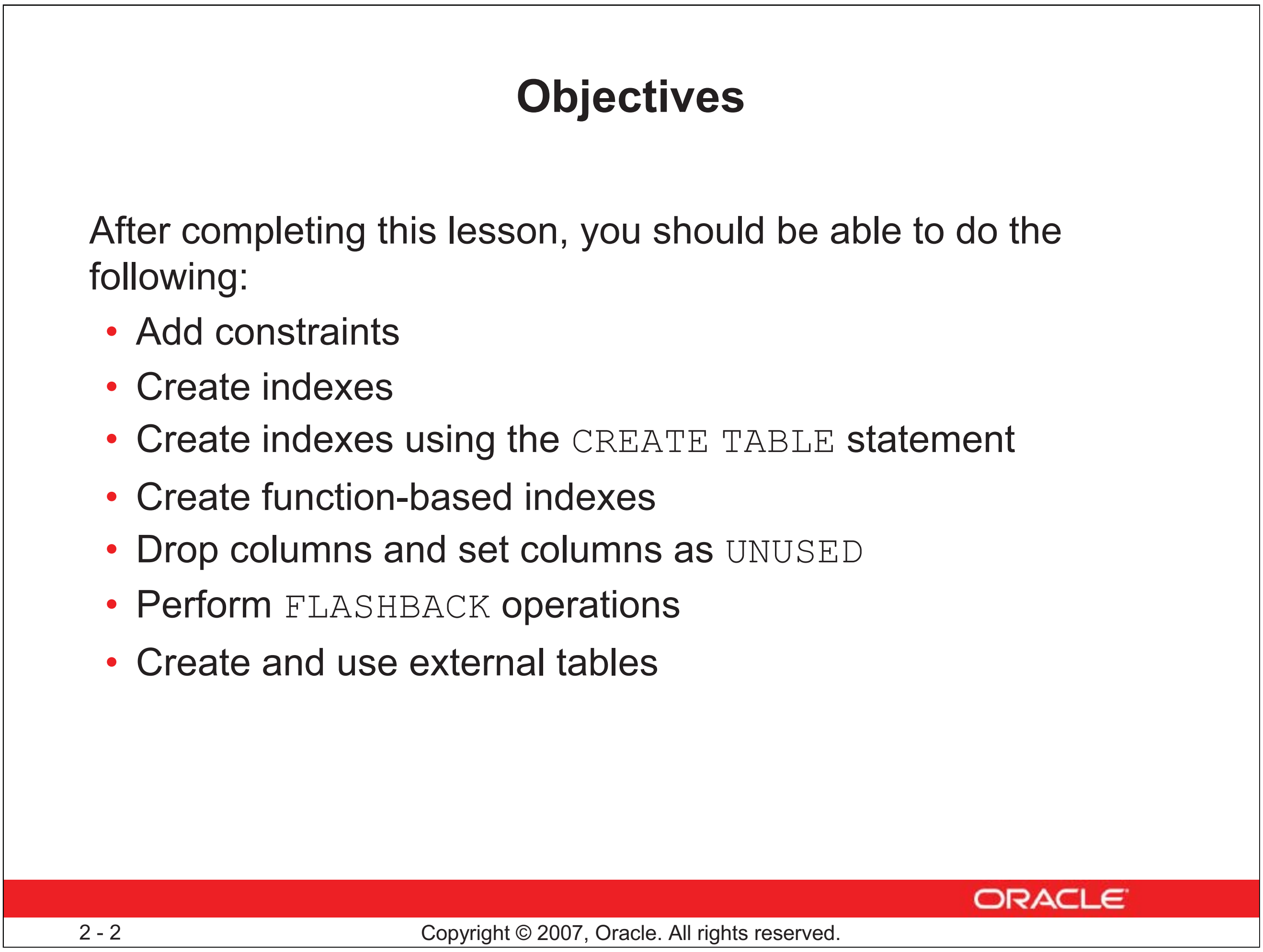
2

Managing Schema Objects



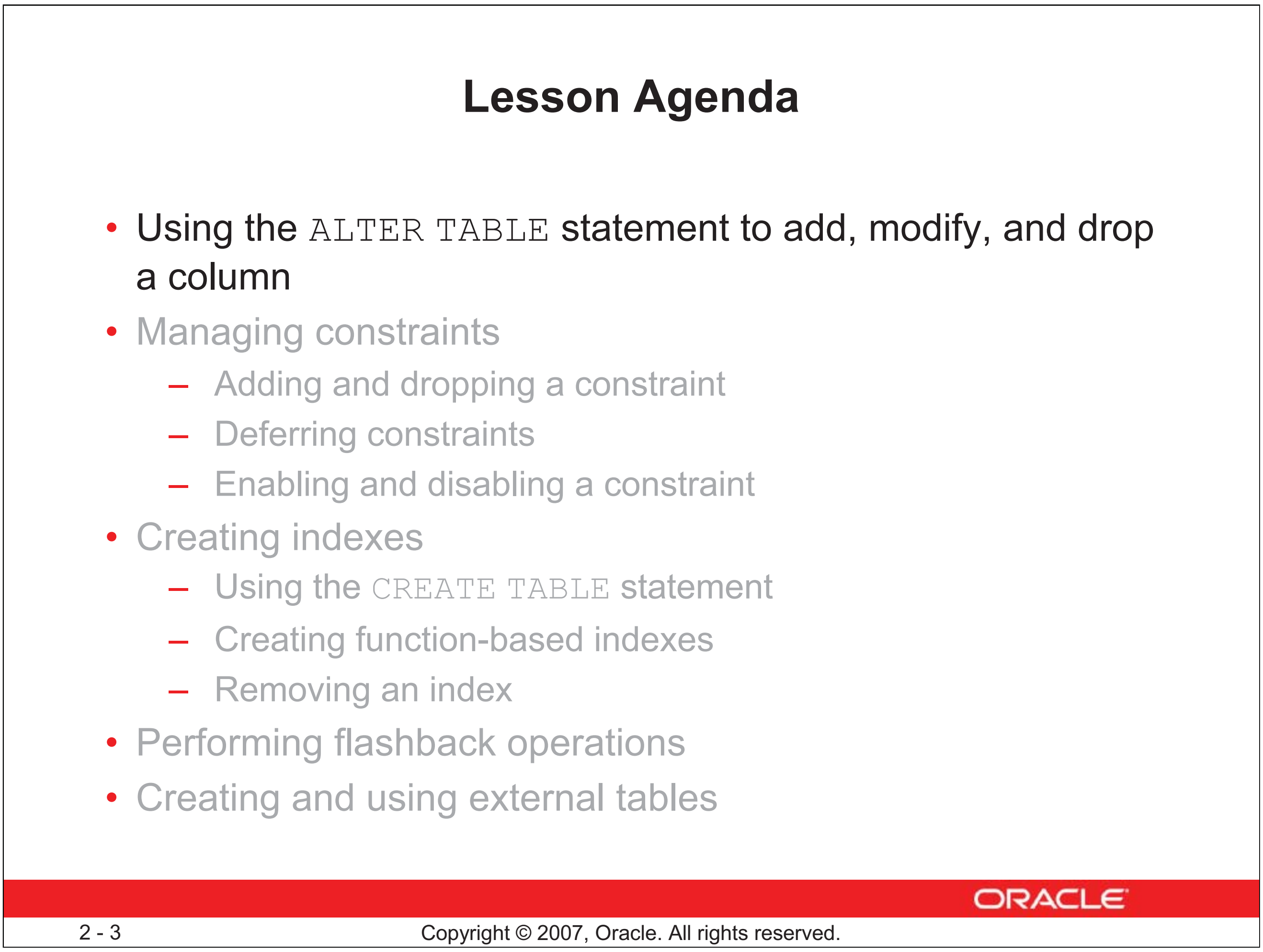
Objectives

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

- Add constraints
- Create indexes
- Create indexes using the `CREATE TABLE` statement
- Create function-based indexes
- Drop columns and set columns as `UNUSED`
- Perform `FLASHBACK` operations
- Create and use external tables

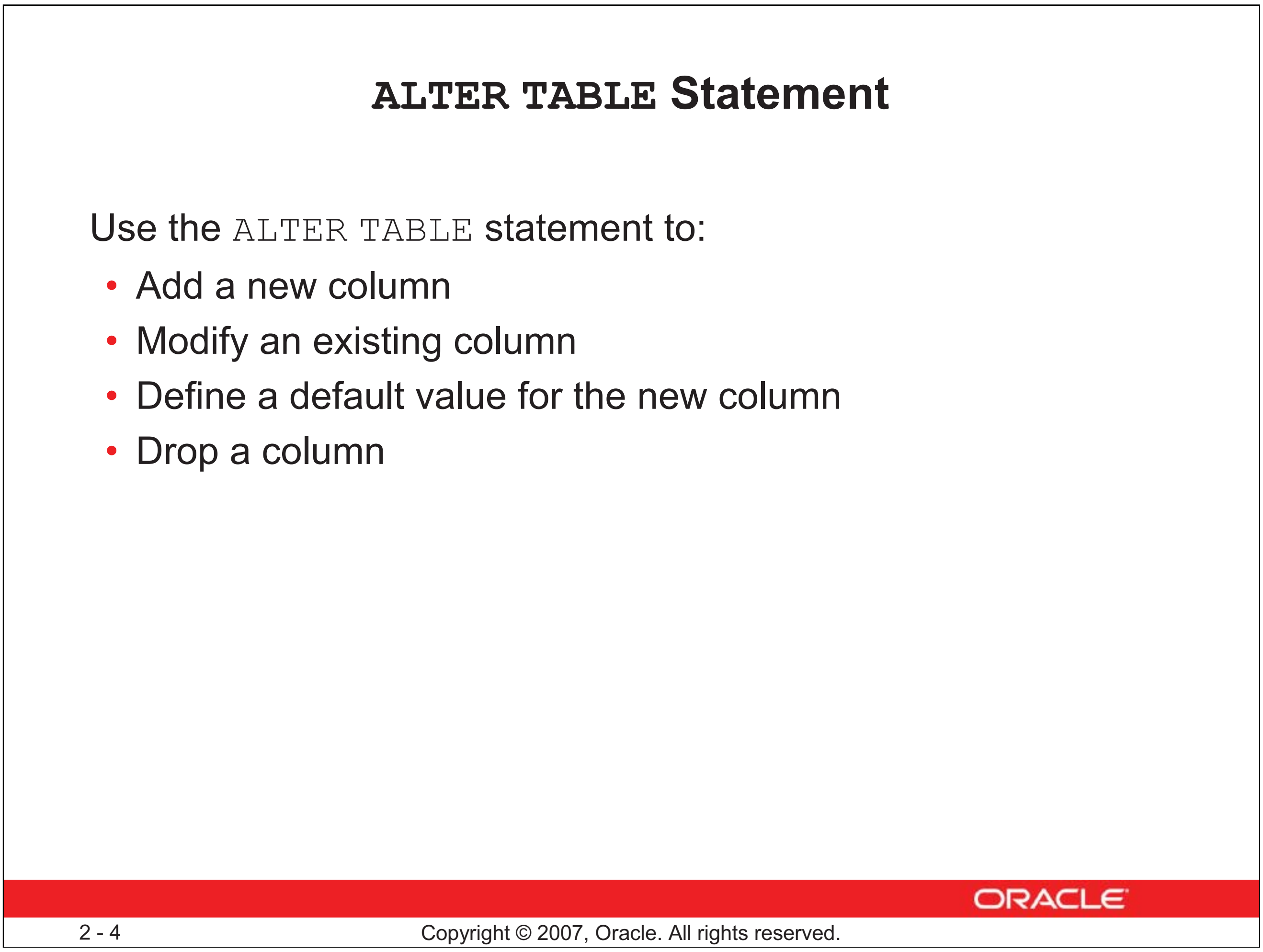
Objectives

This lesson contains information about creating indexes and constraints, and altering existing objects. You also learn about external tables, and the provision to name the index at the time of creating a primary key constraint.



Lesson Agenda

- Using the `ALTER TABLE` statement to add, modify, and drop a column
- Managing constraints
  - Adding and dropping a constraint
  - Deferring constraints
  - Enabling and disabling a constraint
- Creating indexes
  - Using the `CREATE TABLE` statement
  - Creating function-based indexes
  - Removing an index
- Performing flashback operations
- Creating and using external tables



ALTER TABLE Statement

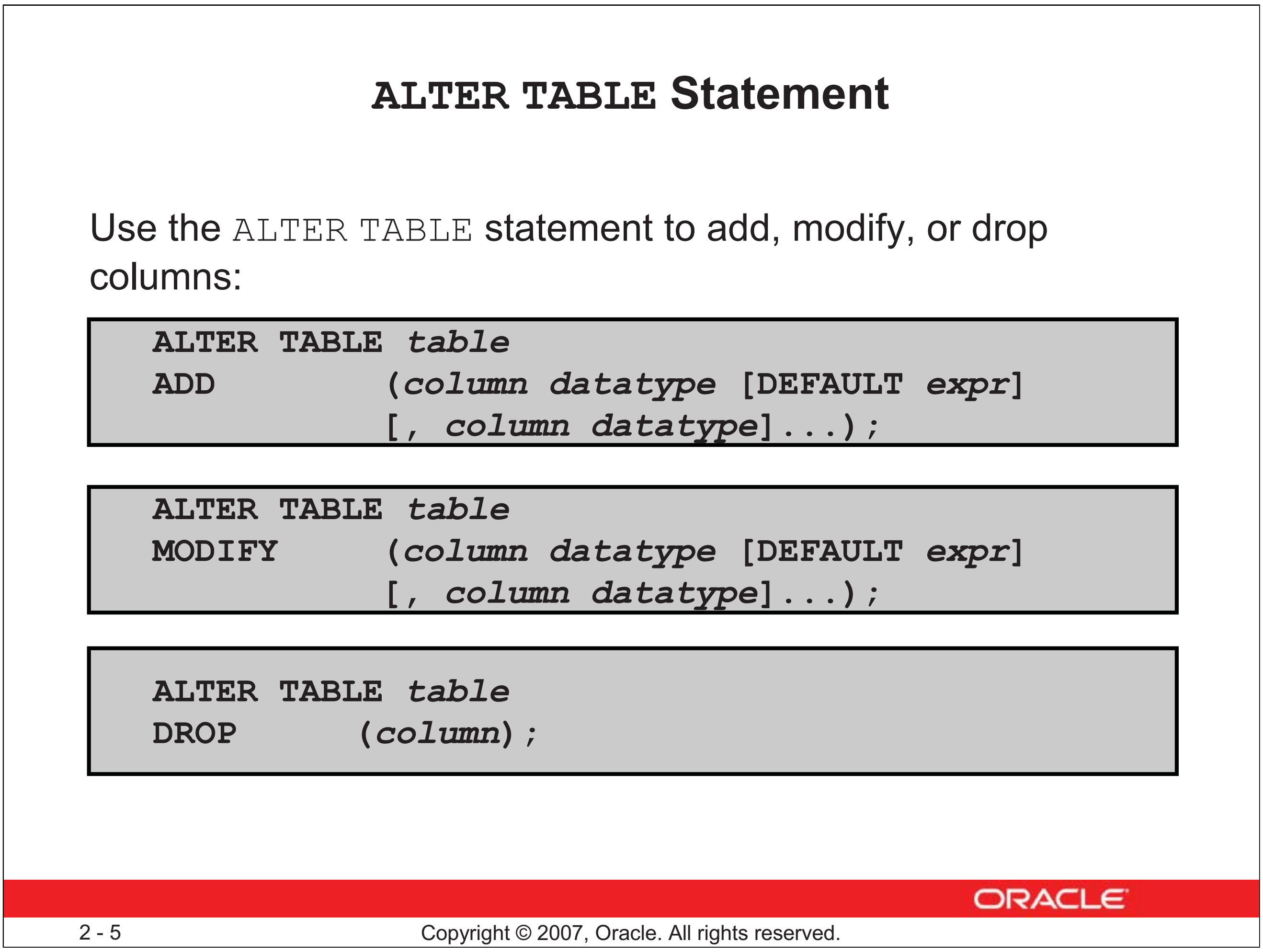
Use the ALTER TABLE statement to:

- Add a new column
- Modify an existing column
- Define a default value for the new column
- Drop a column

2 - 4

ALTER TABLE Statement

After you create a table, you may need to change the table structure because you omitted a column, your column definition needs to be changed, or you need to remove columns. You can do this by using the ALTER TABLE statement.



ALTER TABLE Statement

Use the `ALTER TABLE` statement to add, modify, or drop columns:

```
ALTER TABLE table
ADD        (column datatype [DEFAULT expr]
           [, column datatype]...);
```

```
ALTER TABLE table
MODIFY     (column datatype [DEFAULT expr]
           [, column datatype]...);
```

```
ALTER TABLE table
DROP      (column);
```

2 - 5

ALTER TABLE Statement (continued)

You can add columns to a table, modify columns, and drop columns from a table by using the `ALTER TABLE` statement.

In the syntax:

table	Is the name of the table
ADD|MODIFY|DROP	Is the type of modification
column	Is the name of the column
datatype	Is the data type and length of the column
DEFAULT *expr*	Specifies the default value for a column

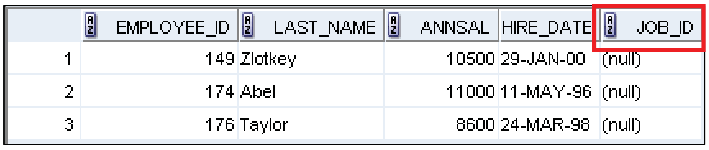
Adding a Column

- You use the `ADD` clause to add columns:

```
ALTER TABLE dept80
ADD         (job_id VARCHAR2(9));
```

```
ALTER TABLE dept80 succeeded.
```

- The new column becomes the last column:



	EMPLOYEE_ID	LAST_NAME	ANNSAL	HIRE_DATE	JOB_ID
1	149	Zlotkey	10500	29-JAN-00	(null)
2	174	Abel	11000	11-MAY-96	(null)
3	176	Taylor	8600	24-MAR-98	(null)

Guidelines for Adding a Column

- You can add or modify columns.
- You cannot specify where the column is to appear. The new column becomes the last column.

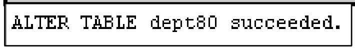
The example in the slide adds a column named `JOB_ID` to the `DEPT80` table. The `JOB_ID` column becomes the last column in the table.

Note: If a table already contains rows when a column is added, then the new column is initially null or takes the default value for all the rows. You can add a mandatory `NOT NULL` column to a table that contains data in the other columns only if you specify a default value. You can add a `NOT NULL` column to an empty table without the default value.

Modifying a Column

- You can change a column's data type, size, and default value.

```
ALTER TABLE dept80
MODIFY      (last_name VARCHAR2(30));
```



```
ALTER TABLE dept80 succeeded.
```

- A change to the default value affects only subsequent insertions to the table.

Modifying a Column

You can modify a column definition by using the `ALTER TABLE` statement with the `MODIFY` clause. Column modification can include changes to a column's data type, size, and default value.

Guidelines

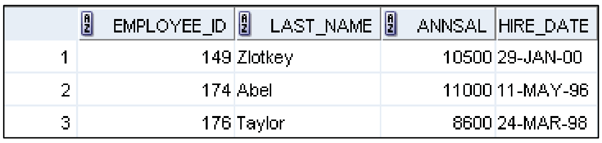
- You can increase the width or precision of a numeric column.
- You can increase the width of character columns.
- You can decrease the width of a column if:
  - The column contains only null values
  - The table has no rows
  - The decrease in column width is not less than the existing values in that column
- You can change the data type if the column contains only null values. The exception to this is `CHAR`-to-`VARCHAR2` conversions, which can be done with data in the columns.
- You can convert a `CHAR` column to the `VARCHAR2` data type or convert a `VARCHAR2` column to the `CHAR` data type only if the column contains null values or if you do not change the size.
- A change to the default value of a column affects only subsequent insertions to the table.

Dropping a Column

Use the `DROP COLUMN` clause to drop columns you no longer need from the table:

```
ALTER TABLE  dept80
DROP COLUMN  job_id;
```

```
ALTER TABLE dept80 succeeded.
```



	EMPLOYEE_ID	LAST_NAME	ANNSAL	HIRE_DATE
1	149	Zlotkey	10500	29-JAN-00
2	174	Abel	11000	11-MAY-96
3	176	Taylor	8600	24-MAR-98

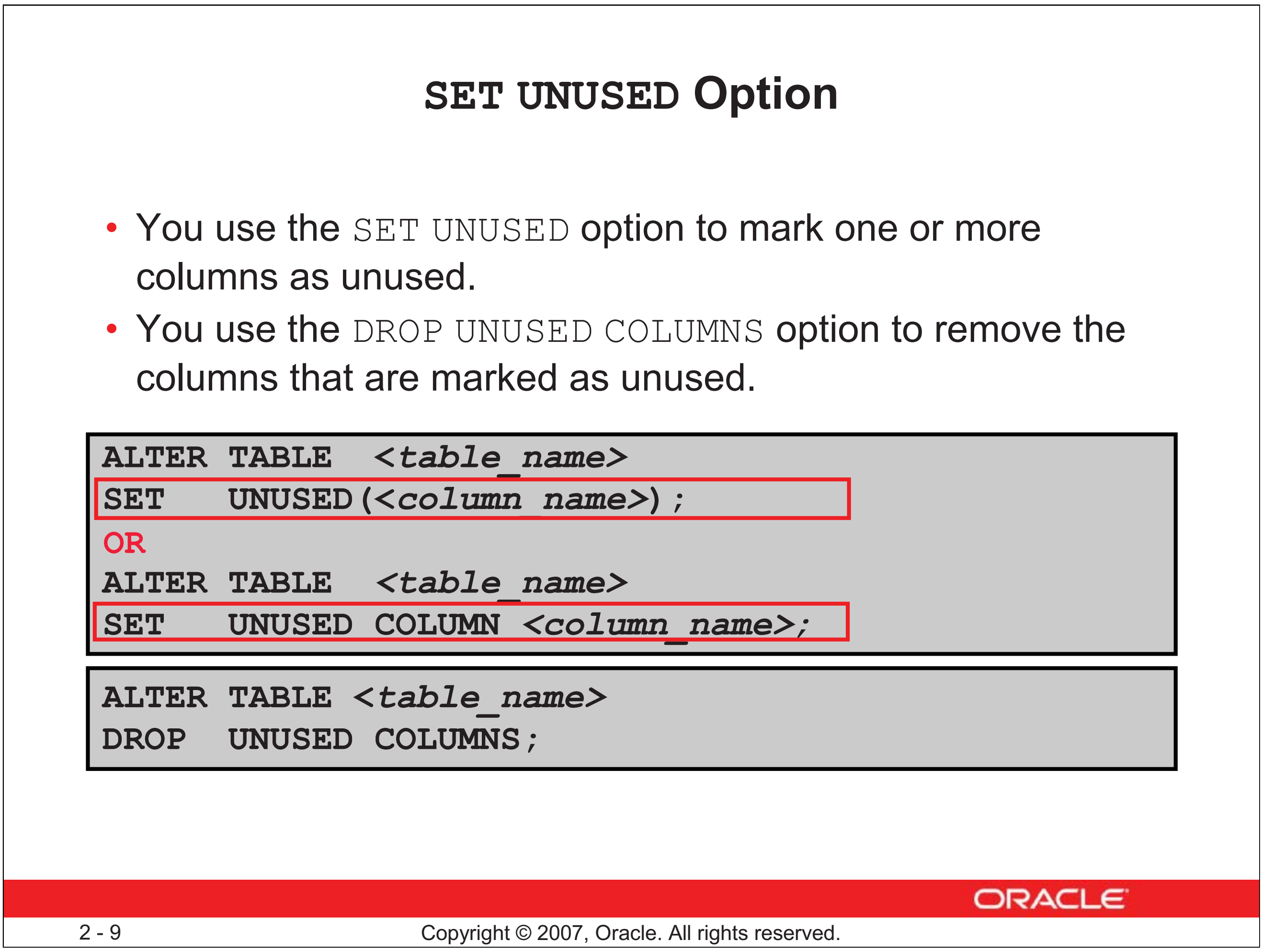
Dropping a Column

You can drop a column from a table by using the `ALTER TABLE` statement with the `DROP COLUMN` clause.

Guidelines

- The column may or may not contain data.
- Using the `ALTER TABLE DROP COLUMN` statement, only one column can be dropped at a time.
- The table must have at least one column remaining in it after it is altered.
- After a column is dropped, it cannot be recovered.
- A column cannot be dropped if it is part of a constraint or part of an index key unless the cascade option is added.
- Dropping a column can take a while if the column has a large number of values. In this case, it may be better to set it to be unused and drop it when there are fewer users on the system to avoid extended locks.

Note: Certain columns can never be dropped, such as columns that form part of the partitioning key of a partitioned table or columns that form part of the primary key of an index-organized table.



SET UNUSED Option

- You use the SET UNUSED option to mark one or more columns as unused.
- You use the DROP UNUSED COLUMNS option to remove the columns that are marked as unused.

```
ALTER TABLE  <table_name>
SET    UNUSED(<column name>);
OR
ALTER TABLE  <table_name>
SET    UNUSED COLUMN <column_name>;
```

```
ALTER TABLE <table_name>
DROP   UNUSED COLUMNS;
```

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2 - 9

SET UNUSED Option

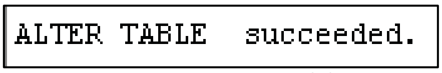
The SET UNUSED option marks one or more columns as unused so that they can be dropped when the demand on system resources is lower. Specifying this clause does not actually remove the target columns from each row in the table (that is, it does not restore the disk space used by these columns). Therefore, the response time is faster than if you executed the DROP clause. Unused columns are treated as if they were dropped, even though their column data remains in the table's rows. After a column has been marked as unused, you have no access to that column. A SELECT * query will not retrieve data from unused columns. In addition, the names and types of columns marked unused will not be displayed during a DESCRIBE statement, and you can add to the table a new column with the same name as an unused column. The SET UNUSED information is stored in the USER_UNUSED_COL_TABS dictionary view.

Note: The guidelines for setting a column to be UNUSED are similar to those for dropping a column.

DROP UNUSED COLUMNS Option

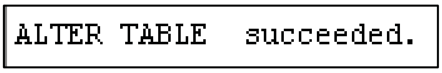
DROP UNUSED COLUMNS removes from the table all columns currently marked as unused. You can use this statement when you want to reclaim the extra disk space from unused columns in the table. If the table contains no unused columns, the statement returns with no errors.

```
ALTER TABLE  dept80
SET   UNUSED (last_name);
```

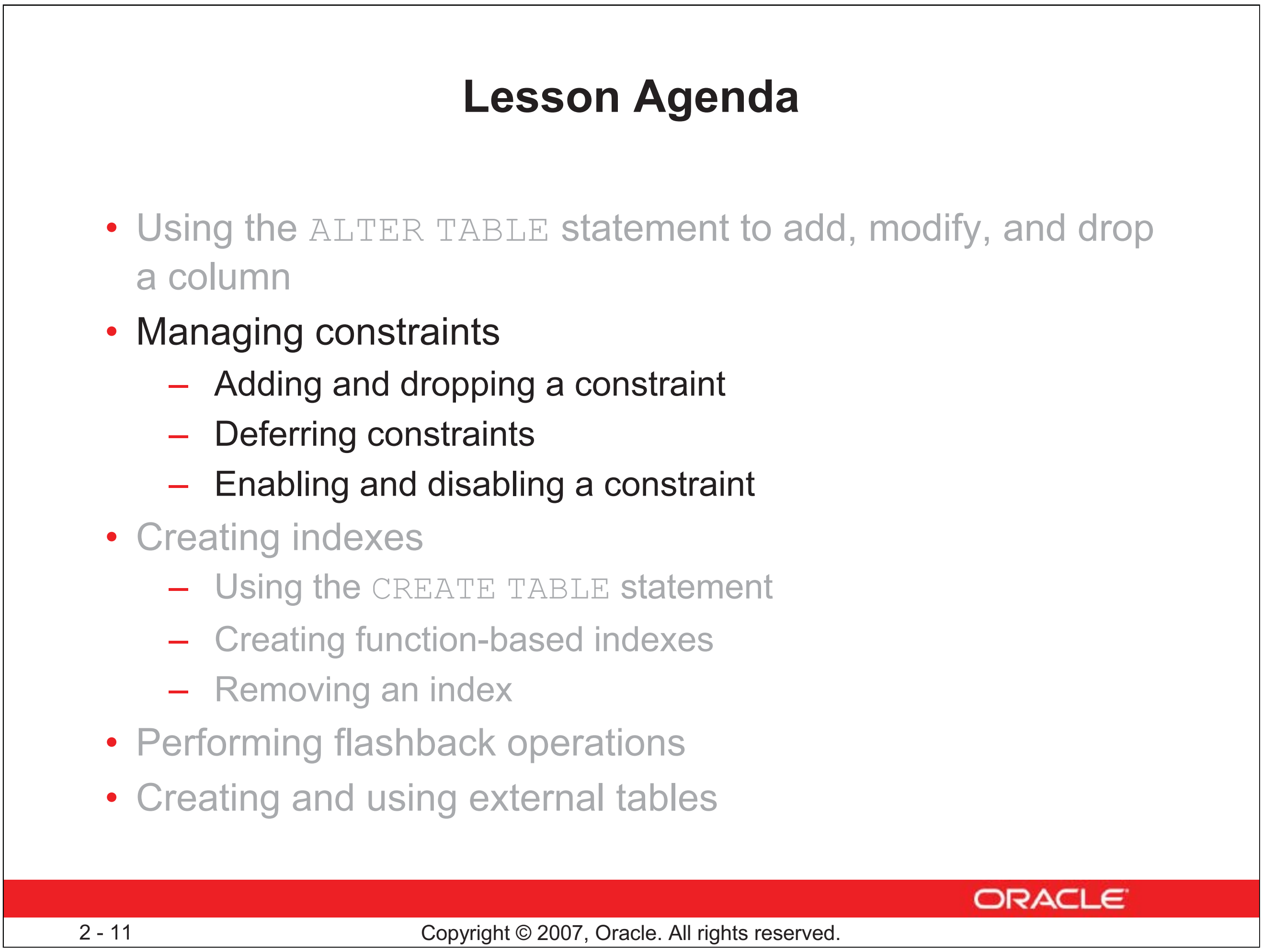


```
ALTER TABLE  succeeded.
```

```
ALTER TABLE  dept80
DROP  UNUSED COLUMNS;
```



```
ALTER TABLE  succeeded.
```



Lesson Agenda

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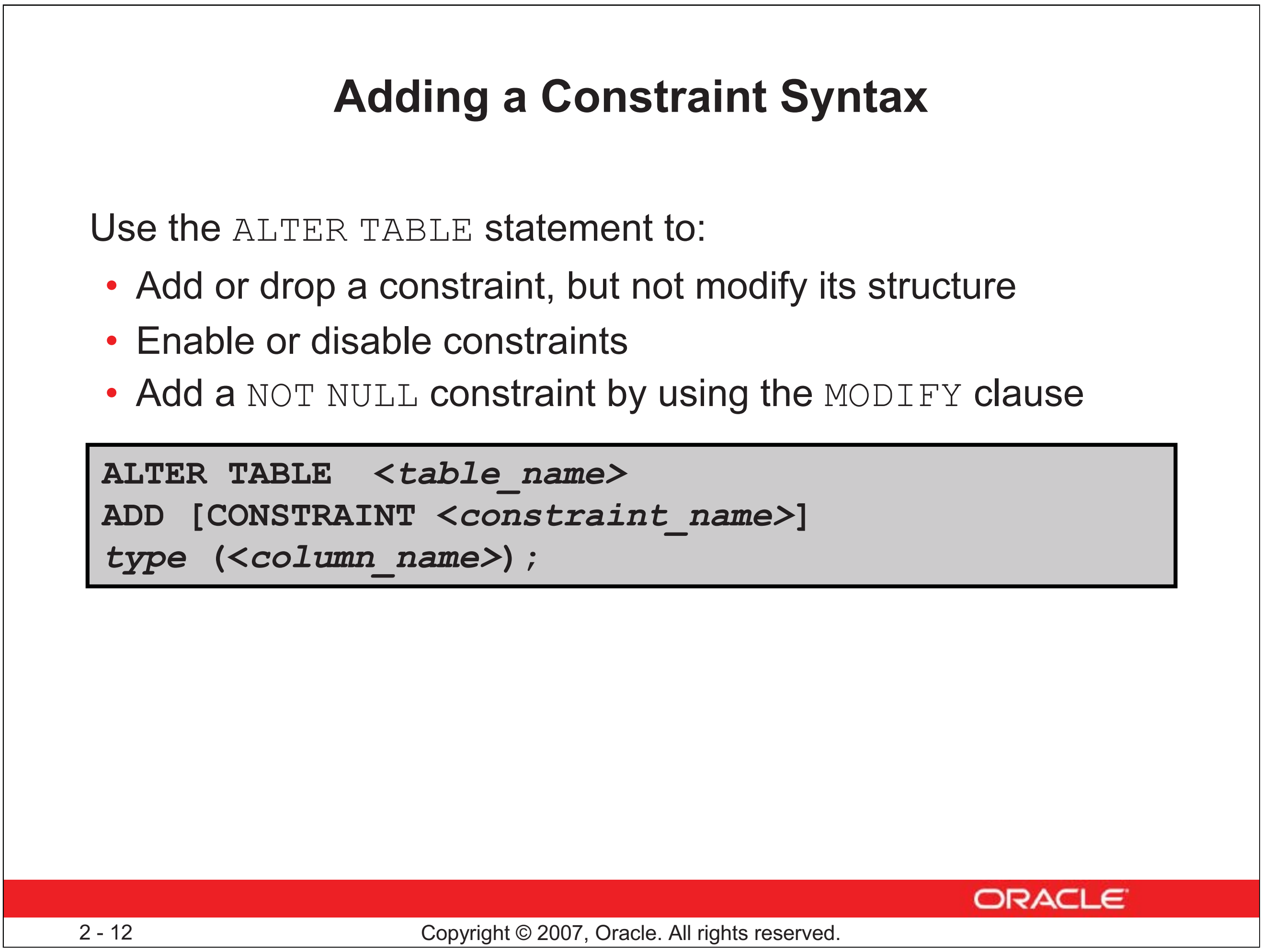


Adding a Constraint Syntax

Use the ALTER TABLE statement to:

- Add or drop a constraint, but not modify its structure
- Enable or disable constraints
- Add a NOT NULL constraint by using the MODIFY clause

```
ALTER TABLE  <table_name>
ADD [CONSTRAINT <constraint_name>]
type (<column_name>);
```

Adding a Constraint

You can add a constraint for existing tables by using the ALTER TABLE statement with the ADD clause.

In the syntax:

table	Is the name of the table
constraint	Is the name of the constraint
type	Is the constraint type
column	Is the name of the column affected by the constraint

The constraint name syntax is optional, although recommended. If you do not name your constraints, the system generates constraint names.

Guidelines

- You can add, drop, enable, or disable a constraint, but you cannot modify its structure.
- You can add a NOT NULL constraint to an existing column by using the MODIFY clause of the ALTER TABLE statement.

Note: You can define a NOT NULL column only if the table is empty or if the column has a value for every row.

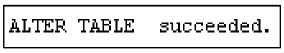
Adding a Constraint

Add a FOREIGN KEY constraint to the EMP2 table indicating that a manager must already exist as a valid employee in the EMP2 table.

```
ALTER TABLE emp2
modify employee_id Primary Key;
```

```
ALTER TABLE emp2 succeeded.
```

```
ALTER TABLE emp2
ADD CONSTRAINT emp_mgr_fk
  FOREIGN KEY(manager_id)
  REFERENCES emp2(employee_id);
```



```
ALTER TABLE  succeeded.
```

Adding a Constraint (continued)

The first example in the slide modifies the EMP2 table to add a PRIMARY KEY constraint on the EMPLOYEE_ID column. Note that because no constraint name is provided, the constraint is automatically named by the Oracle server. The second example in the slide creates a FOREIGN KEY constraint on the EMP2 table. The constraint ensures that a manager exists as a valid employee in the EMP2 table.

ON DELETE CASCADE

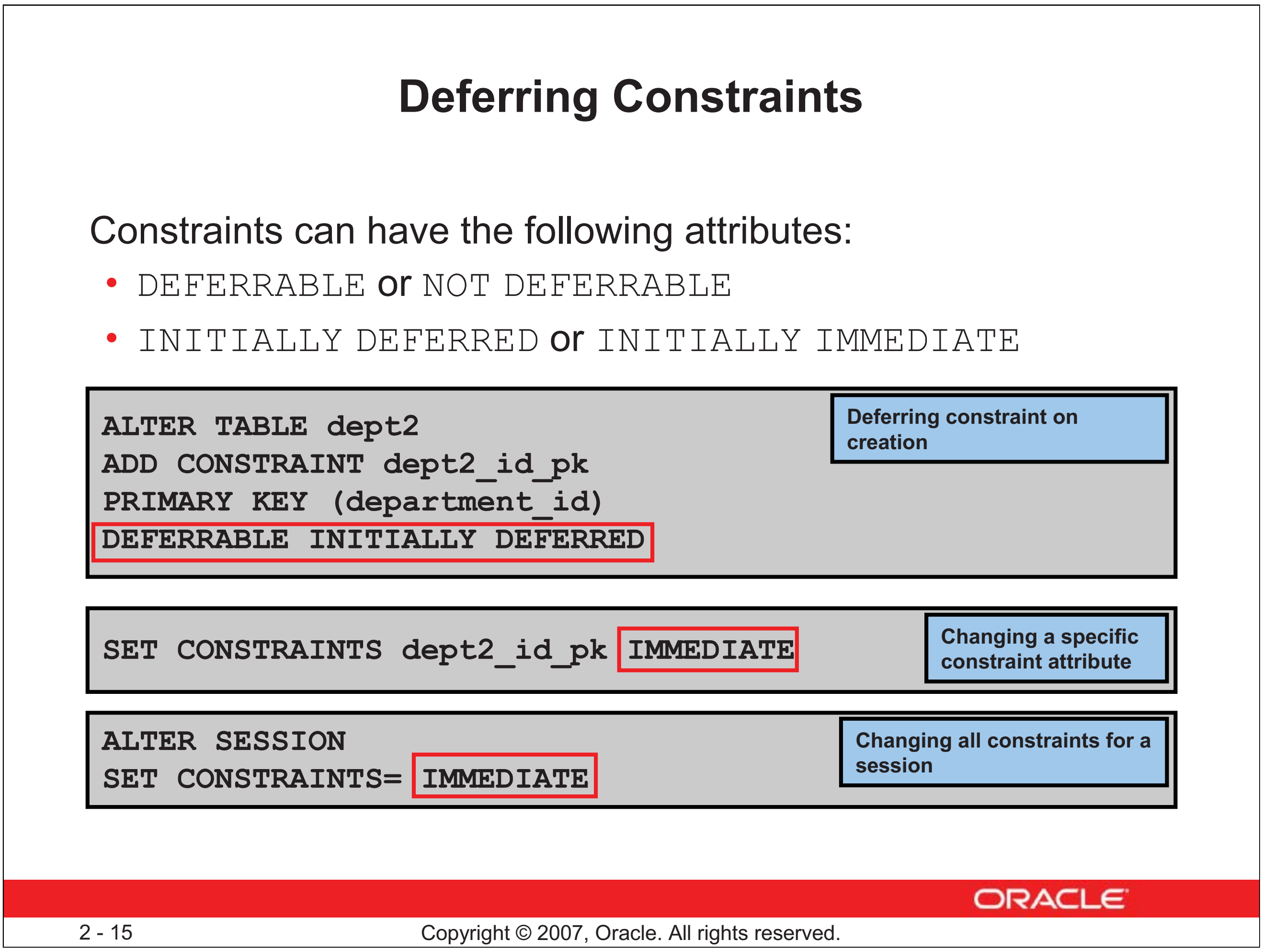
Delete child rows when a parent key is deleted:

```
ALTER TABLE Emp2 ADD CONSTRAINT emp_dt_fk
FOREIGN KEY (Department_id)
REFERENCES departments(department_id) ON DELETE CASCADE;
```

```
ALTER TABLE Emp2 succeeded.
```

ON DELETE CASCADE

The ON DELETE CASCADE action allows parent key data that is referenced from the child table to be deleted, but not updated. When data in the parent key is deleted, all rows in the child table that depend on the deleted parent key values are also deleted. To specify this referential action, include the ON DELETE CASCADE option in the definition of the FOREIGN KEY constraint.



Deferring Constraints

Constraints can have the following attributes:

- `DEFERRABLE` or `NOT DEFERRABLE`
- `INITIALLY DEFERRED` or `INITIALLY IMMEDIATE`

```
ALTER TABLE dept2
ADD CONSTRAINT dept2_id_pk
PRIMARY KEY (department_id)
DEFERRABLE INITIALLY DEFERRED
```

Deferring constraint on creation

```
SET CONSTRAINTS dept2_id_pk IMMEDIATE
```

Changing a specific constraint attribute

```
ALTER SESSION
SET CONSTRAINTS= IMMEDIATE
```

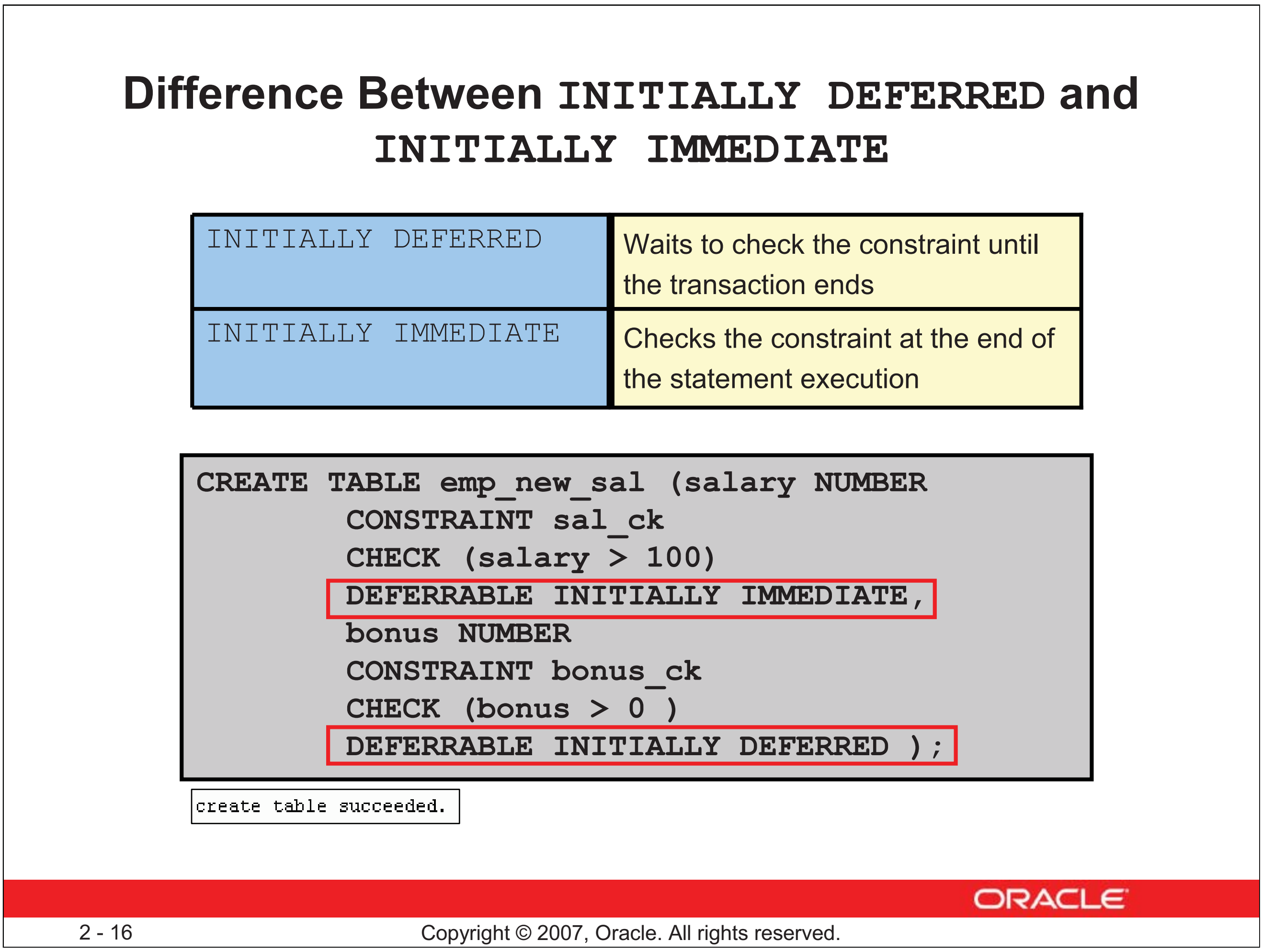
Changing all constraints for a session

Deferring Constraints

You can defer checking constraints for validity until the end of the transaction. A constraint is deferred if the system checks that it is satisfied only on commit. If a deferred constraint is violated, then commit causes the transaction to roll back. If a constraint is immediate (not deferred), then it is checked at the end of each statement. If it is violated, the statement is rolled back immediately. If a constraint causes an action (for example, `DELETE CASCADE`), that action is always taken as part of the statement that caused it, whether the constraint is deferred or immediate. Use the `SET CONSTRAINTS` statement to specify, for a particular transaction, whether a deferrable constraint is checked following each DML statement or when the transaction is committed. To create deferrable constraints, you must create a nonunique index for that constraint.

You can define constraints as either deferrable or not deferrable, and either initially deferred or initially immediate. These attributes can be different for each constraint.

Usage scenario: Company policy dictates that department number 40 should be changed to 45. Changing the `DEPARTMENT_ID` column affects employees assigned to this department. Therefore, you make the primary key and foreign keys deferrable and initially deferred. You update both department and employee information, and at the time of commit, all rows are validated.



Difference Between INITIALLY DEFERRED and INITIALLY IMMEDIATE

INITIALLY DEFERRED	Waits to check the constraint until the transaction ends
INITIALLY IMMEDIATE	Checks the constraint at the end of the statement execution

```
CREATE TABLE emp_new_sal (salary NUMBER
        CONSTRAINT sal_ck
        CHECK (salary > 100)
        DEFERRABLE INITIALLY IMMEDIATE,
        bonus NUMBER
        CONSTRAINT bonus_ck
        CHECK (bonus > 0 )
        DEFERRABLE INITIALLY DEFERRED );
```

```
create table succeeded.
```

Difference Between INITIALLY DEFERRED and INITIALLY IMMEDIATE

A constraint that is defined as deferrable can be specified as either INITIALLY DEFERRED or INITIALLY IMMEDIATE. The INITIALLY IMMEDIATE clause is the default.

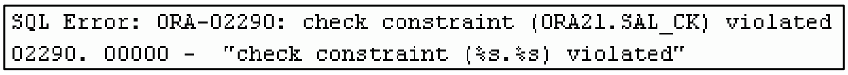
In the slide example:

- The sal_ck constraint is created as DEFERRABLE INITIALLY IMMEDIATE
- The bonus_ck constraint is created as DEFERRABLE INITIALLY DEFERRED

After creating the emp_new_sal table as shown in the slide, you attempt to insert values into the table and observe the results. When both the sal_ck and bonus_ck constraints are satisfied, the rows are inserted without an error.

Example 1: Insert a row that violates sal_ck. In the CREATE TABLE statement, sal_ck is specified as an initially immediate constraint. This means that the constraint is verified immediately after the INSERT statement and you observe an error.

```
INSERT INTO emp_new_sal VALUES(90,5);
```

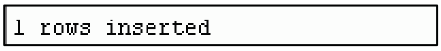


```
SQL Error: ORA-02290: check constraint (ORA21.SAL_CK) violated
02290. 00000 -  "check constraint (%s.%s) violated"
```

Example 2: Insert a row that violates bonus_ck. In the CREATE TABLE statement, bonus_ck is specified as deferrable and also initially deferred. Therefore, the constraint is not verified until you COMMIT or set the constraint state back to immediate.

Difference Between `INITIALLY DEFERRED` and `INITIALLY IMMEDIATE` (continued)

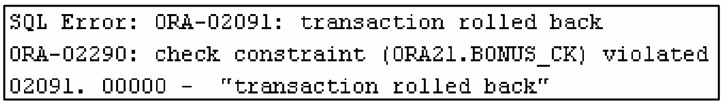
```
INSERT INTO emp_new_sal VALUES(110, -1);
```



```
1 rows inserted
```

The row insertion is successful. But, you observe an error when you commit the transaction.

```
COMMIT;
```

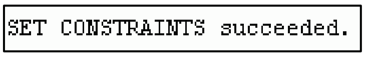


```
SQL Error: ORA-02091: transaction rolled back
ORA-02290: check constraint (ORA21.BONUS_CK) violated
02091. 00000 -  "transaction rolled back"
```

The commit failed due to constraint violation. Therefore, at this point, the transaction is rolled back by the database.

Example 3: Set the `DEFERRED` status to all constraints that can be deferred. Note that you can also set the `DEFERRED` status to a single constraint if required.

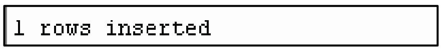
```
SET CONSTRAINTS ALL DEFERRED;
```



```
SET CONSTRAINTS succeeded.
```

Now, if you attempt to insert a row that violates the `sal_ck` constraint, the statement is executed successfully.

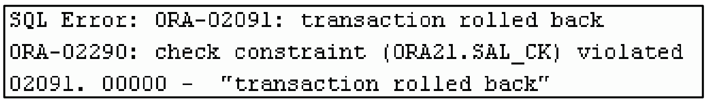
```
INSERT INTO emp_new_sal VALUES(90,5);
```



```
1 rows inserted
```

But, you observe an error when you commit the transaction. The transaction fails and is rolled back. This is because both the constraints are checked upon `COMMIT`.

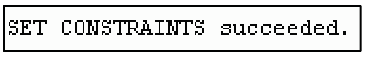
```
COMMIT;
```



```
SQL Error: ORA-02091: transaction rolled back
ORA-02290: check constraint (ORA21.SAL_CK) violated
02091. 00000 -  "transaction rolled back"
```

Example 4: Set the `IMMEDIATE` status to both the constraints that were set as `DEFERRED` in the previous example.

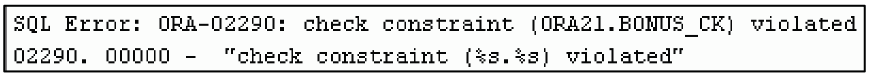
```
SET CONSTRAINTS ALL IMMEDIATE;
```



```
SET CONSTRAINTS succeeded.
```

You observe an error if you attempt to insert a row that violates either `sal_ck` or `bonus_ck`.

```
INSERT INTO emp_new_sal VALUES(110, -1);
```



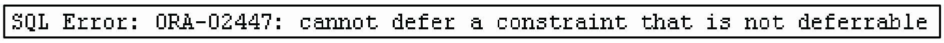
```
SQL Error: ORA-02290: check constraint (ORA21.BONUS_CK) violated
02290. 00000 -  "check constraint (%s.%s) violated"
```

Note: If you create a table without specifying constraint deferability, then the constraint is checked immediately at the end of each statement. For example, with the `CREATE TABLE` statement of the `newemp_details` table, if you do not specify the `newemp_det_pk` constraint deferability, then the constraint is checked immediately.

```
CREATE TABLE newemp_details(emp_id NUMBER, emp_name
VARCHAR2(20),
CONSTRAINT newemp_det_pk PRIMARY KEY(emp_id));
```

When you attempt to defer the `newemp_det_pk` constraint that is not deferrable, you observe the following error:

```
SET CONSTRAINT newemp_det_pk DEFERRED;
```

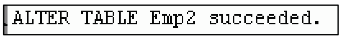


```
SQL Error: ORA-02447: cannot defer a constraint that is not deferrable
```

Dropping a Constraint

- Remove the manager constraint from the EMP2 table:

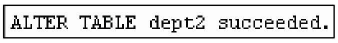
```
ALTER TABLE emp2
DROP CONSTRAINT emp_mgr_fk;
```



```
ALTER TABLE Emp2 succeeded.
```

- Remove the PRIMARY KEY constraint on the DEPT2 table and drop the associated FOREIGN KEY constraint on the EMP2.DEPARTMENT_ID column:

```
ALTER TABLE dept2
DROP PRIMARY KEY CASCADE;
```



```
ALTER TABLE dept2 succeeded.
```

Dropping a Constraint

To drop a constraint, you can identify the constraint name from the USER_CONSTRAINTS and USER_CONS_COLUMNS data dictionary views. Then use the ALTER TABLE statement with the DROP clause. The CASCADE option of the DROP clause causes any dependent constraints also to be dropped.

Syntax

```
ALTER TABLE  table
 DROP  PRIMARY KEY | UNIQUE (column) |
       CONSTRAINT   constraint  [CASCADE];
```

In the syntax:

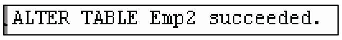
table	Is the name of the table
column	Is the name of the column affected by the constraint
constraint	Is the name of the constraint

When you drop an integrity constraint, that constraint is no longer enforced by the Oracle server and is no longer available in the data dictionary.

Disabling Constraints

- Execute the `DISABLE` clause of the `ALTER TABLE` statement to deactivate an integrity constraint.
- Apply the `CASCADE` option to disable dependent integrity constraints.

```
ALTER TABLE emp2
DISABLE CONSTRAINT emp_dt_fk;
```



```
ALTER TABLE Emp2 succeeded.
```

Disabling a Constraint

You can disable a constraint without dropping it or re-creating it by using the `ALTER TABLE` statement with the `DISABLE` clause.

Syntax

```
ALTER   TABLE   table
 DISABLE CONSTRAINT constraint [CASCADE];
```

In the syntax:

table	Is the name of the table
constraint	Is the name of the constraint

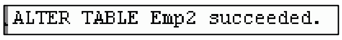
Guidelines

- You can use the `DISABLE` clause in both the `CREATE TABLE` statement and the `ALTER TABLE` statement.
- The `CASCADE` clause disables dependent integrity constraints.
- Disabling a unique or primary key constraint removes the unique index.

Enabling Constraints

- Activate an integrity constraint currently disabled in the table definition by using the `ENABLE` clause.

```
ALTER TABLE        emp2
ENABLE CONSTRAINT emp_dt_fk;
```



```
ALTER TABLE Emp2 succeeded.
```

- A `UNIQUE` index is automatically created if you enable a `UNIQUE` key or a `PRIMARY KEY` constraint.

Enabling a Constraint

You can enable a constraint without dropping it or re-creating it by using the `ALTER TABLE` statement with the `ENABLE` clause.

Syntax

```
ALTER   TABLE      table
ENABLE  CONSTRAINT constraint;
```

In the syntax:

table	Is the name of the table
constraint	Is the name of the constraint

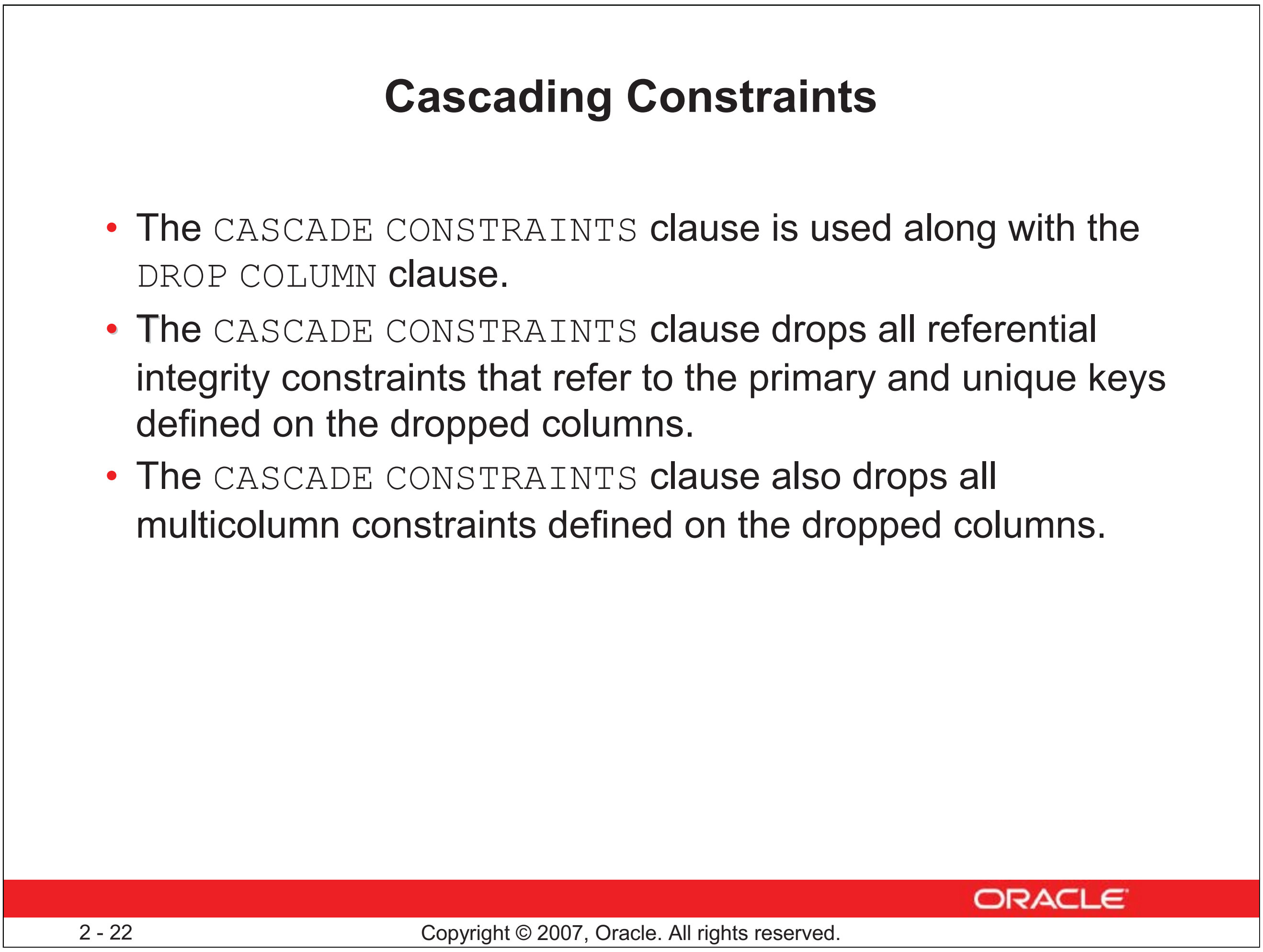
Guidelines

- If you enable a constraint, that constraint applies to all the data in the table. All the data in the table must comply with the constraint.
- If you enable a `UNIQUE` key or a `PRIMARY KEY` constraint, a `UNIQUE` or `PRIMARY KEY` index is created automatically. If an index already exists, then it can be used by these keys.
- You can use the `ENABLE` clause in both the `CREATE TABLE` statement and the `ALTER TABLE` statement.

Enabling a Constraint (continued)

Guidelines (continued)

- Enabling a primary key constraint that was disabled with the `CASCADE` option does not enable any foreign keys that are dependent on the primary key.
- To enable a `UNIQUE` or `PRIMARY KEY` constraint, you must have the privileges necessary to create an index on the table.



Cascading Constraints

- The `CASCADE CONSTRAINTS` clause is used along with the `DROP COLUMN` clause.
- The `CASCADE CONSTRAINTS` clause drops all referential integrity constraints that refer to the primary and unique keys defined on the dropped columns.
- The `CASCADE CONSTRAINTS` clause also drops all multicolumn constraints defined on the dropped columns.

Cascading Constraints

This statement illustrates the usage of the `CASCADE CONSTRAINTS` clause. Assume that the `TEST1` table is created as follows:

```
CREATE TABLE test1 (
  col1_pk NUMBER PRIMARY KEY,
  col2_fk NUMBER,
  col1 NUMBER,
  col2 NUMBER,
  CONSTRAINT fk_constraint FOREIGN KEY (col2_fk) REFERENCES
    test1,
  CONSTRAINT ck1 CHECK (col1_pk > 0 and col1 > 0),
  CONSTRAINT ck2 CHECK (col2_fk > 0));
```

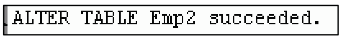
An error is returned for the following statements:

```
ALTER TABLE test1 DROP (col1_pk);    —col1_pk is a parent key.
ALTER TABLE test1 DROP (col1); —col1 is referenced by the multicolumn
                                        constraint, ck1.
```

Cascading Constraints

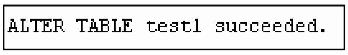
Example:

```
ALTER TABLE emp2
DROP COLUMN employee_id CASCADE CONSTRAINTS;
```



```
ALTER TABLE Emp2 succeeded.
```

```
ALTER TABLE test1
DROP (col1_pk, col2_fk, col1) CASCADE CONSTRAINTS;
```



```
ALTER TABLE test1 succeeded.
```

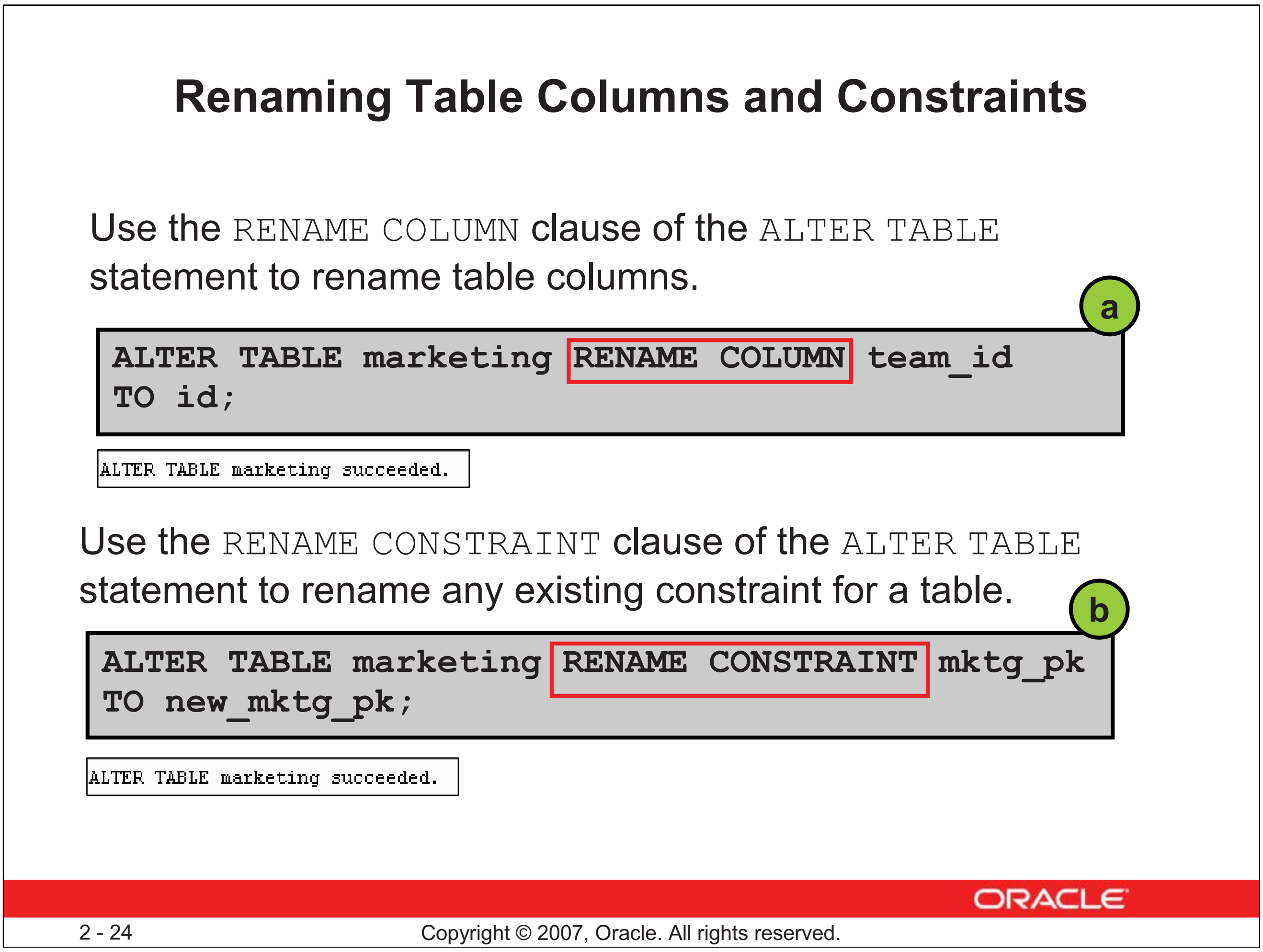
Cascading Constraints (continued)

Submitting the following statement drops the EMPLOYEE_ID column, the primary key constraint, and any foreign key constraints referencing the primary key constraint for the EMP2 table:

```
ALTER TABLE emp2 DROP COLUMN employee_id CASCADE CONSTRAINTS;
```

If all columns referenced by the constraints defined on the dropped columns are also dropped, then CASCADE CONSTRAINTS is not required. For example, assuming that no other referential constraints from other tables refer to the COL1_PK column, it is valid to submit the following statement without the CASCADE CONSTRAINTS clause for the TEST1 table created on the previous page:

```
ALTER TABLE test1 DROP (col1_pk, col2_fk, col1);
```



Renaming Table Columns and Constraints

Use the `RENAME COLUMN` clause of the `ALTER TABLE` statement to rename table columns.

a

```
ALTER TABLE marketing RENAME COLUMN team_id
TO id;
```

```
ALTER TABLE marketing succeeded.
```

Use the `RENAME CONSTRAINT` clause of the `ALTER TABLE` statement to rename any existing constraint for a table.

b

```
ALTER TABLE marketing RENAME CONSTRAINT mktg_pk
TO new_mktg_pk;
```

```
ALTER TABLE marketing succeeded.
```

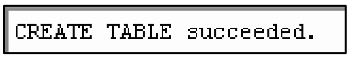
2 - 24

Renaming Table Columns and Constraints

When you rename a table column, the new name must not conflict with the name of any existing column in the table. You cannot use any other clauses in conjunction with the `RENAME COLUMN` clause.

The slide examples use the `marketing` table with the primary key `mktg_pk` defined on the `id` column.

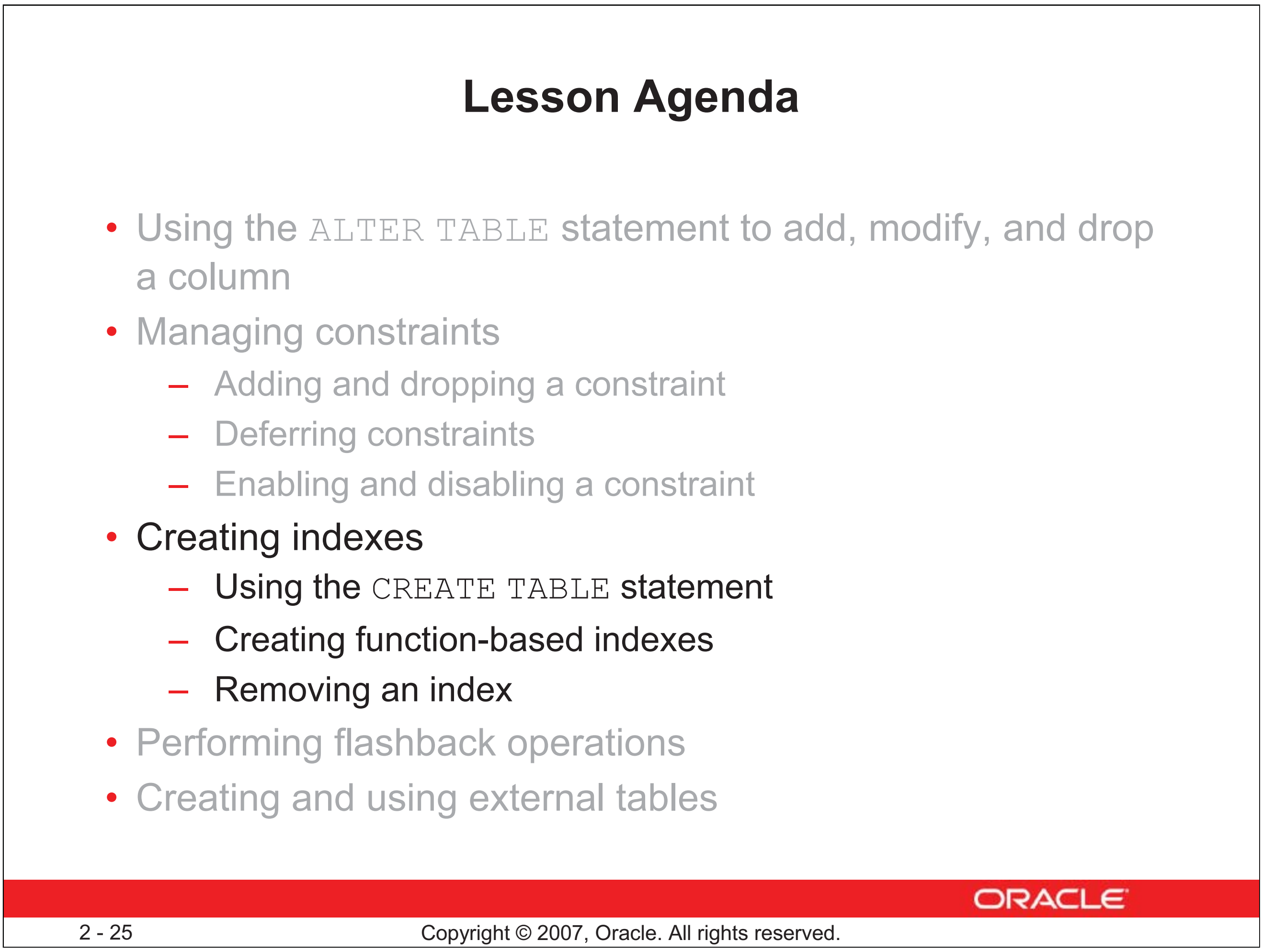
```
CREATE TABLE marketing (team_id  NUMBER(10),
                        target   VARCHAR2(50),
CONSTRAINT mktg_pk PRIMARY KEY(team_id));
```



```
CREATE TABLE succeeded.
```

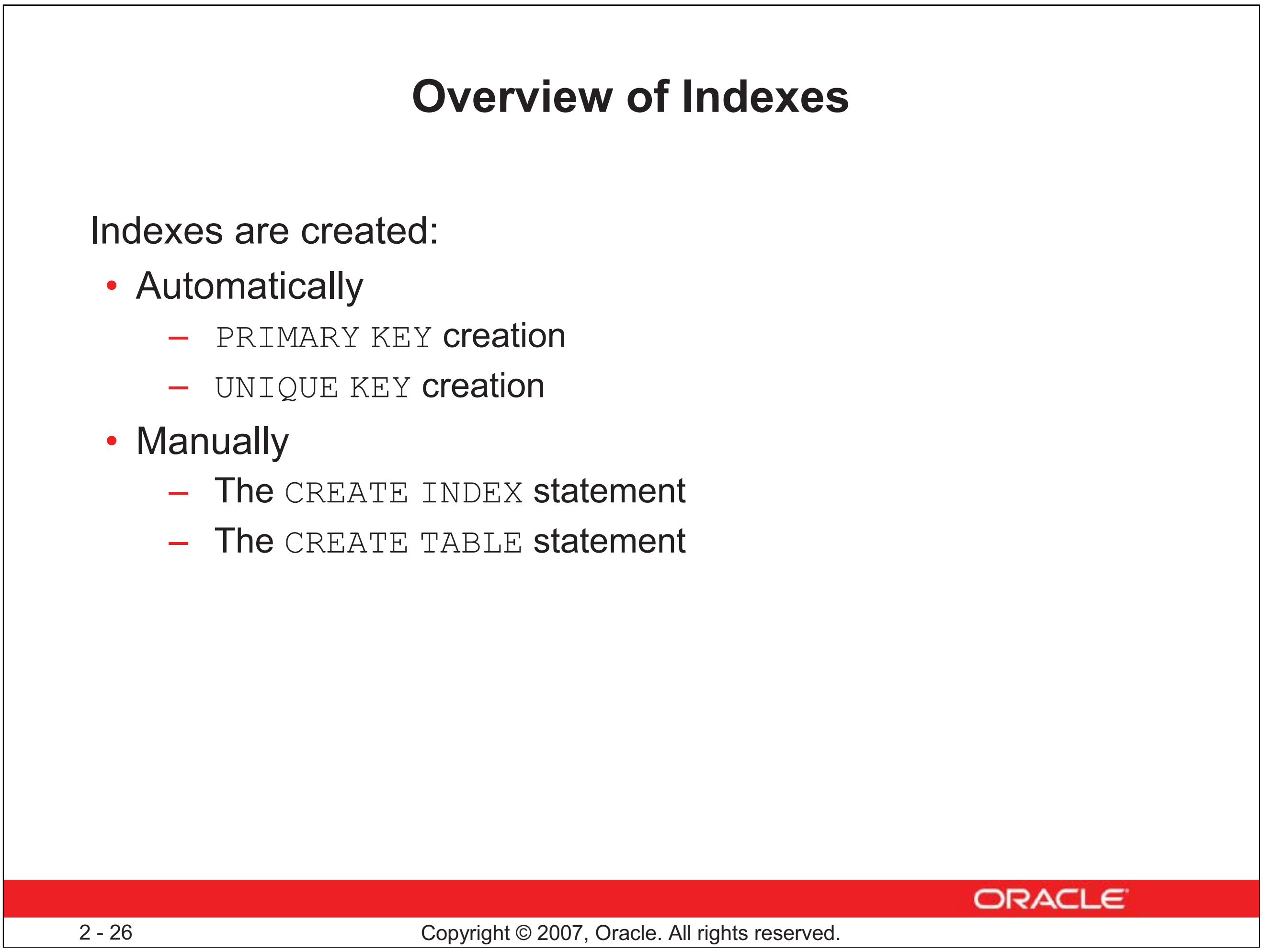
Example **a** shows that the `id` column of the marketing table is renamed `mktg_id`. Example **b** shows that `mktg_pk` is renamed `new_mktg_pk`.

When you rename any existing constraint for a table, the new name must not conflict with any of your existing constraint names. You can use the `RENAME CONSTRAINT` clause to rename system-generated constraint names.



Lesson Agenda

- Using the `ALTER TABLE` statement to add, modify, and drop a column
- Managing constraints
  - Adding and dropping a constraint
  - Deferring constraints
  - Enabling and disabling a constraint
- Creating indexes
  - Using the `CREATE TABLE` statement
  - Creating function-based indexes
  - Removing an index
- Performing flashback operations
- Creating and using external tables



Overview of Indexes

Indexes are created:

- Automatically
  - PRIMARY KEY creation
  - UNIQUE KEY creation
- Manually
  - The CREATE INDEX statement
  - The CREATE TABLE statement

2 - 26

Overview of Indexes

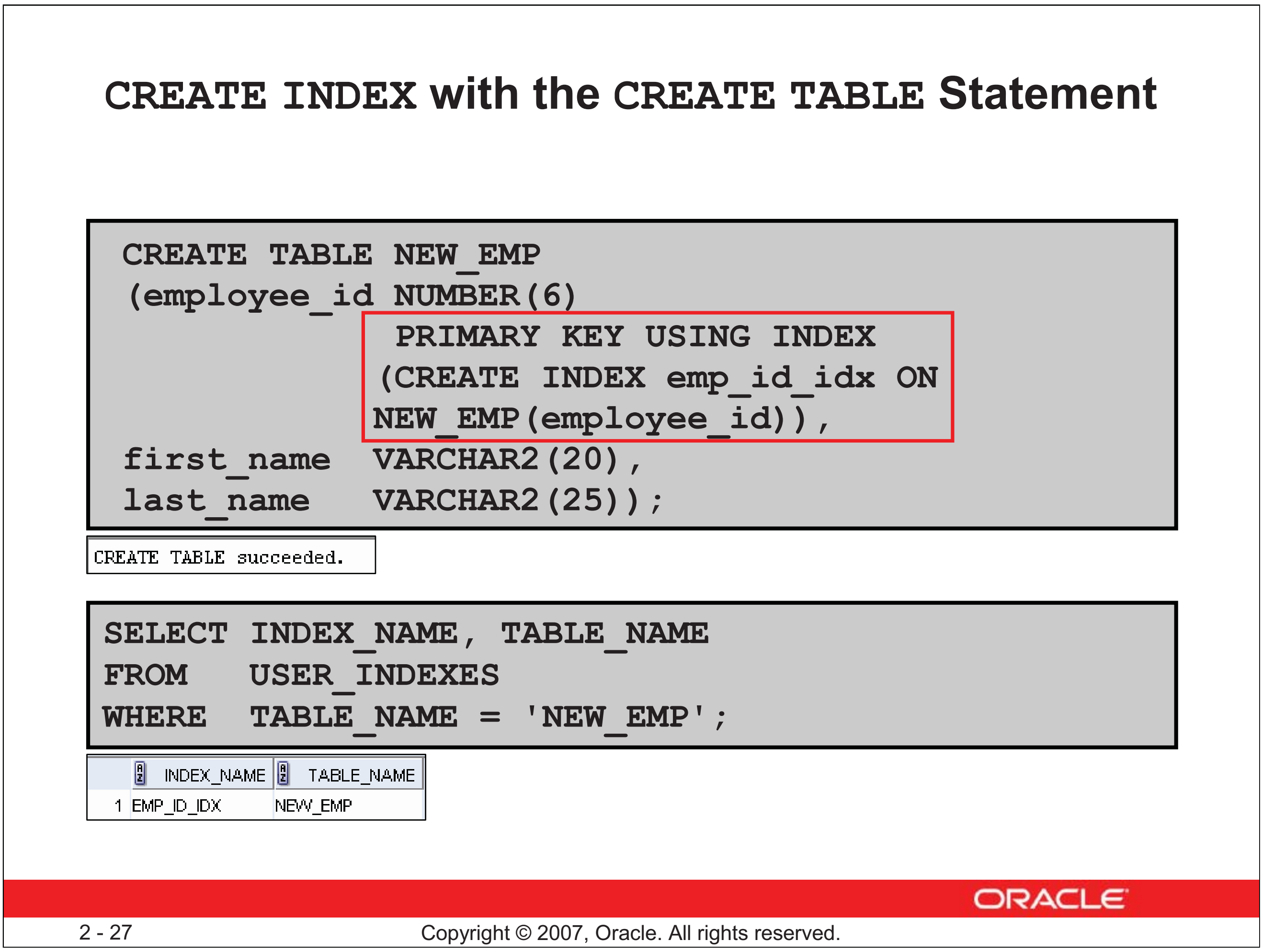
Two types of indexes can be created. One type is a unique index. The Oracle server automatically creates a unique index when you define a column or group of columns in a table to have a `PRIMARY KEY` or a `UNIQUE` key constraint. The name of the index is the name given to the constraint.

The other type of index is a nonunique index, which a user can create. For example, you can create an index for a `FOREIGN KEY` column to be used in joins to improve retrieval speed.

You can create an index on one or more columns by issuing the `CREATE INDEX` statement.

For more information, see *Oracle Database 11g SQL Reference*.

Note: You can manually create a unique index, but it is recommended that you create a unique constraint, which implicitly creates a unique index.



CREATE INDEX with the CREATE TABLE Statement

```
CREATE TABLE NEW_EMP
 (employee_id NUMBER(6)
                PRIMARY KEY USING INDEX
               (CREATE INDEX emp_id_idx ON
               NEW_EMP(employee_id)),
 first_name   VARCHAR2(20),
 last_name    VARCHAR2(25));
```

```
CREATE TABLE succeeded.
```

```
SELECT  INDEX_NAME, TABLE_NAME
FROM    USER_INDEXES
WHERE   TABLE_NAME = 'NEW_EMP';
```

	INDEX_NAME	TABLE_NAME
1	EMP_ID_IDX	NEW_EMP

CREATE INDEX with the CREATE TABLE Statement

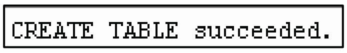
In the example in the slide, the CREATE INDEX clause is used with the CREATE TABLE statement to create a primary key index explicitly. You can name your indexes at the time of primary key creation to be different from the name of the PRIMARY KEY constraint.

You can query the USER_INDEXES data dictionary view for information about your indexes.

Note: You learn more about USER_INDEXES in the lesson titled "Managing Objects with Data Dictionary Views."

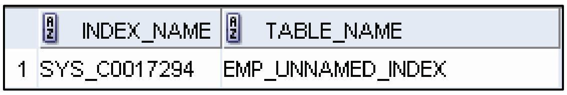
The following example illustrates the database behavior if the index is not explicitly named:

```
CREATE TABLE EMP_UNNAMED_INDEX
    (employee_id NUMBER(6) PRIMARY KEY ,
     first_name VARCHAR2(20),
     last_name VARCHAR2(25));
```



```
CREATE TABLE succeeded.
```

```
SELECT INDEX_NAME, TABLE_NAME
FROM   USER_INDEXES
WHERE  TABLE_NAME = 'EMP_UNNAMED_INDEX';
```



	INDEX_NAME	TABLE_NAME
1	SYS_C0017294	EMP_UNNAMED_INDEX

CREATE INDEX with the CREATE TABLE Statement (continued)

Observe that the Oracle server gives a generic name to the index that is created for the PRIMARY KEY column.

You can also use an existing index for your PRIMARY KEY column—for example, when you are expecting a large data load and want to speed up the operation. You may want to disable the constraints while performing the load and then enable them, in which case having a unique index on the primary key will still cause the data to be verified during the load. So you can first create a nonunique index on the column designated as PRIMARY KEY, and then create the PRIMARY KEY column and specify that it should use the existing index. The following examples illustrate this process:

Step 1: Create the table:

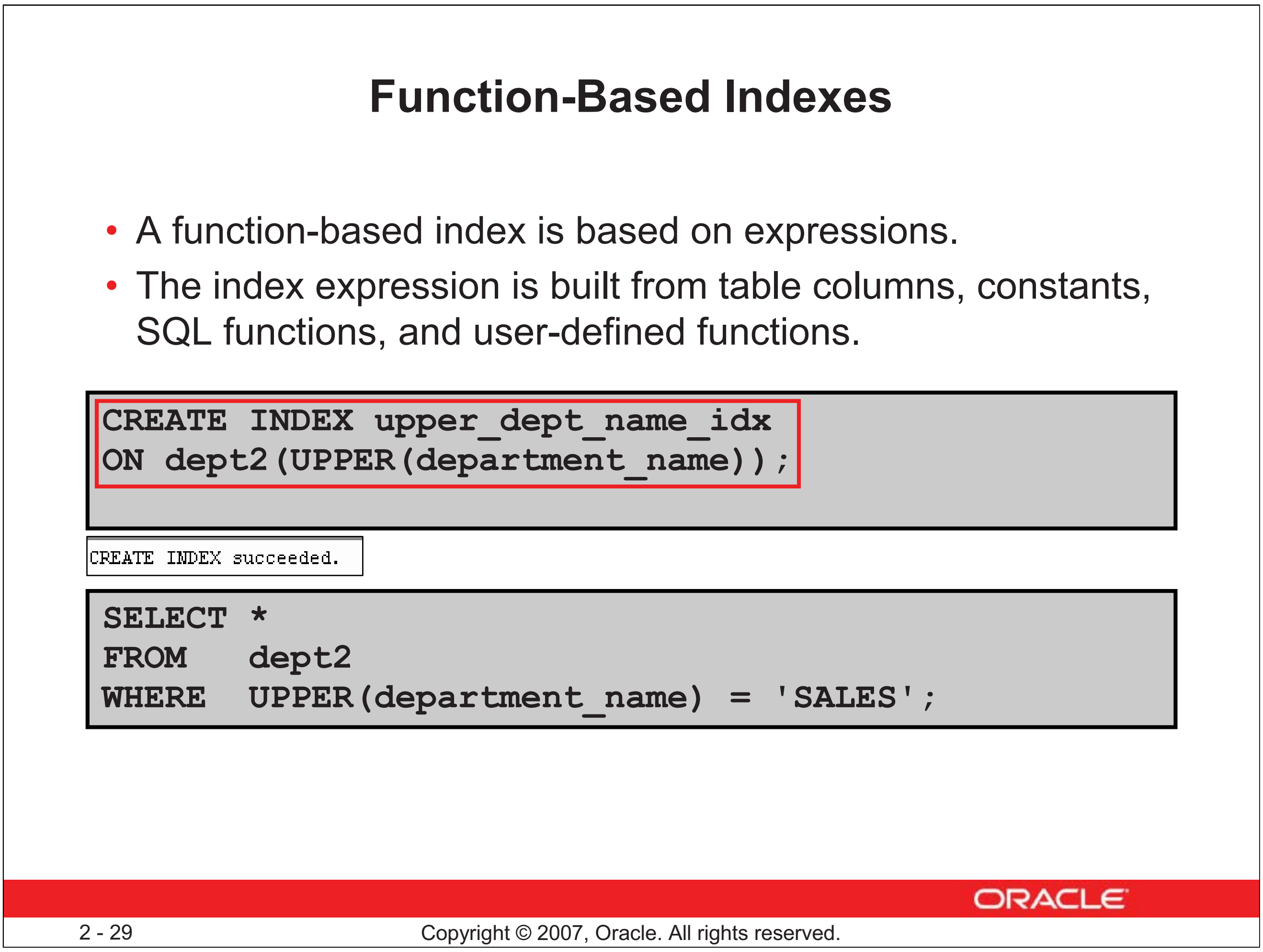
```
CREATE TABLE NEW_EMP2
 (employee_id NUMBER(6),
 first_name  VARCHAR2(20),
 last_name   VARCHAR2(25)
 );
```

Step 2: Create the index:

```
CREATE INDEX emp_id_idx2 ON
  new_emp2(employee_id);
```

Step 3: Create the primary key:

```
ALTER TABLE new_emp2 ADD PRIMARY KEY (employee_id) USING INDEX
 emp_id_idx2;
```



Function-Based Indexes

- A function-based index is based on expressions.
- The index expression is built from table columns, constants, SQL functions, and user-defined functions.

```
CREATE INDEX upper_dept_name_idx
ON dept2(UPPER(department_name));
```

```
CREATE INDEX succeeded.
```

```
SELECT *
FROM   dept2
WHERE  UPPER(department_name) = 'SALES';
```

Function-Based Indexes

Function-based indexes defined with the UPPER(*column_name*) or LOWER(*column_name*) keywords allow non-case-sensitive searches. For example, consider the following index:

```
CREATE INDEX upper_last_name_idx ON emp2 (UPPER(last_name));
```

This facilitates processing queries such as:

```
SELECT * FROM emp2 WHERE UPPER(last_name) = 'KING';
```

The Oracle server uses the index only when that particular function is used in a query. For example, the following statement may use the index, but without the WHERE clause, the Oracle server may perform a full table scan:

```
SELECT   *
FROM     employees
WHERE    UPPER (last_name) IS NOT NULL
ORDER BY UPPER (last_name);
```

Note: The QUERY_REWRITE_ENABLED initialization parameter must be set to TRUE for a function-based index to be used.

The Oracle server treats indexes with columns marked DESC as function-based indexes. The columns marked DESC are sorted in descending order.

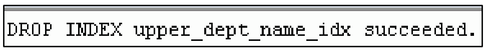
Removing an Index

- Remove an index from the data dictionary by using the `DROP INDEX` command:

```
DROP INDEX index;
```

- Remove the `UPPER_DEPT_NAME_IDX` index from the data dictionary:

```
DROP INDEX upper_dept_name_idx;
```



```
DROP INDEX upper_dept_name_idx succeeded.
```

- To drop an index, you must be the owner of the index or have the `DROP ANY INDEX` privilege.

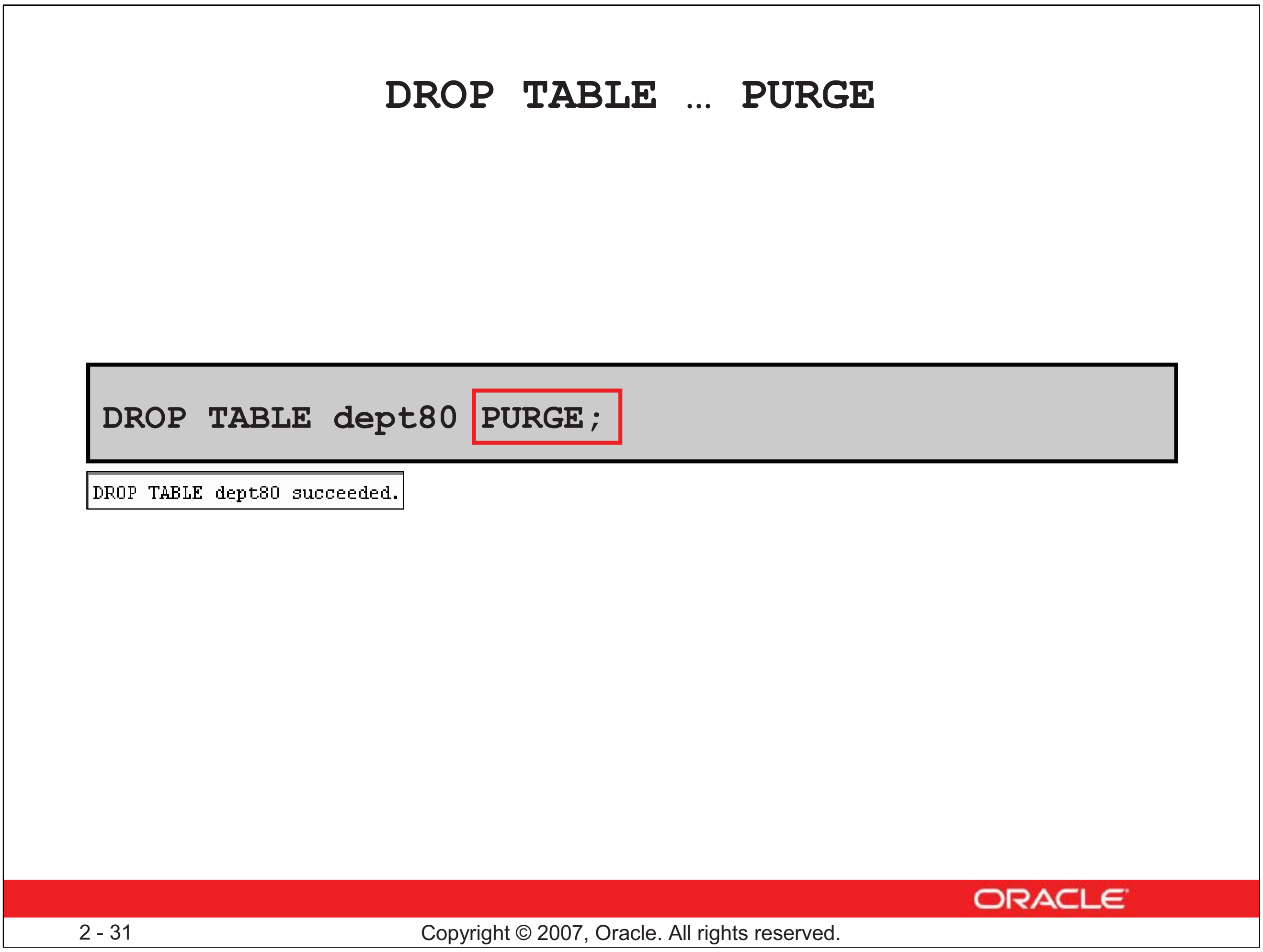
Removing an Index

You cannot modify indexes. To change an index, you must drop it and then re-create it. Remove an index definition from the data dictionary by issuing the `DROP INDEX` statement. To drop an index, you must be the owner of the index or have the `DROP ANY INDEX` privilege.

In the syntax:

`index` Is the name of the index

Note: If you drop a table, then indexes, constraints, and triggers are automatically dropped, but views and sequences remain.



DROP TABLE … PURGE

```
DROP TABLE dept80 PURGE;
```

```
DROP TABLE dept80 succeeded.
```

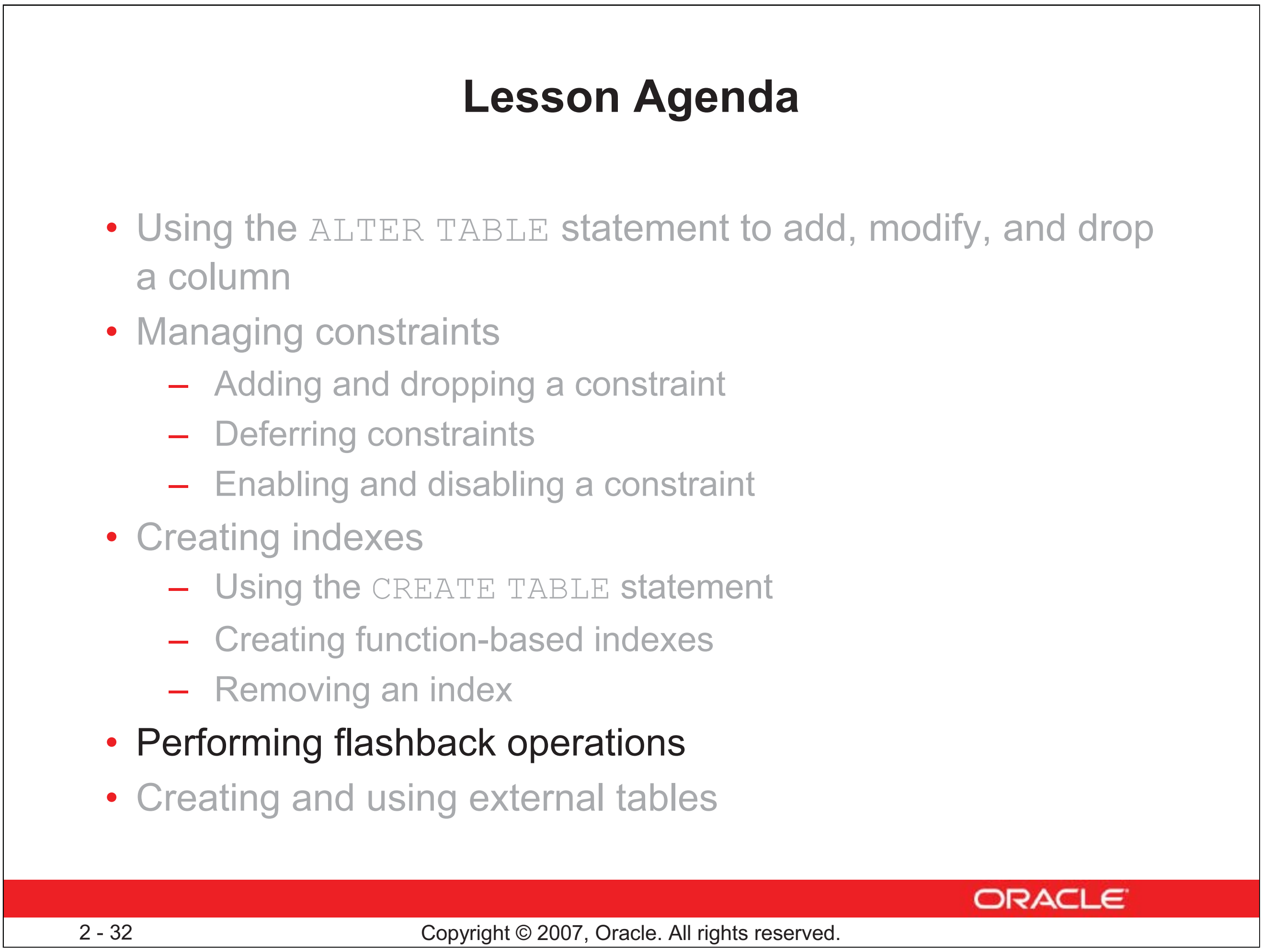
DROP TABLE … PURGE

Oracle Database provides a feature for dropping tables. When you drop a table, the database does not immediately release the space associated with the table. Rather, the database renames the table and places it in a recycle bin, where it can later be recovered with the `FLASHBACK TABLE` statement if you find that you dropped the table in error. If you want to immediately release the space associated with the table at the time you issue the `DROP TABLE` statement, then include the `PURGE` clause as shown in the statement in the slide.

Specify `PURGE` only if you want to drop the table and release the space associated with it in a single step. If you specify `PURGE`, then the database does not place the table and its dependent objects into the recycle bin.

Using this clause is equivalent to first dropping the table and then purging it from the recycle bin. This clause saves you one step in the process. It also provides enhanced security if you want to prevent sensitive material from appearing in the recycle bin.

Note: You cannot roll back a `DROP TABLE` statement with the `PURGE` clause, and you cannot recover the table if you drop it with the `PURGE` clause. This feature was not available in earlier releases.



Lesson Agenda

- Using the `ALTER TABLE` statement to add, modify, and drop a column
- Managing constraints
  - Adding and dropping a constraint
  - Deferring constraints
  - Enabling and disabling a constraint
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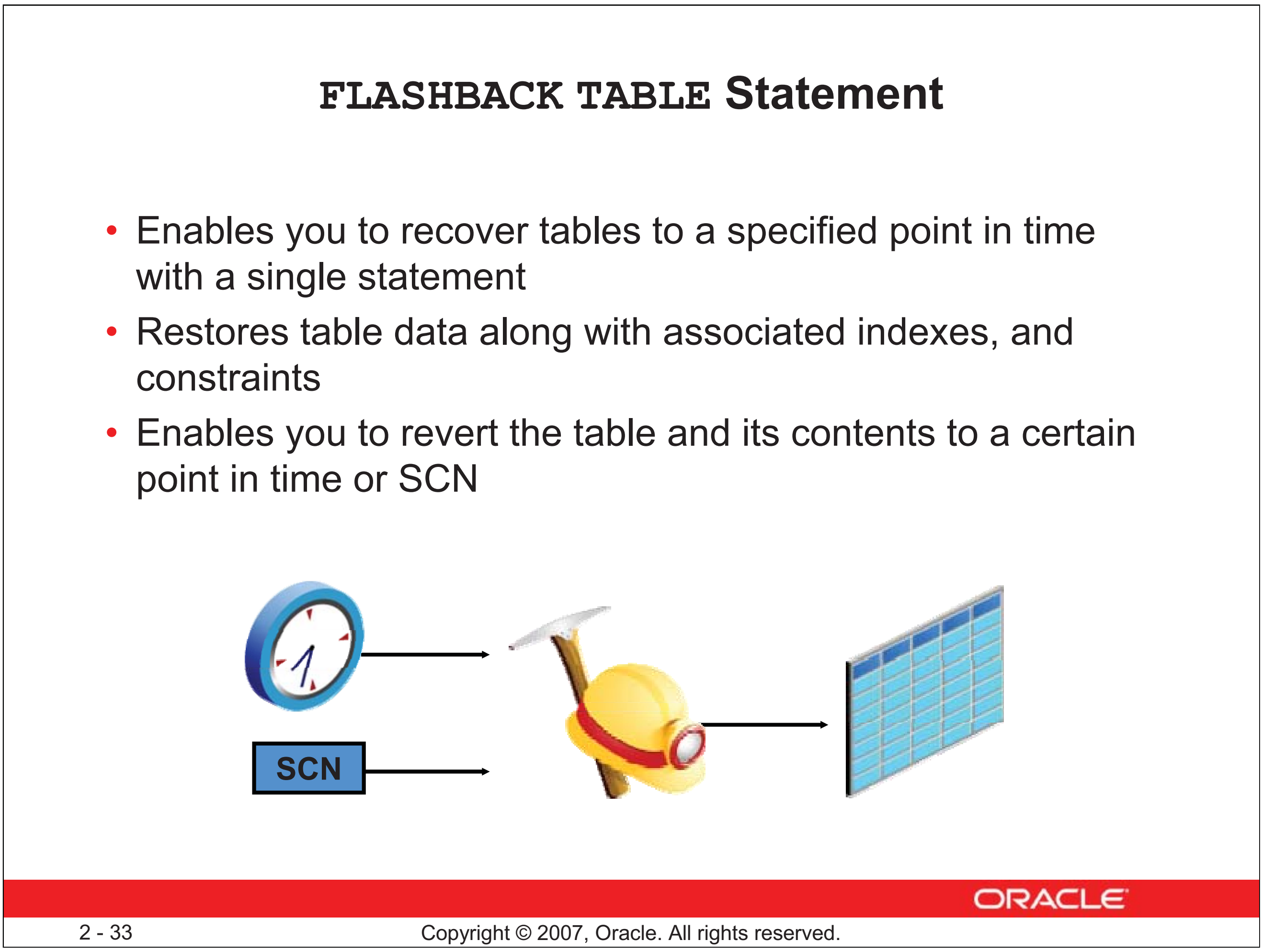


FLASHBACK TABLE Statement

- Enables you to recover tables to a specified point in time with a single statement
- Restores table data along with associated indexes, and constraints
- Enables you to revert the table and its contents to a certain point in time or SCN

2 - 33

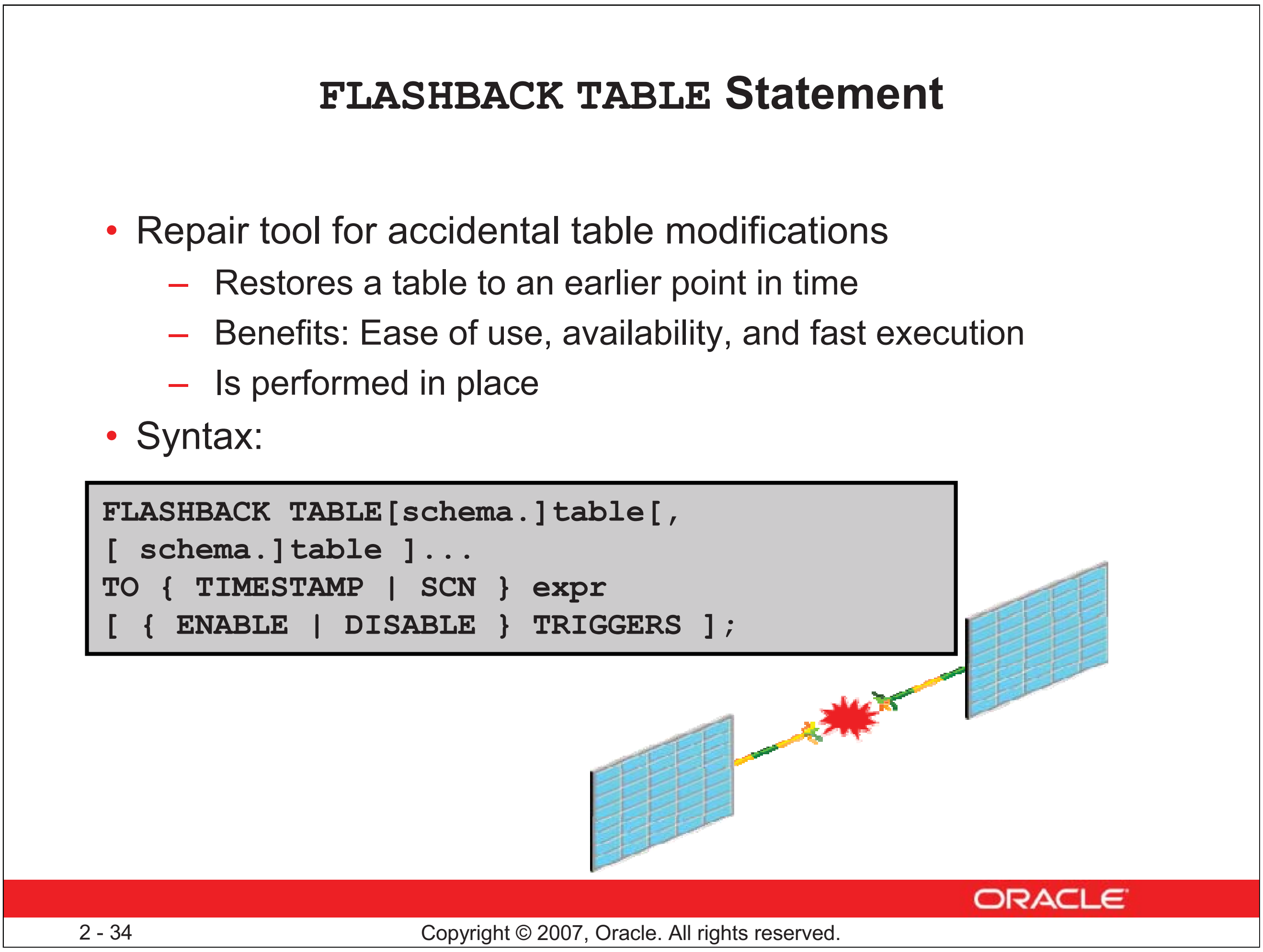
FLASHBACK TABLE Statement

Oracle Flashback Table enables you to recover tables to a specified point in time with a single statement. You can restore table data along with associated indexes, and constraints, while the database is online, undoing changes to only the specified tables.

The Flashback Table feature is similar to a self-service repair tool. For example, if a user accidentally deleted important rows from a table and then wanted to recover the deleted rows, you can use the `FLASHBACK TABLE` statement to restore the table to the time before the deletion and see the missing rows in the table.

When using the `FLASHBACK TABLE` statement, you can revert the table and its contents to a certain time or to an SCN.

Note: The system change number (SCN) is an integer value associated with each change to the database. It is a unique incremental number in the database. Every time you commit a transaction, a new SCN is recorded.



FLASHBACK TABLE Statement

- Repair tool for accidental table modifications
  - Restores a table to an earlier point in time
  - Benefits: Ease of use, availability, and fast execution
  - Is performed in place
- Syntax:

```
FLASHBACK TABLE[schema.]table[,
[ schema.]table ]...
TO { TIMESTAMP | SCN } expr
[ { ENABLE | DISABLE } TRIGGERS ];
```

2 - 34

FLASHBACK TABLE Statement (continued)

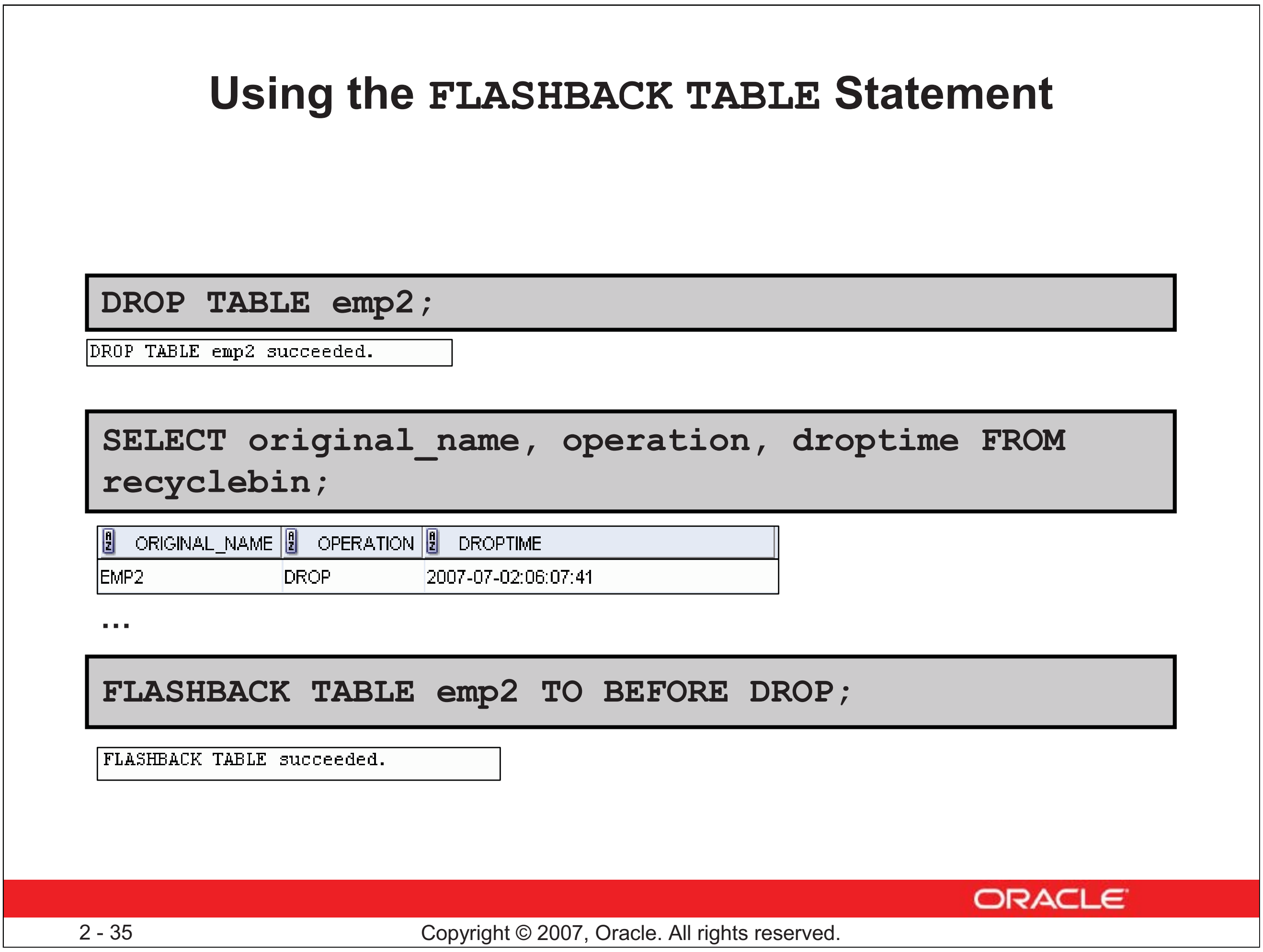
Self-Service Repair Facility

Oracle Database provides a SQL data definition language (DDL) command, `FLASHBACK TABLE`, to restore the state of a table to an earlier point in time in case it is inadvertently deleted or modified. The `FLASHBACK TABLE` command is a self-service repair tool to restore data in a table along with associated attributes such as indexes or views. This is done while the database is online by rolling back only the subsequent changes to the given table. Compared to traditional recovery mechanisms, this feature offers significant benefits such as ease of use, availability, and faster restoration. It also takes the burden off the DBA to find and restore application-specific properties. The flashback table feature does not address physical corruption caused because of a bad disk.

Syntax

You can invoke a `FLASHBACK TABLE` operation on one or more tables, even on tables in different schemas. You specify the point in time to which you want to revert by providing a valid time stamp. By default, database triggers are disabled during the flashback operation for all tables involved. You can override this default behavior by specifying the `ENABLE TRIGGERS` clause.

Note: For more information about recycle bin and flashback semantics, refer to *Oracle Database Administrator's Guide 11g Release 1 (11.1).*



Using the **FLASHBACK TABLE** Statement

```
DROP TABLE emp2;
```

```
DROP TABLE emp2 succeeded.
```

```
SELECT original_name, operation, droptime FROM
recyclebin;
```

ORIGINAL_NAME	OPERATION	DROPTIME
EMP2	DROP	2007-07-02:06:07:41

…

```
FLASHBACK TABLE emp2 TO BEFORE DROP;
```

```
FLASHBACK TABLE succeeded.
```

Using the FLASHBACK TABLE Statement

Syntax and Examples

The example restores the EMP2 table to a state before a DROP statement.

The recycle bin is actually a data dictionary table containing information about dropped objects. Dropped tables and any associated objects—such as, indexes, constraints, nested tables, and so on—are not removed and still occupy space. They continue to count against user space quotas until specifically purged from the recycle bin or the situation where they must be purged by the database because of tablespace space constraints.

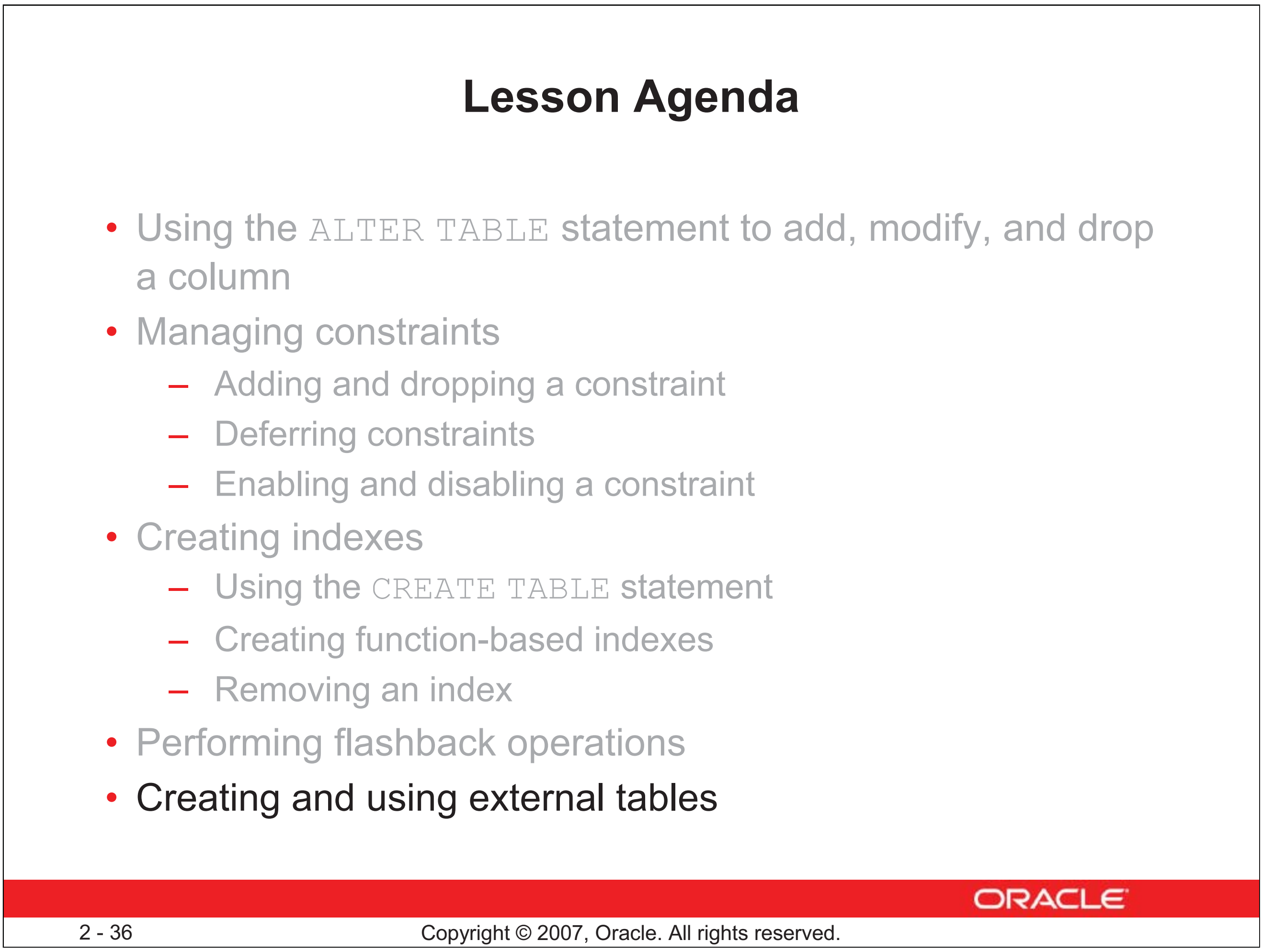
Each user can be thought of as an owner of a recycle bin because, unless a user has the SYSDBA privilege, the only objects that the user has access to in the recycle bin are those that the user owns. A user can view his or her objects in the recycle bin by using the following statement:

```
SELECT * FROM RECYCLEBIN;
```

When you drop a user, any objects belonging to that user are not placed in the recycle bin and any objects in the recycle bin are purged.

You can purge the recycle bin with the following statement:

```
PURGE RECYCLEBIN;
```



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- Using the `ALTER TABLE` statement to add, modify, and drop a column
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  - Adding and dropping a constraint
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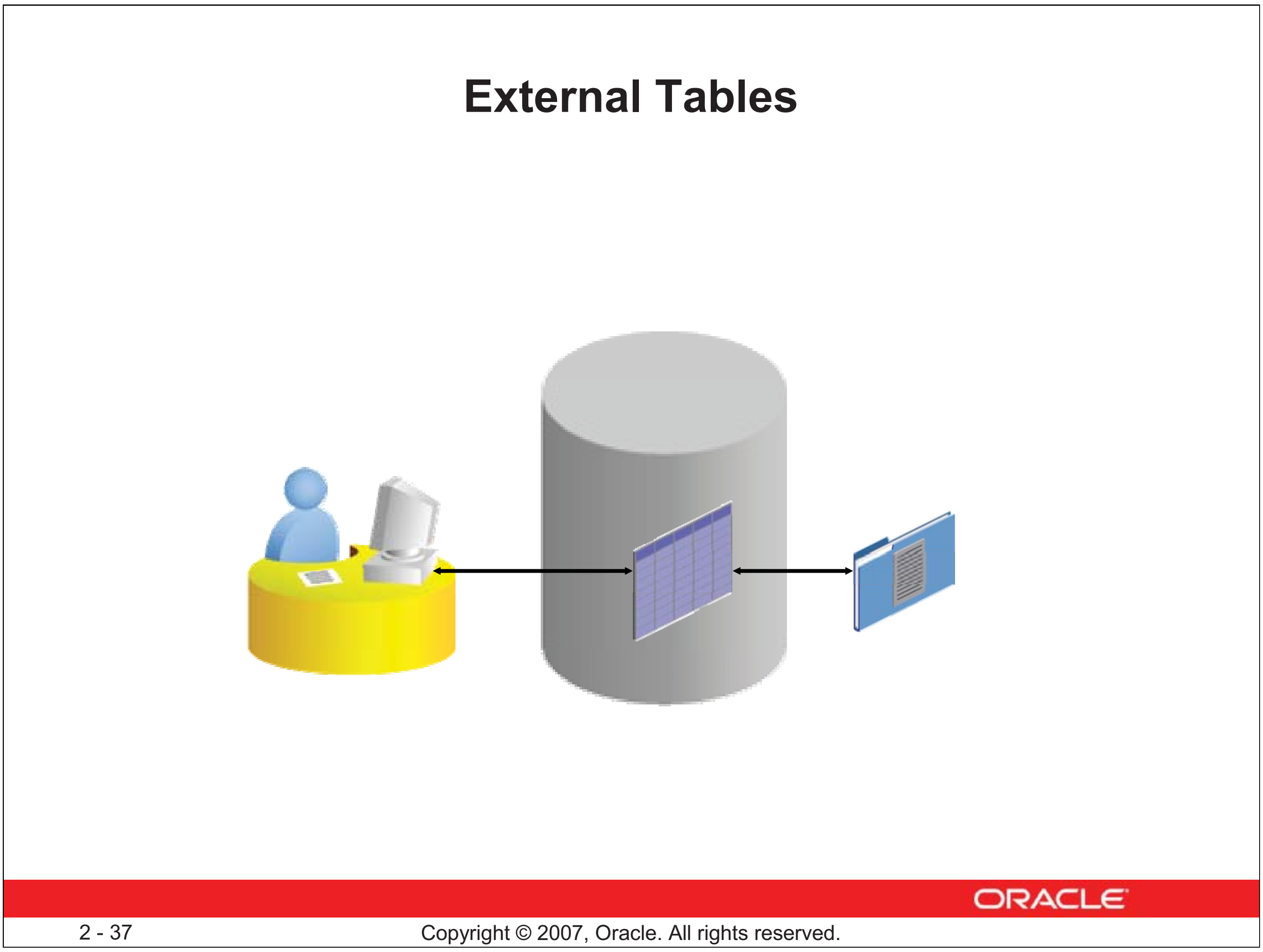


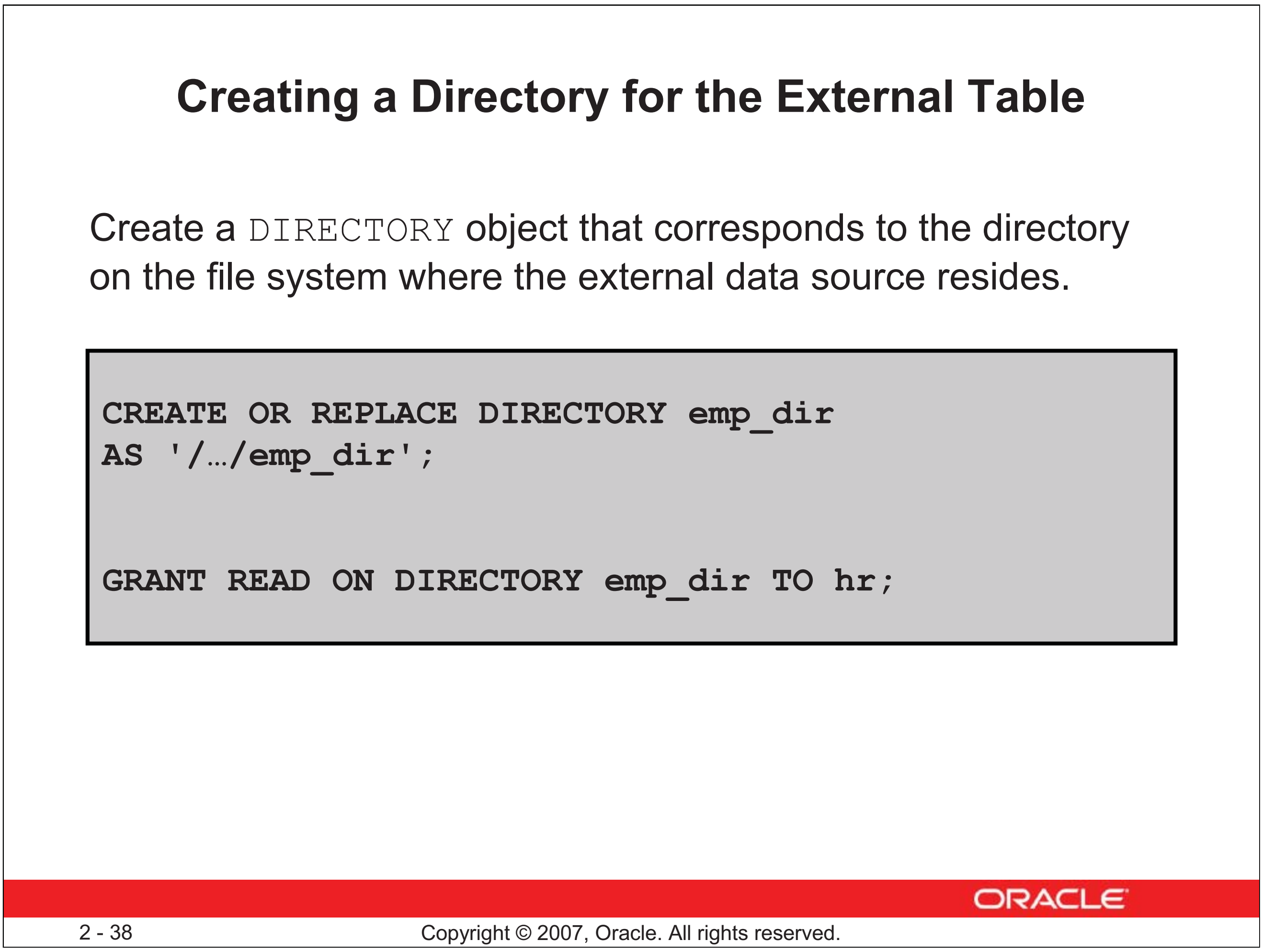
External Tables

External Tables

An external table is a read-only table whose metadata is stored in the database but whose data is stored outside the database. This external table definition can be thought of as a view that is used for running any SQL query against external data without requiring that the external data first be loaded into the database. The external table data can be queried and joined directly and in parallel without requiring that the external data first be loaded in the database. You can use SQL, PL/SQL and Java to query the data in an external table.

The main difference between external tables and regular tables is that externally organized tables are read-only. No data manipulation language (DML) operations are possible, and no indexes can be created on them. However, you can create an external table, and thus unload data, by using the `CREATE TABLE AS SELECT` command.

The Oracle server provides two major access drivers for external tables. One, the loader access driver (or `ORACLE_LOADER`) is used for reading data from external files whose format can be interpreted by the SQL*Loader utility. Note that not all SQL*Loader functionality is supported with external tables. The `ORACLE_DATAPUMP` access driver can be used to both import and export data using a platform-independent format. The `ORACLE_DATAPUMP` access driver writes rows from a `SELECT` statement to be loaded into an external table as part of a `CREATE TABLE ...ORGANIZATION EXTERNAL...AS SELECT` statement. You can then use `SELECT` to read data out of that data file. You can also create an external table definition on another system and use that data file. This allows data to be moved between Oracle databases.



Creating a Directory for the External Table

Create a `DIRECTORY` object that corresponds to the directory on the file system where the external data source resides.

```
CREATE OR REPLACE DIRECTORY emp_dir
AS '/…/emp_dir';


GRANT READ ON DIRECTORY emp_dir TO hr;
```

Example of Creating an External Table

Use the `CREATE DIRECTORY` statement to create a directory object. A directory object specifies an alias for a directory on the server's file system where an external data source resides. You can use directory names when referring to an external data source, rather than hard code the operating system path name, for greater file management flexibility.

You must have `CREATE ANY DIRECTORY` system privileges to create directories. When you create a directory, you are automatically granted the `READ` and `WRITE` object privileges and can grant `READ` and `WRITE` privileges to other users and roles. The DBA can also grant these privileges to other users and roles.

A user needs `READ` privileges for all directories used in external tables to be accessed and `WRITE` privileges for the log, bad, and discard file locations being used.

In addition, a `WRITE` privilege is necessary when the external table framework is being used to unload data.

Oracle also provides the `ORACLE_DATAPUMP` type, with which you can unload data (that is, read data from a table in the database and insert it into an external table) and then reload it into an Oracle database. This is a one-time operation that can be done when the table is created. After the creation and initial population is done, you cannot update, insert, or delete any rows.

Example of Creating an External Table (continued)

Syntax

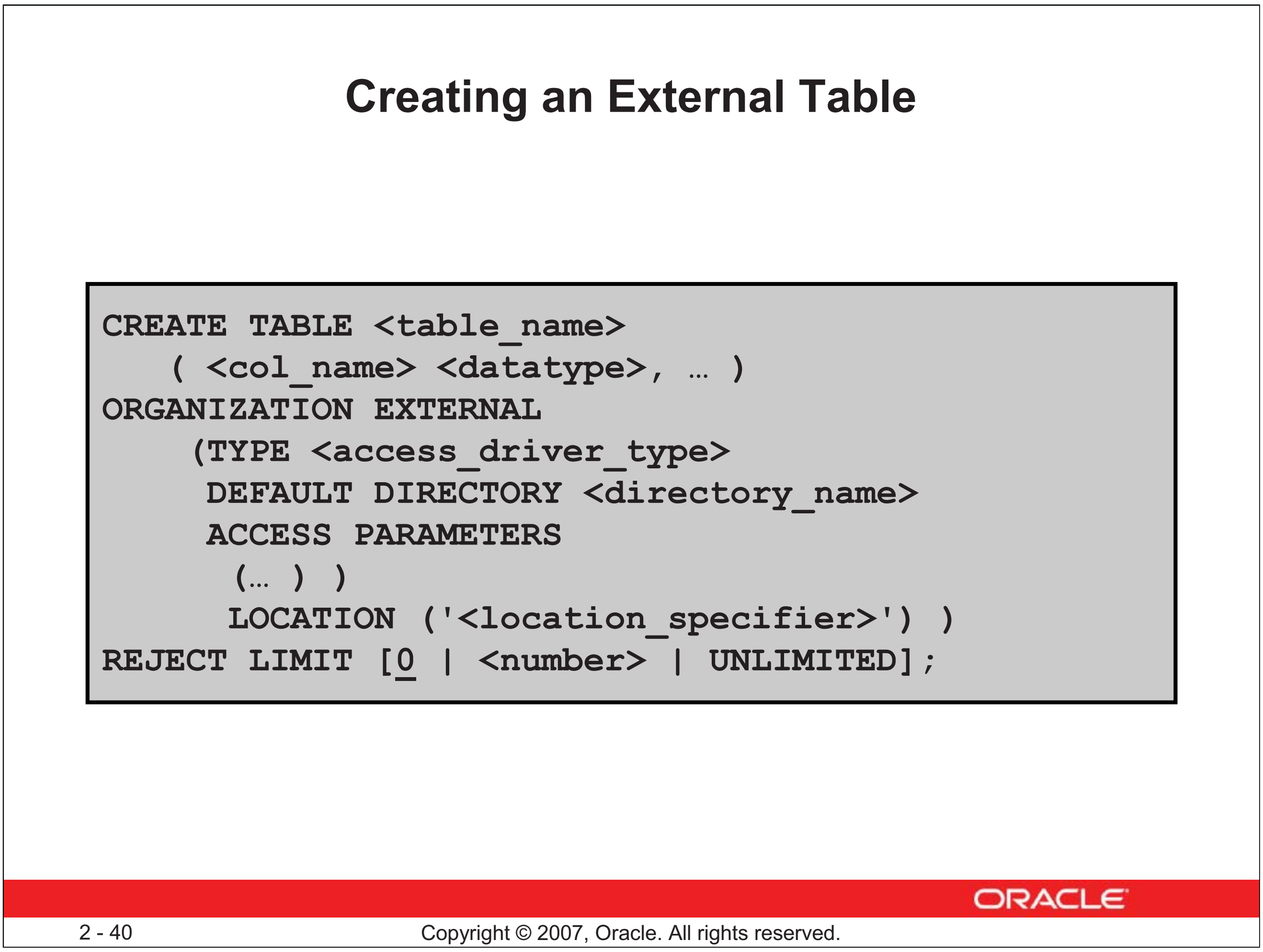
```
CREATE [OR REPLACE] DIRECTORY AS 'path_name';
```

In the syntax:

`OR REPLACE` Specify `OR REPLACE` to re-create the directory database object if it already exists. You can use this clause to change the definition of an existing directory without dropping, re-creating, and regranting database object privileges previously granted on the directory. Users who were previously granted privileges on a redefined directory can continue to access the directory without requiring that the privileges be regranted.

`directory` Specify the name of the directory object to be created. The maximum length of the directory name is 30 bytes. You cannot qualify a directory object with a schema name.

`'path_name'` Specify the full path name of the operating system directory to be accessed. The path name is case-sensitive.



Creating an External Table

```
CREATE TABLE <table_name>
   ( <col_name> <datatype>, … )
ORGANIZATION EXTERNAL
    (TYPE <access_driver_type>
     DEFAULT DIRECTORY <directory_name>
     ACCESS PARAMETERS
      (… ) )
      LOCATION ('<location_specifier>') )
REJECT LIMIT [0 | <number> | UNLIMITED];
```

Creating an External Table

You create external tables using the `ORGANIZATION EXTERNAL` clause of the `CREATE TABLE` statement. You are not, in fact, creating a table. Rather, you are creating metadata in the data dictionary that you can use to access external data. You use the `ORGANIZATION` clause to specify the order in which the data rows of the table are stored. By specifying `EXTERNAL` in the `ORGANIZATION` clause, you indicate that the table is a read-only table located outside the database. Note that the external files must already exist outside the database.

`TYPE` *`<access_driver_type>`* indicates the access driver of the external table. The access driver is the application programming interface (API) that interprets the external data for the database. If you do not specify `TYPE`, Oracle uses the default access driver, `ORACLE_LOADER`. The other option is `ORACLE_DATAPUMP`.

You use the `DEFAULT DIRECTORY` clause to specify one or more Oracle database directory objects that correspond to directories on the file system where the external data sources may reside.

The optional `ACCESS PARAMETERS` clause enables you to assign values to the parameters of the specific access driver for this external table.

Creating an External Table (continued)

Use the LOCATION clause to specify one external locator for each external data source. Usually, *<location_specifier>* is a file, but it need not be.

The REJECT LIMIT clause enables you to specify how many conversion errors can occur during a query of the external data before an Oracle error is returned and the query is aborted. The default value is 0.

The syntax for using the ORACLE_DATAPUMP access driver is as follows:

```
CREATE TABLE extract_emps
ORGANIZATION EXTERNAL (TYPE ORACLE_DATAPUMP
                       DEFAULT DIRECTORY …
                       ACCESS PARAMETERS (… )
                       LOCATION (…)
                       PARALLEL 4
                       REJECT LIMIT UNLIMITED
AS
SELECT * FROM …;
```

Creating an External Table by Using ORACLE_LOADER

```
CREATE TABLE oldemp (
  fname char(25), lname CHAR(25))
  ORGANIZATION EXTERNAL
  (TYPE ORACLE_LOADER
  DEFAULT DIRECTORY emp_dir
  ACCESS PARAMETERS
  (RECORDS DELIMITED BY NEWLINE
   NOBADFILE
   NOLOGFILE
  FIELDS TERMINATED BY ','
  (fname POSITION ( 1:20) CHAR,
   lname POSITION (22:41) CHAR))
  LOCATION ('emp.dat'))
  PARALLEL 5
  REJECT LIMIT 200;
```

```
CREATE TABLE succeeded.
```

Example of Creating an External Table by Using the ORACLE_LOADER Access Driver

Assume that there is a flat file that has records in the following format:

```
10,jones,11-Dec-1934
20,smith,12-Jun-1972
```

Records are delimited by new lines, and the fields are all terminated by a comma (,). The name of the file is /emp_dir/emp.dat.

To convert this file as the data source for an external table, whose metadata will reside in the database, you must perform the following steps:

1. Create a directory object, emp_dir, as follows:
   ```
   CREATE DIRECTORY emp_dir AS '/emp_dir' ;
   ```
2. Run the CREATE TABLE command shown in the slide.

The example in the slide illustrates the table specification to create an external table for the file:

```
/emp_dir/emp.dat
```

Example of Creating an External Table by Using the ORACLE_LOADER Access Driver (continued)

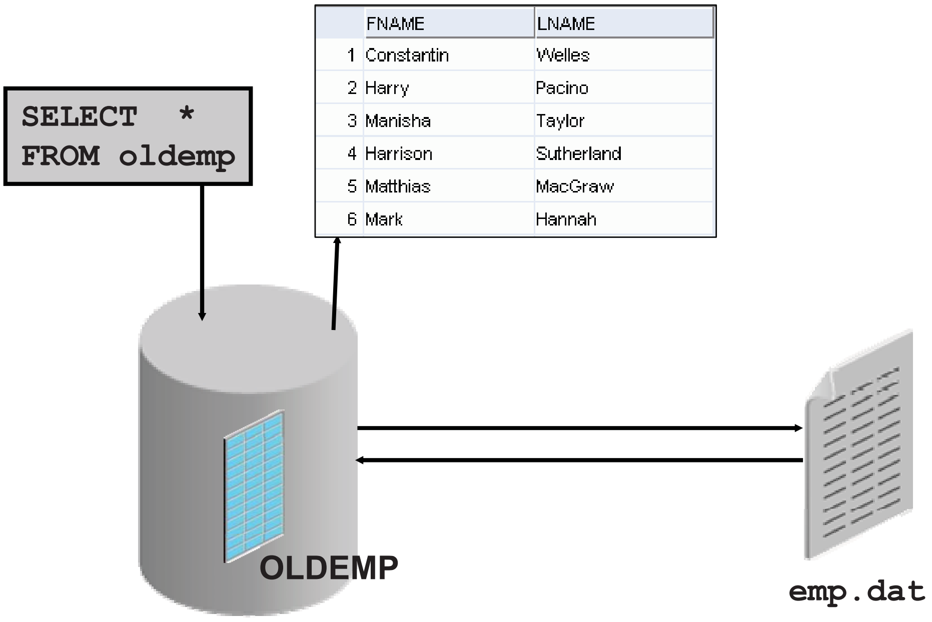
In the example, the TYPE specification is given only to illustrate its use. ORACLE_LOADER is the default access driver if not specified. The ACCESS PARAMETERS option provides values to parameters of the specific access driver, which are interpreted by the access driver, not by the Oracle server.

The PARALLEL clause enables five parallel execution servers to simultaneously scan the external data sources (files) when executing the INSERT INTO TABLE statement. For example, if PARALLEL=5 were specified, then more than one parallel execution server can be working on a data source. Because external tables can be very large, for performance reasons, it is advisable to specify the PARALLEL clause, or a parallel hint for the query.

The REJECT LIMIT clause specifies that if more than 200 conversion errors occur during a query of the external data, then the query be aborted and an error be returned. These conversion errors can arise when the access driver tries to transform the data in the data file to match the external table definition.

After the CREATE TABLE command executes successfully, the OLDEMP external table can be described and queried like a relational table.

Querying External Tables



```
SELECT  *
FROM oldemp
```

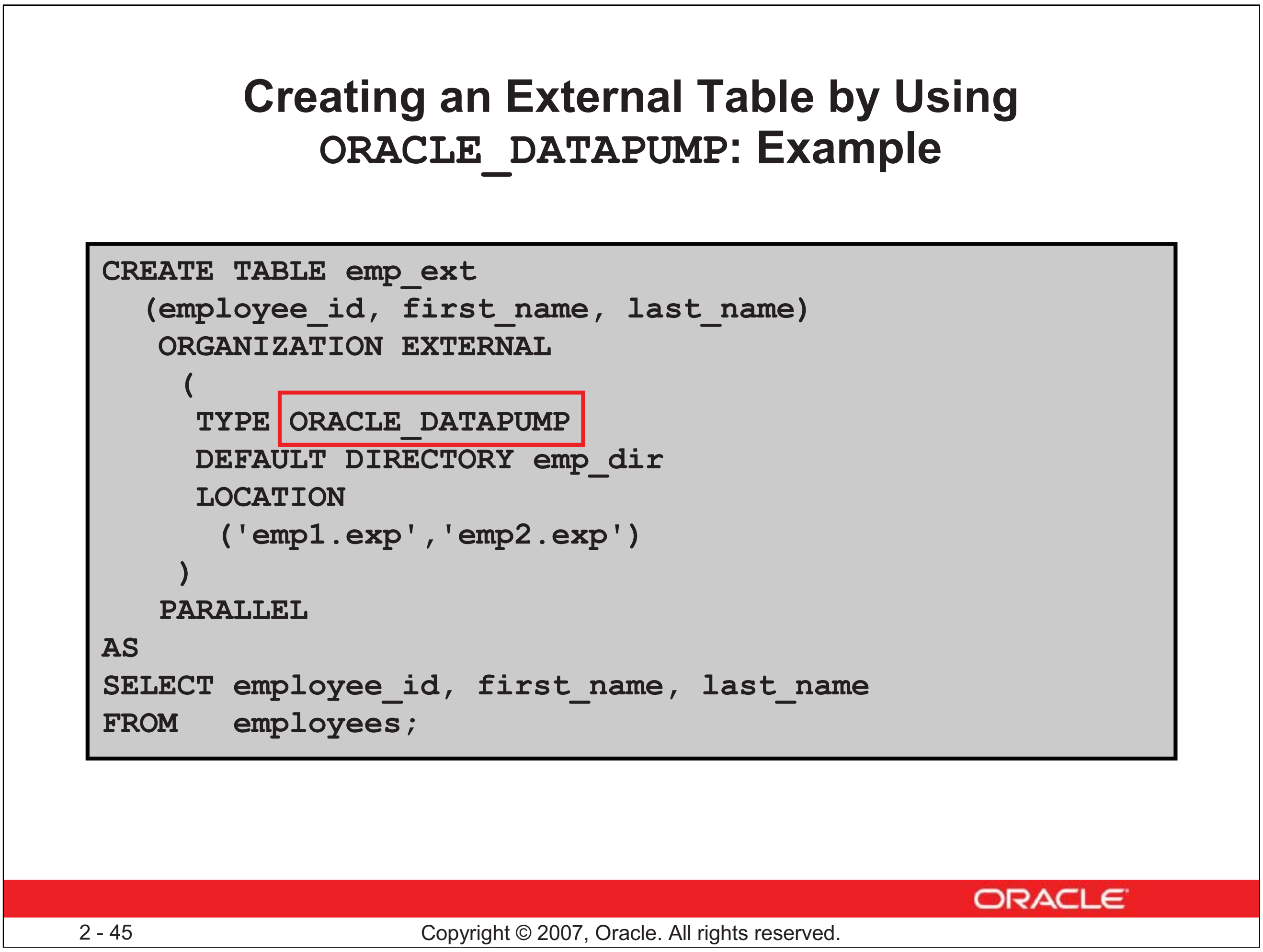
	FNAME	LNAME
1	Constantin	Welles
2	Harry	Pacino
3	Manisha	Taylor
4	Harrison	Sutherland
5	Matthias	MacGraw
6	Mark	Hannah

Querying External Tables

An external table does not describe any data that is stored in the database. It does not describe how data is stored in the external source. Instead, it describes how the external table layer must present the data to the server. It is the responsibility of the access driver and the external table layer to do the necessary transformations required on the data in the data file so that it matches the external table definition.

When the database server accesses data in an external source, it calls the appropriate access driver to get the data from an external source in a form that the database server expects.

It is important to remember that the description of the data in the data source is separate from the definition of the external table. The source file can contain more or fewer fields than there are columns in the table. Also, the data types for fields in the data source can be different from the columns in the table. The access driver takes care of ensuring that the data from the data source is processed so that it matches the definition of the external table.



Creating an External Table by Using ORACLE_DATAPUMP: Example

```
CREATE TABLE emp_ext
  (employee_id, first_name, last_name)
   ORGANIZATION EXTERNAL
    (
     TYPE ORACLE_DATAPUMP
     DEFAULT DIRECTORY emp_dir
     LOCATION
      ('emp1.exp','emp2.exp')
    )
   PARALLEL
AS
SELECT employee_id, first_name, last_name
FROM   employees;
```

2 - 45

Creating an External Table by Using ORACLE_DATAPUMP: Example

You can perform the unload and reload operations with external tables by using the ORACLE_DATAPUMP access driver.

Note: In the context of external tables, loading data refers to the act of data being read from an external table and loaded into a table in the database. Unloading data refers to the act of reading data from a table and inserting it into an external table.

The example in the slide illustrates the table specification to create an external table by using the ORACLE_DATAPUMP access driver. Data is then populated into the two files: emp1.exp and emp2.exp.

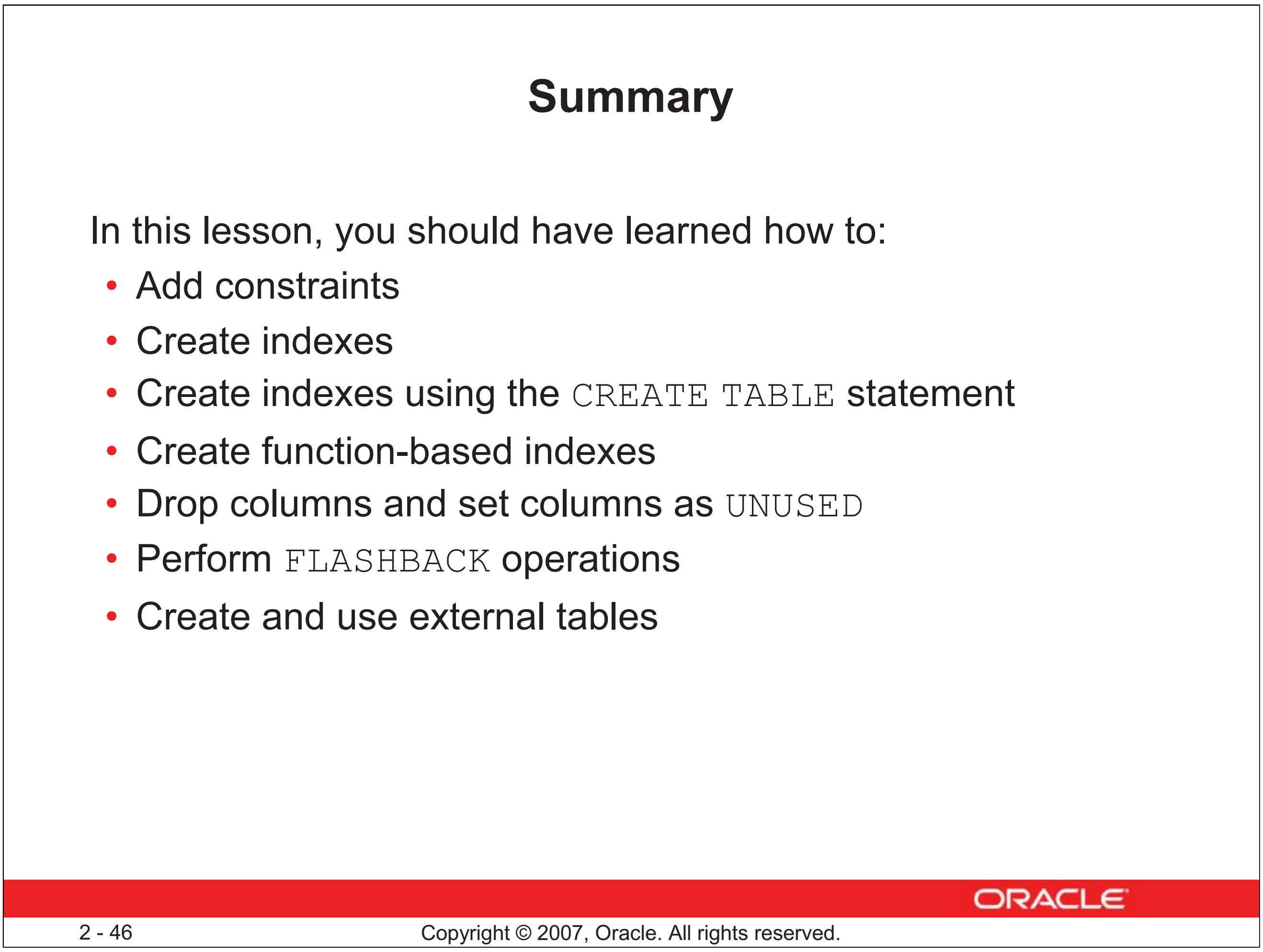
To populate data read from the EMPLOYEES table into an external table, you must perform the following steps:

1. Create a directory object, emp_dir, as follows:
   ```
   CREATE DIRECTORY emp_dir AS '/emp_dir' ;
   ```
2. Run the CREATE TABLE command shown in the slide.

Note: The emp_dir directory is the same as created in the previous example of using ORACLE_LOADER.

You can query the external table by executing the following code:

```
SELECT * FROM emp_ext;
```



Summary

In this lesson, you should have learned how to:

- Add constraints
- Create indexes
- Create indexes using the `CREATE TABLE` statement
- Create function-based indexes
- Drop columns and set columns as `UNUSED`
- Perform `FLASHBACK` operations
- Create and use external tables

2 - 46

Summary

Alter tables to add or modify columns or constraints. Create indexes and function-based indexes using the `CREATE INDEX` statement. Drop unused columns. Use `FLASHBACK` mechanics to restore tables. Use the `external_table` clause to create an external table, which is a read-only table whose metadata is stored in the database but whose data is stored outside the database. Use external tables to query data without first loading it into the database. Name your `PRIMARY KEY` column indexes as you create the table with the `CREATE TABLE` statement.