11

Applications for Triggers

Objectives

After completing this lesson, you should be able to do the following:

- Create additional database triggers
- Explain the rules governing triggers
- Implement triggers

Creating Database Triggers

- Triggering a user event:
  - `CREATE`, `ALTER`, or `DROP`
  - Logging on or off
- Triggering database or system event:
  - Shutting down or starting up the database
  - A specific error (or any error) being raised

Creating Triggers on DDL Statements

Syntax:

```
CREATE [OR REPLACE] TRIGGER trigger_name
Timing
[ddl_event1 [OR ddl_event2 OR ...]]
ON {DATABASE|SCHEMA}
trigger_body
```

Creating Triggers on System Events

Syntax:

```
CREATE [OR REPLACE] TRIGGER trigger_name
timing
[database_event1 [OR database_event2 OR ...]]
ON {DATABASE|SCHEMA}
trigger_body
```

LOGON and LOGOFF Triggers: Example

```
CREATE OR REPLACE TRIGGER logon_trig
AFTER LOGON  ON  SCHEMA
BEGIN
 INSERT INTO log_trig_table(user_id,log_date,action)
 VALUES (USER, SYSDATE, 'Logging on');
END;
/
```

```
CREATE OR REPLACE TRIGGER logoff_trig
BEFORE LOGOFF  ON  SCHEMA
BEGIN
 INSERT INTO log_trig_table(user_id,log_date,action)
 VALUES (USER, SYSDATE, 'Logging off');
END;
/
```

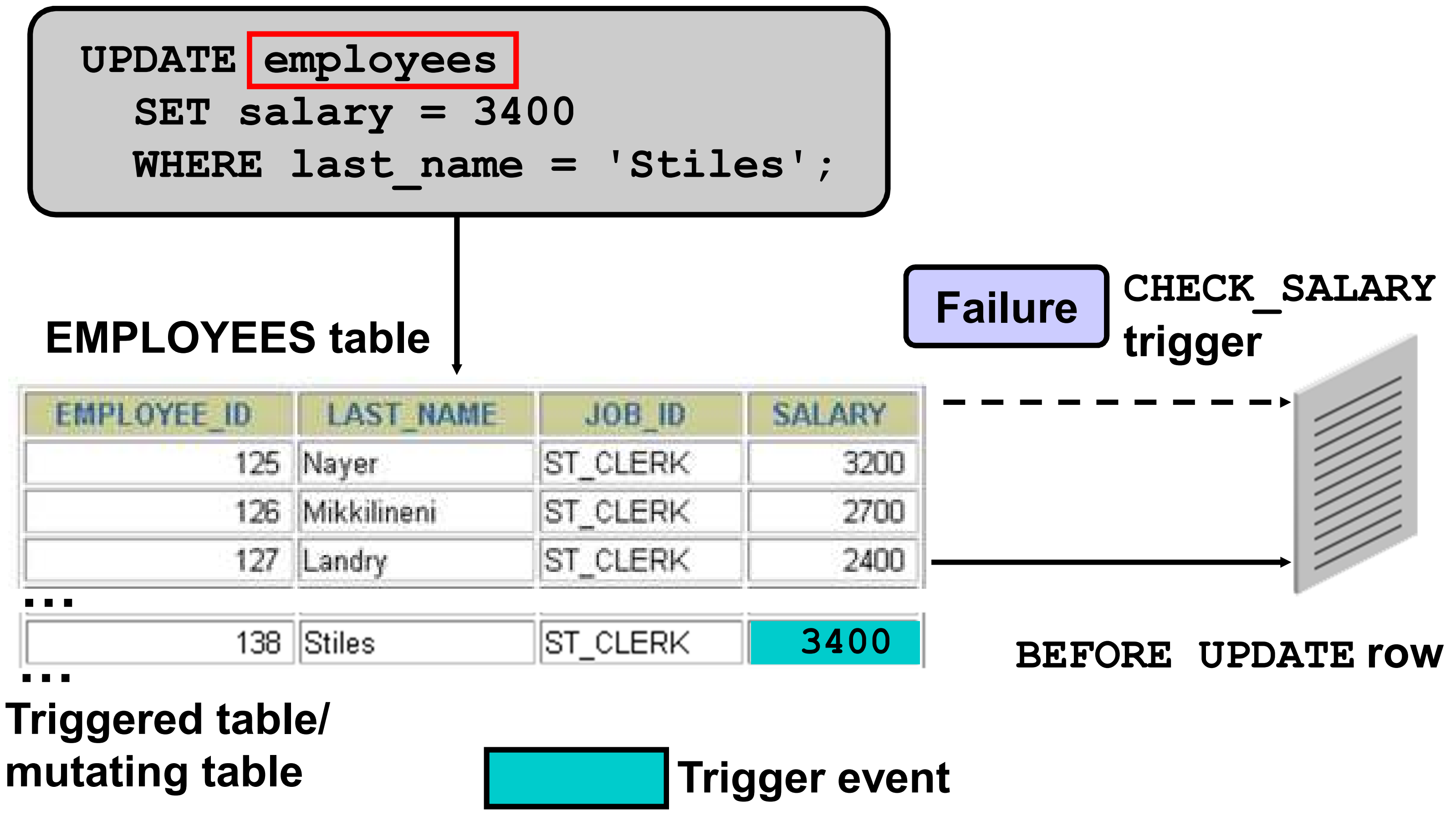
CALL Statements

```
CREATE [OR REPLACE] TRIGGER trigger_name
timing
event1 [OR event2 OR event3]
ON table_name
[REFERENCING OLD AS old | NEW AS new]
[FOR EACH ROW]
[WHEN condition]
CALL procedure_name
/
```

```
CREATE OR REPLACE TRIGGER log_employee
BEFORE INSERT ON EMPLOYEES
CALL log_execution
/
```

Note: There is no semicolon at the end of the `CALL` statement.

Reading Data from a Mutating Table



```
UPDATE employees
   SET salary = 3400
   WHERE last_name = 'Stiles';
```

EMPLOYEES table

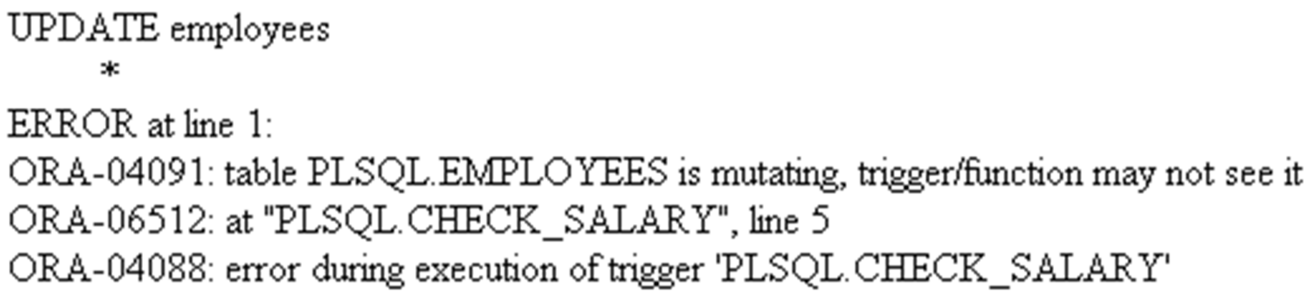
EMPLOYEE_ID	LAST_NAME	JOB_ID	SALARY
125	Nayer	ST_CLERK	3200
126	Mikkilineni	ST_CLERK	2700
127	Landry	ST_CLERK	2400
...			
138	Stiles	ST_CLERK	3400
...			

Mutating Table: Example

```
CREATE OR REPLACE TRIGGER check_salary
  BEFORE INSERT OR UPDATE OF salary, job_id
  ON employees
  FOR EACH ROW
  WHEN (NEW.job_id <> 'AD_PRES')
DECLARE
  minsalary employees.salary%TYPE;
  maxsalary employees.salary%TYPE;
BEGIN
  SELECT MIN(salary), MAX(salary)
   INTO  minsalary, maxsalary
   FROM  employees
   WHERE job_id = :NEW.job_id;
  IF :NEW.salary < minsalary OR
     :NEW.salary > maxsalary THEN
     RAISE_APPLICATION_ERROR(-20505,'Out of range');
  END IF;
END;
/
```

Mutating Table: Example

```
UPDATE employees
 SET salary = 3400
 WHERE last_name = 'Stiles';
```



```
UPDATE employees
     *
ERROR at line 1:
ORA-04091: table PLSQL.EMPLOYEES is mutating, trigger/function may not see it
ORA-06512: at "PLSQL.CHECK_SALARY", line 5
ORA-04088: error during execution of trigger 'PLSQL.CHECK_SALARY'
```

Benefits of Database Triggers

- Improved data security:
  - Provide enhanced and complex security checks
  - Provide enhanced and complex auditing
- Improved data integrity:
  - Enforce dynamic data integrity constraints
  - Enforce complex referential integrity constraints
  - Ensure that related operations are performed together implicitly

Managing Triggers

The following system privileges are required to manage triggers:

- `CREATE/ALTER/DROP (ANY) TRIGGER` privilege: enables you to create a trigger in any schema
- `ADMINISTER DATABASE TRIGGER` privilege: enables you to create a trigger on `DATABASE`
- `EXECUTE` privilege (if your trigger refers to any objects that are not in your schema)

Note: Statements in the trigger body use the privileges of the trigger owner, not the privileges of the user executing the operation that fires the trigger.

Business Application Scenarios for Implementing Triggers

You can use triggers for:

- Security
- Auditing
- Data integrity
- Referential integrity
- Table replication
- Computing derived data automatically
- Event logging

Note: Appendix C covers each of these examples in more detail.

Viewing Trigger Information

You can view the following trigger information:

- `USER_OBJECTS` data dictionary view: object information
- `USER_TRIGGERS` data dictionary view: text of the trigger
- `USER_ERRORS` data dictionary view: PL/SQL syntax errors (compilation errors) of the trigger

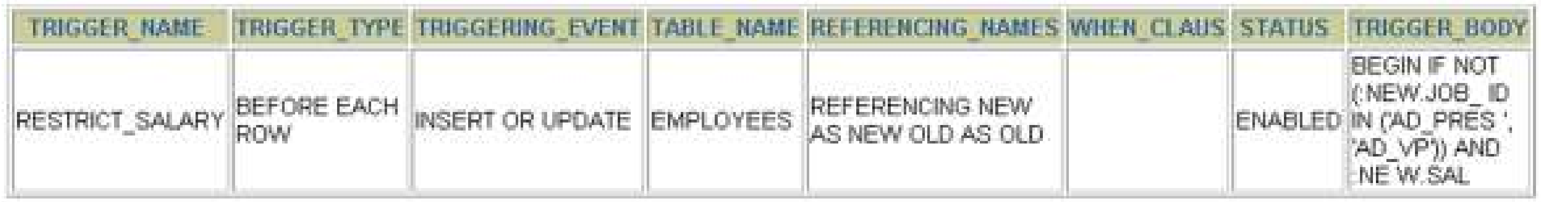
Using USER_TRIGGERS

Column	Column Description
TRIGGER_NAME	Name of the trigger
TRIGGER_TYPE	The type is BEFORE, AFTER, INSTEAD OF
TRIGGERING_EVENT	The DML operation firing the trigger
TABLE_NAME	Name of the database table
REFERENCING_NAMES	Name used for :OLD and :NEW
WHEN_CLAUSE	The when_clause used
STATUS	The status of the trigger
TRIGGER_BODY	The action to take

* Abridged column list

Listing the Code of Triggers

```
SELECT trigger_name, trigger_type, triggering_event,
         table_name, referencing_names,
         status, trigger_body
FROM   user_triggers
WHERE  trigger_name = 'RESTRICT_SALARY';
```



TRIGGER_NAME	TRIGGER_TYPE	TRIGGERING_EVENT	TABLE_NAME	REFERENCING_NAMES	WHEN_CLAUS	STATUS	TRIGGER_BODY
RESTRICT_SALARY	BEFORE EACH ROW	INSERT OR UPDATE	EMPLOYEES	REFERENCING NEW AS NEW OLD AS OLD		ENABLED	BEGIN IF NOT (:NEW.JOB_ ID IN ('AD_PRES ', 'AD_VP')) AND :NE W.SAL

Summary

In this lesson, you should have learned how to:

- Use advanced database triggers
- List mutating and constraining rules for triggers
- Describe the real-world application of triggers
- Manage triggers
- View trigger information

Practice 11: Overview

This practice covers the following topics:

- Creating advanced triggers to manage data integrity rules
- Creating triggers that cause a mutating table exception
- Creating triggers that use package state to solve the mutating table problem