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Database Programming with PL/SQL

10-2
Managing Package Concepts

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Objectives

This lesson covers the following objectives:

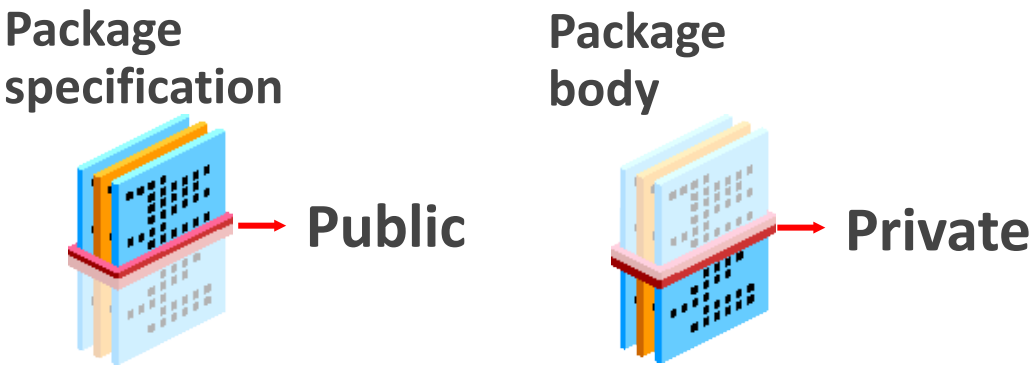
- Explain the difference between public and private package constructs
- Designate a package construct as either public or private
- Specify the appropriate syntax to drop packages
- Identify views in the Data Dictionary that manage packages
- Identify guidelines for using packages

Purpose

- How would you create a procedure or function that cannot be invoked directly from an application (maybe for security reasons), but can be invoked only from other PL/SQL subprograms?
- You would create a private subprogram within a package.
- In this lesson, you learn how to create private subprograms.
- You also learn how to drop packages, and how to view them in the Data Dictionary.
- You also learn about the additional benefits of packages.

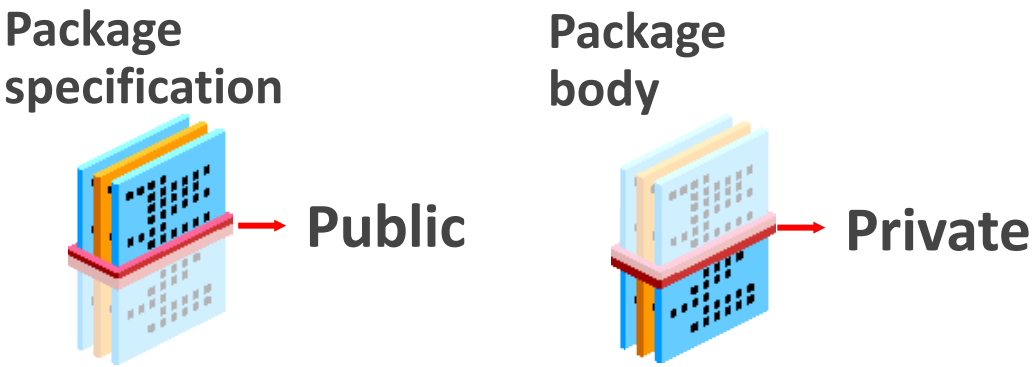
Components of a PL/SQL Package

- Public components are declared in the package specification.
- You can invoke public components from any calling environment, provided the user has been granted EXECUTE privilege on the package.



Components of a PL/SQL Package

- Private components are declared only in the package body and can be referenced only by other (public or private) constructs within the same package body.
- Private components can reference the package's public components.



Visibility of Package Components

- The *visibility* of a component describes whether that component can be seen, that is, referenced and used by other components or objects.
- Visibility of components depends on where they are declared.

Visibility of Package Components

You can declare components in three places within a package:

- Globally in the package specification: these components are visible throughout the package body and by the calling environment
- Locally in the package body, but outside any subprogram, these components are visible throughout the package body, but not by the calling environment
- Locally in the package body, within a specific subprogram, these components are visible only within that subprogram.

Global/Local Compared to Public/Private

- Remember that public components declared in the specification are visible to the calling environment, while private components declared only within the body are not.
- Therefore all public components are global, while all private components are local.
- So what's the difference between public and global, and between private and local?

Global/Local Compared to Public/Private

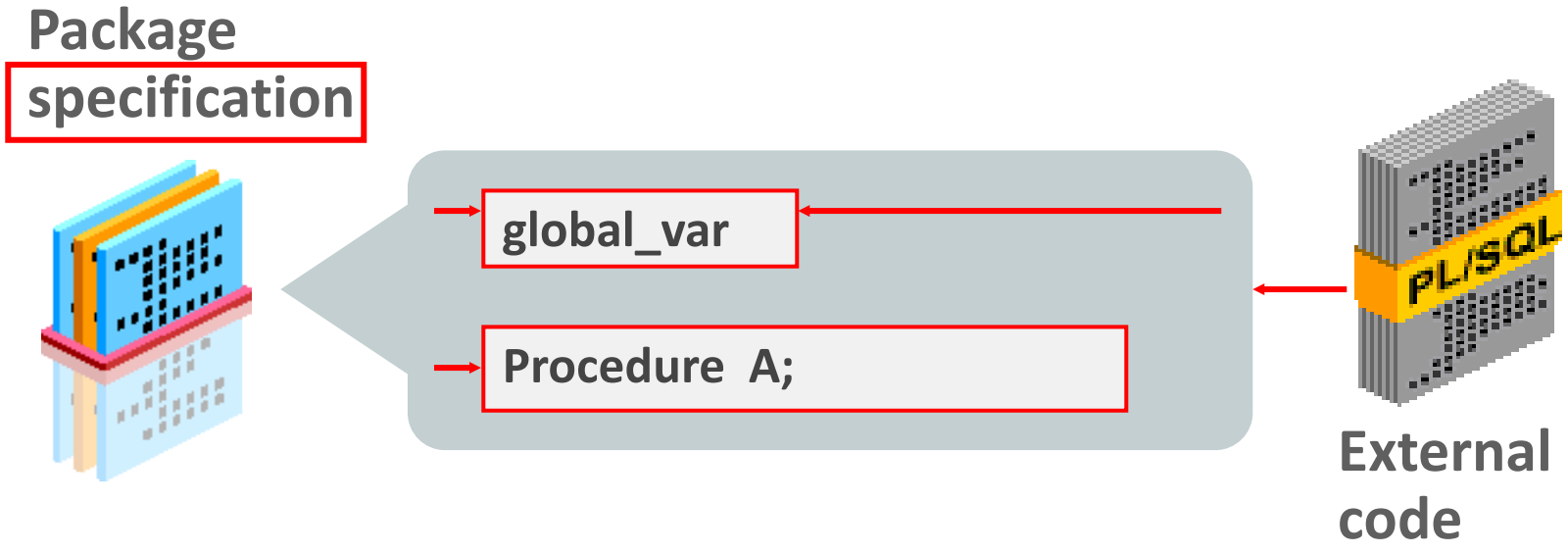
- The answer is “no difference”—they are the same thing!
- But you use public/private when describing procedures and functions, and global/local when describing other components such as variables, constants, and cursors.

Visibility of Global (Public) Components

Globally declared components are visible internally and externally to the package, such as:

- A global variable declared in a package specification can be referenced and changed outside the package (for example, `global_var` can be referenced externally).
- A public subprogram declared in the specification can be called from external code sources (for example, `Procedure A` can be called from an environment external to the package).

Visibility of Global (Public) Components

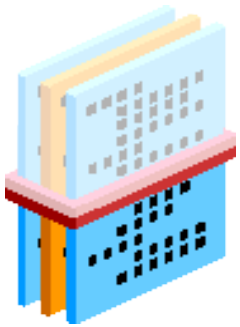


Visibility of Local (Private) Components

Local components are visible only within the structure in which they are declared, such as the following:

- Local variables defined within a specific subprogram can be referenced only within that subprogram, and are not visible to external components.
- Local variables that are declared in a package body can be referenced by other components in the same package body.
- They are not visible to any subprograms or objects that are outside the package.

Visibility of Local (Private) Components



Package body

variable_1

```
Procedure  B  IS
BEGIN … END;
```

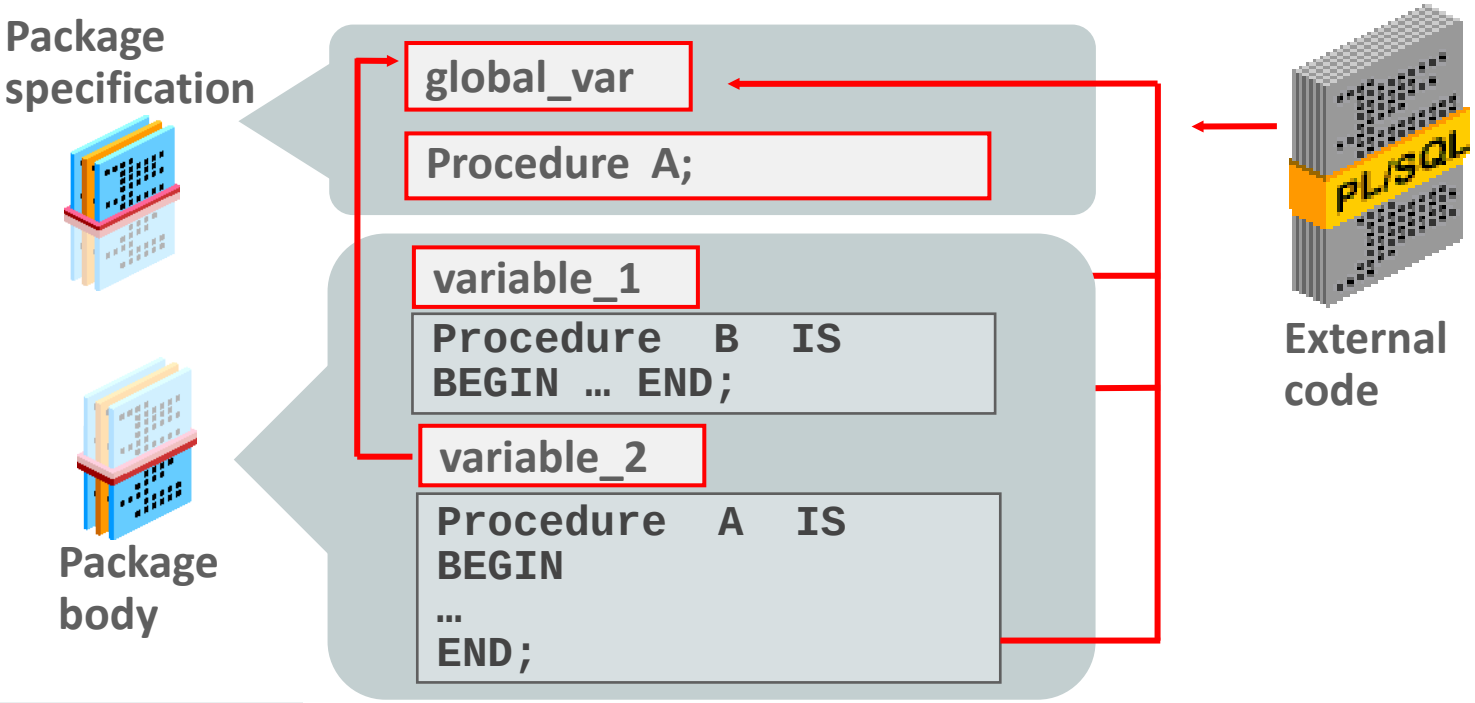
variable_2

```
Procedure  A  IS

BEGIN
…
END;
```

Visibility of Local (Private) Components

Note: Private subprograms, such as `Procedure B`, can be invoked only with public subprograms, such as `Procedure A`, or other private package constructs.



Example of Package Specification: salary_pkg:

- You have a business rule that no employee's salary can be increased by more than 20 percent at one time.

```
CREATE OR REPLACE PACKAGE salary_pkg
IS
  g_max_sal_raise CONSTANT NUMBER := 0.20;
  PROCEDURE update_sal
     (p_employee_id   employees.employee_id%TYPE,
      p_new_salary    employees.salary%TYPE);
END salary_pkg;
```

- g_max_sal_raise is a global constant initialized to 0.20.
- update_sal is a public procedure that updates an employee's salary.

Example of Package Body: salary_pkg:

```
CREATE OR REPLACE PACKAGE BODY salary_pkg IS
  FUNCTION validate_raise  -- private function
    (p_old_salary employees.salary%TYPE,
     p_new_salary employees.salary%TYPE)
  RETURN BOOLEAN IS
  BEGIN
    IF  p_new_salary >
       (p_old_salary * (1 + g_max_sal_raise)) THEN
      RETURN FALSE;
    ELSE
      RETURN TRUE;
    END IF;
  END validate_raise;

  -- next slide shows the public procedure
```

Example of Package Body: salary_pkg:

```
...
 PROCEDURE update_sal   -- public procedure
   (p_employee_id   employees.employee_id%TYPE,
    p_new_salary    employees.salary%TYPE)
 IS  v_old_salary   employees.salary%TYPE; -- local variable
 BEGIN
   SELECT salary INTO v_old_salary FROM employees
      WHERE employee_id = p_employee_id;
   IF validate_raise(v_old_salary, p_new_salary) THEN
      UPDATE employees SET salary = p_new_salary
         WHERE employee_id = p_employee_id;
   ELSE
     RAISE_APPLICATION_ERROR(-20210, 'Raise too high');
   END IF;
 END update_sal;
END salary_pkg;
```

Invoking Package Subprograms

After the package is stored in the database, you can invoke subprograms stored within the same package or stored in another package.

Within the same package	**Specify the subprogram name** **`Subprogram;`** **You can fully qualify a subprogram within the same package, but this is optional.** **`package_name.subprogram;`**
External to the package	**Fully qualify the (public) subprogram with its package name** **`package_name.subprogram;`**

Invoking Package Subprograms

Which of the following invocations from outside the `salary_pkg` are valid (assuming the caller either owns or has EXECUTE privilege on the package)?

```
DECLARE
  v_bool    BOOLEAN;
  v_number  NUMBER;
BEGIN
  salary_pkg.update_sal(100,25000);                    -- 1
  update_sal(100,25000);                               -- 2
  v_bool := salary_pkg.validate_raise(24000,25000); -- 3
  v_number := salary_pkg.g_max_sal_raise;              -- 4
  v_number := salary_pkg.v_old_salary;                 -- 5
END;
```

Removing Packages

- To remove the entire package, specification and body, use the following syntax:

```
DROP PACKAGE package_name;
```

- To remove only the package body, use the following syntax:

```
DROP PACKAGE BODY package_name;
```

- You cannot remove the package specification on its own.

Viewing Packages in the Data Dictionary

- The source code for PL/SQL packages is maintained and is viewable through the USER_SOURCE and ALL_SOURCE tables in the Data Dictionary.
- To view the package specification, use:

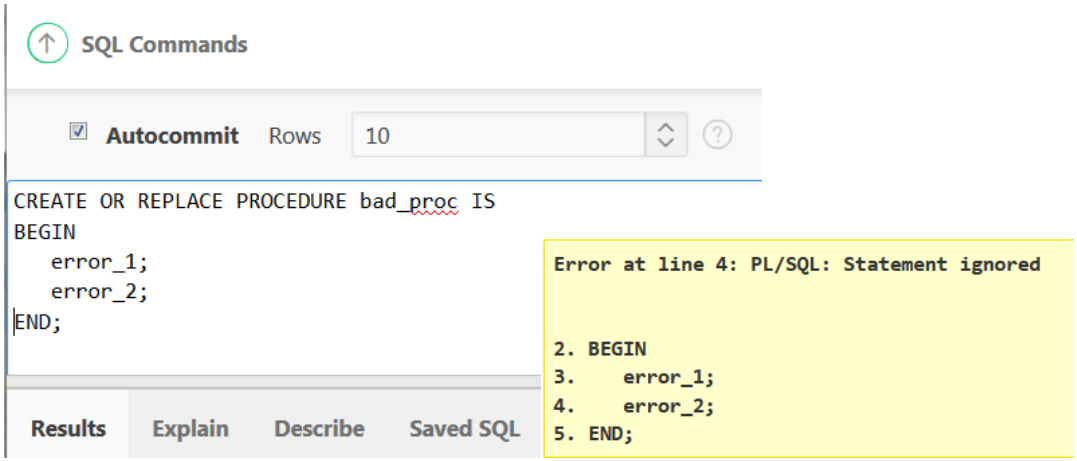
```
SELECT text
  FROM   user_source
  WHERE  name = 'SALARY_PKG' AND type = 'PACKAGE'
  ORDER BY line;
```

- To view the package body, use:

```
SELECT text
  FROM   user_source
  WHERE  name = 'SALARY_PKG' AND type = 'PACKAGE BODY'
  ORDER BY line;
```

Using USER_ERRORS

- When a PL/SQL subprogram fails to compile, Application Express displays the error number and message text for the FIRST error.



- You can query USER_ERRORS to see all errors.

Using USER_ERRORS

- To see all the errors (not just the first one), you query the USER_ERRORS dictionary table:

```
CREATE OR REPLACE PROCEDURE bad_proc
IS BEGIN
  error_1;  -- this is an error
  error_2;  -- this is another error
END;
```

```
SELECT line, text, position  -- where and error message
  FROM USER_ERRORS
  WHERE name = 'BAD_PROC' AND type = 'PROCEDURE'
  ORDER BY sequence;
```

- The output of this code is on the next slide.

Using USER_ERRORS

- The code on the previous slide produces this output:

LINE	TEXT	POSITION
3	PLS-00201: identifier 'ERROR_1' must be declared	4
3	PL/SQL: Statement ignored	4
4	PLS-00201: identifier 'ERROR_2' must be declared	4
4	PL/SQL: Statement ignored	4

- USER_ERRORS does not show the source code.
- We can `JOIN` our query to USER_SOURCE to see the source code as well. The next slide shows how.

Adding USER_SOURCE

Join USER_SOURCE and USER_ERRORS to see a more complete picture of the compile errors.

```
SELECT e.line, e.position, s.text AS SOURCE, e.text AS ERROR
  FROM USER_ERRORS e, USER_SOURCE s
  WHERE e.name = s.name AND e.type = s.type
    AND e.line = s.line
    AND e.name = 'BAD_PROC' and e.type = 'PROCEDURE'
  ORDER BY e.sequence;
```

LINE	POSITION	SOURCE	ERROR
3	4	error_1;	PLS-00201: identifier 'ERROR_1' must be declared
3	4	error_1;	PL/SQL: Statement ignored
4	4	error_2;	PLS-00201: identifier 'ERROR_2' must be declared
4	4	error_2;	PL/SQL: Statement ignored

Guidelines for Writing Packages

- Construct packages for general use.
- Create the package specification before the body.
- The package specification should contain only those constructs that you want to be public/global.
- Only recompile the package body, if possible, because changes to the package specification require recompilation of all programs that call the package.
- The package specification should contain as few constructs as possible.

Advantages of Using Packages

- Modularity: Encapsulating related constructs.
- Easier maintenance: Keeping logically related functionality together.
- Easier application design: Coding and compiling the specification and body separately.
- Hiding information:
  - Only the declarations in the package specification are visible and accessible to applications.
  - Private constructs in the package body are hidden and inaccessible.
  - All coding is hidden in the package body.

Advantages of Using Packages

- Added functionality: Persistency of variables and cursors
- Better performance:
  - The entire package is loaded into memory when the package is first referenced.
  - There is only one copy in memory for all users.
  - The dependency hierarchy is simplified.
- Overloading: Multiple subprograms having the same name.

Terminology

Key terms used in this lesson included:

- Private components
- Public components
- Visibility

Summary

In this lesson, you should have learned how to:

- Explain the difference between public and private package constructs
- Designate a package construct as either public or private
- Specify the appropriate syntax to drop packages
- Identify views in the Data Dictionary that manage packages
- Identify guidelines for using packages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