auditing
  - Object auditing



Auditing Features (contd.)

- Auditing Modifiers
  - When Success/When Failure
  - All users or selected users
  - All objects or selected objects
  - By session or by access
- Audit Trail Storage
  - Database
  - OS

Other Auditing Features

- Auto Auditing or Admin Auditing
  - Admin audit log
  - Alert Log
- Auditing via database triggers
- Redo logs and Archive logs

Things to Remember

- Audit records are generated during the EXECUTION phase of the statement execution.
- Audit record generation is done via autonomous transaction feature, thus independent of user's transaction
- No audit records are generated for sessions connected as SYSDBA or CONNECT INTERNAL

Audit Tables/Views

Auditing Tables and Views

- Audit trail table
  - SYS.AUD$
  - Owner: SYS Tablespace: SYSTEM
  - Move it or not to move it: That's the question?

- Audit Options views
  - ALL_DEF_AUDIT_OPTS
  - DBA_PRIV_AUDIT_OPTS
  - DBA_STMT_AUDIT_OPTS
  - DBA_OBJ_AUDIT_OPTS/USER_OBJ_AUDIT_OPTS

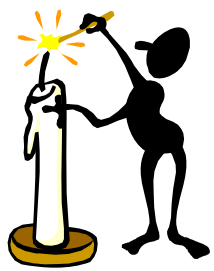
Audit Tables and Views(contd.)

- Audit Trail views
  - DBA_AUDIT_TRAIL/USER_AUDIT_TRAIL
  - DBA_AUDIT_SESSION/USER_AUDIT_SESSION
  - DBA_AUDIT_OBJECT/USER_AUDIT_OBJECT
  - DBA_AUDIT_STATEMENT/USER_AUDIT_STATEMENT
  - DBA_AUDIT_EXISTS
- Audit Code Lookup Views
  - AUDIT_ACTIONS
  - STMT_AUDIT_OPTION_MAP
  - SYSTEM_PRIVILEGE_MAP

How to Start and Stop Auditing

How to Start Auditing

1. Enable auditing feature (Turn on the master switch)
   - Init.ora parameter AUDIT_TRAIL=DB|OS
   - Bounce the database
2. Setup auditing options
   - AUDIT SQL statement



How to Stop Auditing

- Unset auditing options
  - NOAUDIT SQL statement
  - Note: NOAUDIT stmt syntax must match the AUDIT stmt syntax
- Disable Auditing feature (Turn off the master switch)
  - Init.ora parameter AUDIT_TRAIL=NONE
  - Bounce the database

Types of Auditing

Session Auditing

- Provides login and logout auditing
- Can audit login success or failure or both
- Some session stats are also recorded with logout information
- Must have AUDIT SYSTEM privilege

Session Auditing Example

- **AUDIT SESSION** [WHENEVER SUCCESSFUL | WHENEVER NOT SUCCESSFUL]

- **SELECT os_username, username, timestamp, logoff_time, action_name, returncode, logoff_lread, logoff_pread FROM dba_audit_session**

```
OS_USERNM USERNAME TIMESTAMP           LOGOFF_TIME         ACT_NM  RT_CD  LRD  PRD
--------- -------- ------------------- ------------------- ------- ----- ----- ---
AK837609  SYSTEM   01/09/2002 12:46:01 01/09/2002 12:53:16 LOGOFF      0  542   0
AK837609  SYS      01/09/2002 12:53:16                    LOGON    1017
AK837609  SYSTEM   01/09/2002 12:53:20                    LOGON       0
```

Privilege Auditing

- Provides auditing of system privilege uses
  - delete any table, alter table, create table, public synonym
- Audit record generated whenever an audited system privilege is used by the user.
- Audit option becomes active for subsequent connections
- Must have AUDIT SYSTEM privilege
- **Note: Object privileges are checked before system privileges.**
  - Delete priv. on a table takes precedence over DELETE ANY TABLE priv.

Privilege Auditing Example

- audit create table by akapur by access;

- **SELECT user_name, privilege, success, failure**
  FROM dba_priv_audit_opts;

```
USER_NAME  PRIVILEGE            SUCCESS    FAILURE
---------- -------------------- ---------- ----------
           CREATE SESSION       BY ACCESS  BY ACCESS
AKAPUR     CREATE TABLE         BY ACCESS  BY ACCESS
```

- **SELECT username,owner,obj_name,action_name,priv_used,timestamp**
  FROM dba_audit_object;

```
USERNAME  OWNER   OBJ_NAME  ACTION_NAME     PRIV_USED       TIMESTAMP
--------- ------- --------- --------------- --------------- -------------------
AKAPUR    AKAPUR  TEST      CREATE TABLE    CREATE TABLE    01/09/2002 13:43:12
SYSTEM    SYS     AUD$      TRUNCATE TABLE  DROP ANY TABLE  01/04/2002 14:43:28
```

Statement Auditing

- Provides DDL and DML statement auditing
  - table, index, procedure, profile, sequence, role,…
  - NOT EXISTS: audits all SQL stmts that fail due to “object does not exist” error.
- Can audit either success or failure and by session or by access
- Audit option becomes active for subsequent connections
- Must have AUDIT SYSTEM privilege

Statement auditing Example

- AUDIT index BY ACCESS WHENEVER SUCCESSFUL
- **SELECT user_name,audit_option,success,failure**
  FROM dba_stmt_audit_opts

```
USER_NAME  AUDIT_OPTION    SUCCESS    FAILURE
---------- --------------- ---------- ----------
           NOT EXISTS      BY ACCESS  BY ACCESS
           INDEX           BY ACCESS  NOT SET
AKAPUR     CREATE TABLE    BY ACCESS  BY ACCESS
```

- **SELECT username,owner,obj_name,action_name,priv_used,timestamp**
  FROM dba_audit_object

```
USERNAME  OWNER   OBJ_NAME   ACTION_NAME     PRIV_USED        TIMESTAMP
--------- ------- ---------- --------------- ---------------- -------------------
SYSTEM    AKAPUR  TEST_IDX1  CREATE INDEX    CREATE ANY INDEX 01/09/2002 14:17:59
AKAPUR    AKAPUR  TEST       CREATE TABLE    CREATE TABLE     01/09/2002 13:43:12
SYSTEM    SYS     AUD$       TRUNCATE TABLE  DROP ANY TABLE   01/04/2002 14:43:28
```

Object Auditing

- Provides capability to audit specific objects
  - AUDIT DELETE ON hr.dept
- Object must be in user's schema or user must have AUDIT ANY privilege
- Can audit tables, indexes, sequences, procedures and packages.
  - Note: Can not audit individual procedures within packages
- Audit changes for objects become effective immediately!

Object Auditing Example

- audit alter, grant on default by access whenever successful;

- **SELECT alt, gra FROM all_def_audit_opts**

```
ALT     GRA
------- -------
A/-     A/-
```

- **SELECT username,owner,obj_name,action_name,obj_privilege, grantee,timestamp FROM dba_audit_statement;**

```
USERNA OWNER  OBJ_NAME     ACTION_NAME  OBJ_PRIVILEGE    GRANTEE TIMESTAMP
------ ------ ------------ ------------ ---------------- ------- -----------------
AKAPUR AKAPUR TEST_DEFAULT GRANT OBJECT ---------Y------ SYSTEM 01/09/2002 8:00:45
```

- OBJ_PRIV flag values are Y/N for alter, audit, comment, delete, grant, index, lock, rename, select, update, references and execute. Last three are reserved.

Object Auditing Example (contd.)

- audit alter, delete, update on akapur.test by access;

- **SELECT owner,object_name,object_type,alt,del,upd**
  FROM dba_obj_audit_opts WHERE object_name='TEST'

```
OWNER      OBJECT_NAM OBJECT_TY ALT     DEL     UPD
---------- ---------- --------- ------- ------- -------
AKAPUR     TEST       TABLE     A/A     A/A     A/A
```

- **SELECT username,owner,obj_name,action_name,priv_used,timestamp**
  FROM dba_audit_object;

```
USERNAME OWNER   OBJ_NAME ACTION_NAME  PRIV_USED TIMESTAMP
-------- ------- -------- ------------ --------- ------------------
AKAPUR   AKAPUR  TEST     ALTER TABLE            01/09/2002 16:25:29
```

Other Auditing Methods

Auto Auditing

- Database startups, database shutdowns and administrator logins (as sysdba) are ALWAYS logged in OS audit logs.
  - For WINNT: System Event log
  - For Unix: $ORACLE_HOME/rdbms/audit
- Certain admin actions logged in ALERT LOG.
  - Create database, create controlfile, create tablespace,…
- NOTE: This auditing is independent of AUDIT_TRAIL init.ora parameter setting

Detailed Auditing via Triggers

- Database triggers can be used to augment auditing
- Triggers can be used to get column change information
- Triggers are more resource intensive than auditing but can provide more detailed auditing information
- Use AFTER triggers for auditing

Auditing using Redo/Arch Logs

- Since Redo/Arch logs contain detailed DML/DDL activity, Log Miner maybe used to either investigate foul play or to reverse an inadvertent action.
- Can also use Log Miner on a regular basis to monitor and log certain activity.
    - Why do it if Audit option is already available?
        - To log column value changes!

Fine-Grain Auditing

Fine-Grain Auditing

- Fine grain auditing (FGA) has been introduced in Oracle 9i.
- Built on Fine Grain Access control.
- Added FGA$ and FGA_LOG$ tables.
- Added several DBA_FGA% and USER_FGA% views.
- FGA allows auditing of SELECT statements.
- For example, audit SELECT on Salary column of EMP table for all users that do not have HR role

Fine-Grain Auditing (contd.)

- Administer FGA using DBMS_FGA package
  - DBMS_FGA.ADD_POLICY
  - DBMS_FGA.DROP_POLICY
  - DBMS_FGA.DISABLE_POLICY
  - DBMS_FGA.ENABLE_POLICY
- FGA ONLY works with cost based optimizer.
- ALWAYS ANALYZE the table being audited!!
- Auditing decision made during FETCH phase.

Fine Grain Auditing Example

- Audit SALARY column of EMP table for records where SALARY > 10000
  - **EXEC DBMS_FGA.ADD_POLICY(OBJECT_SCHEMA=> 'SYSTEM', -**
    OBJECT_NAME=> 'EMP', POLICY_NAME=> 'VIEW_SAL', -
    AUDIT_CONDITION => 'salary > 10000 ', AUDIT_COLUMN =>
    'SALARY');

- **select * from emp;**
- **select timestamp, db_user, object_schema, sql_text**
  from dba_fga_audit_Trail;
- TIMESTAMP DB_USER OBJECT_SCH SQL_TEXT

```
------------------- ---------- ----------   -----------------
02/12/2002 12:57:51 SYSTEM     SYSTEM       select * from emp
```

- **select * from emp where salary < 500;**
  - NOTE: No audit record generated.

Auditing Guidelines

Auditing Guidelines

- Always protect the audit table
- Audit with specific goal in mind.
- Try and not use AUDIT ALL!
- Trim the audit trail periodically. Instead of just deleting records, may want to archive them. (Copy records to another table and then export that table)

Protect Audit Trail

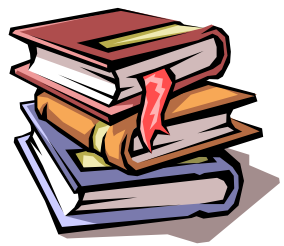
- Audit the audit trail table!
  - AUDIT UPDATE, DELETE ON SYS.AUD$ BY ACCESS
  - AUDIT DROP ANY TABLE BY ACCESS
- A non-privileged session that has delete access on AUD$ will not be able to delete these audit records.
- Keep SYSDBA, DROP ANY TABLE, DELETE on AUD$, UPDATE on AUD$ under strict control

What If…

- Audit table is full?
  - Users will not be able to logon if auditing sessions
  - Users will get warnings for each auditable action
- Move AUD$ to another TS?
  - This action is not supported by Oracle
  - Move it back before database upgrades and possibly patches

References

- Oracle 8i Concepts Manual
- Oracle 8i Administration Guide
- Oracle 9i Concepts Manual
- Oracle 9i Administration Guide
- Metalink Notes: 72460.1, 1019377.6, 1025314.6, 103964.1, 1068714.6



Questions?

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