Oracle® TimesTen In-Memory Database

PL/SQL Developer's Guide

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Oracle TimesTen In-Memory Database PL/SQL Developer's Guide, Release 26.1

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Contents

3 Data Types in PL/SQL in TimesTen

4 Errors and Exception Handling

5 Examples Using TimesTen SQL in PL/SQL

8 TimesTen PL/SQL Support: Reference Summary

About This Content

TimesTen supports standard application interfaces JDBC, ODBC, and ODP.NET; Oracle interfaces PL/SQL, OCI, and Pro*C/C++; and the TimesTen TTClasses library for C++. This document covers PL/SQL.

Audience

This document is intended for anyone developing or supporting applications that use PL/SQL with TimesTen. Although it provides some overview, you should be familiar with PL/SQL or have access to more detailed documentation.

You should also be familiar with TimesTen, SQL (Structured Query Language), and database operations.

You would typically use PL/SQL through some programming interface such as those mentioned above, so should also consult the appropriate TimesTen developer documentation.

Documentation Accessibility

For information about Oracle's commitment to accessibility, visit the Oracle Accessibility Program website at http://www.oracle.com/pls/topic/lookup?ctx=acc&id=docacc.

Access to Oracle Support

Oracle customers that have purchased support have access to electronic support through My Oracle Support. For information, visit http://www.oracle.com/pls/topic/lookup?ctx=acc&id=info or visit http://www.oracle.com/pls/topic/lookup?ctx=acc&id=trs if you are hearing impaired.

Related Resources

Oracle Database documentation is available on the Oracle documentation website. This may be especially useful for Oracle Database features that TimesTen supports but does not attempt to fully document, such as OCI and Pro*C/C++. In particular, these Oracle Database documents may be of interest:

-
-
-
-

In addition, numerous third-party documents are available that describe PL/SQL in detail.

Conventions

The following text conventions are used in this document.

Convention	Meaning
boldface	Boldface type indicates graphical user interface elements associated with an action, or terms defined in text or the glossary.
italic	Italic type indicates book titles, emphasis, or placeholder variables for which you supply particular values.
`monospace`	Monospace type indicates commands within a paragraph, URLs, code in examples, text that appears on the screen, or text that you enter.

1

Introduction to PL/SQL in TimesTen

This chapter provides a brief introduction to TimesTen PL/SQL.

Overview of PL/SQL Features

This overview introduces PL/SQL features.

About PL/SQL

TimesTen supports PL/SQL (Procedural Language Extension to SQL), a programming language that enables you to integrate procedural constructs with SQL in your database.

TimesTen Release 26.1 implements the PL/SQL language from Oracle Database release 26ai. As such, most PL/SQL features present in that release of Oracle Database are also present in TimesTen, operating in essentially the same way. (Refer to TimesTen PL/SQL Support: Reference Summary for differences.)

Features of PL/SQL in TimesTen

PL/SQL support in TimesTen enables you to do several things.

- Take full advantage of the PL/SQL programming language.
- Execute PL/SQL from your client applications that use these APIs:
  - ODBC
  - JDBC
  - Oracle Call Interface (OCI)
  - Oracle Pro*C/C++
  - Oracle Data Provider for .NET (ODP.NET)
  - TTClasses (TimesTen C++ library)
- Execute TimesTen SQL from PL/SQL.
- Create, alter, or drop standalone procedures, functions, packages and package bodies.
- Use PL/SQL packages to extend your database functionality and to provide PL/SQL access to SQL features.
- Handle exceptions and errors in your PL/SQL applications.

- Set connection attributes in your database to customize your PL/SQL environment.
- Alter session parameters so you can manage your PL/SQL environment.
- Display PL/SQL metadata in your database by using PL/SQL system views.

> **Note**
>
> See Privileges for PL/SQL Statements and Operations in *Oracle TimesTen In-Memory Database Security Guide*.

TimesTen PL/SQL Components and Operations

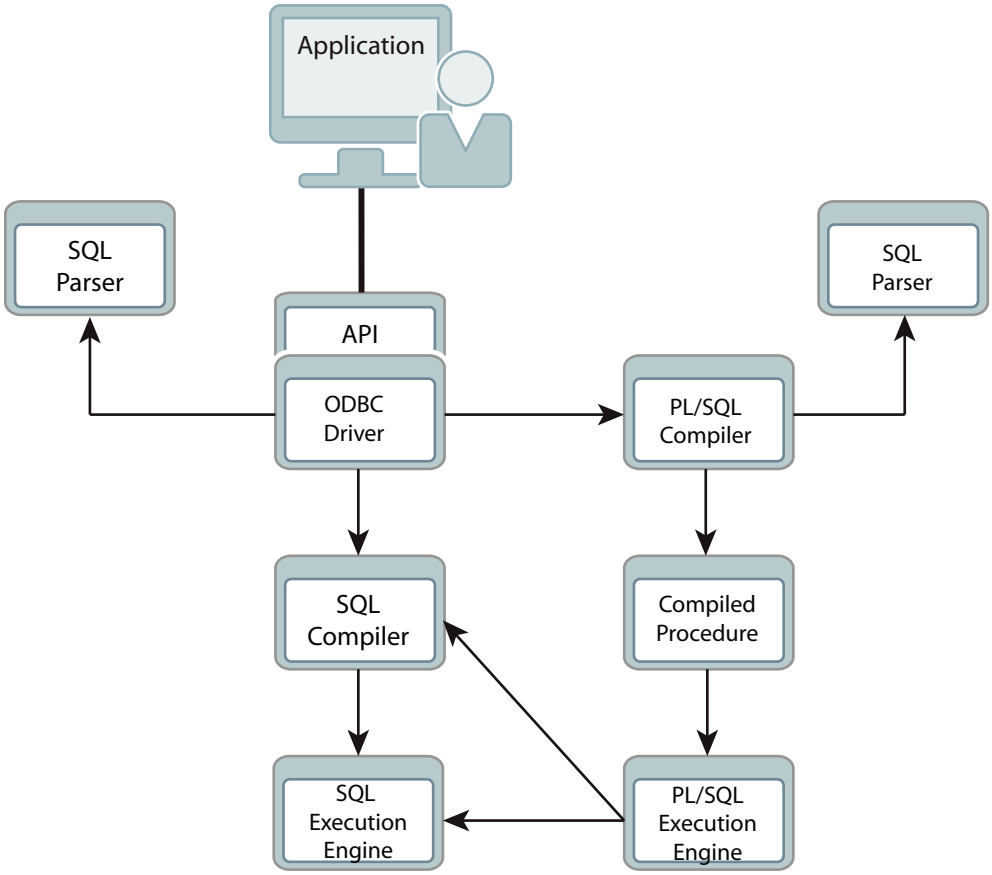
This section provides an overview of PL/SQL operations in TimesTen, including discussion of how an application interacts with PL/SQL and how PL/SQL components interact with other components of TimesTen.

The following topics are covered:

Application Interaction with TimesTen and PL/SQL

PL/SQL components interact with each other and with other TimesTen components during PL/SQL operations.

Figure 1-1 TimesTen PL/SQL Components



An application uses the API of its choice—ODBC, JDBC, OCI, Pro*C, ODP.NET, or TTClasses—to send requests to the database. ODBC is the TimesTen native API, so each of the other APIs ultimately calls the ODBC layer.

The ODBC driver calls the TimesTen SQL parser to examine each incoming request and determine whether it is SQL or PL/SQL. The request is then passed to the appropriate subsystem within TimesTen. PL/SQL source and SQL statements are compiled, optimized and executed by the PL/SQL subsystem and SQL subsystem, respectively.

The PL/SQL compiler is responsible for generating executable code from PL/SQL source, while the SQL compiler does the same for SQL statements. Each compiler generates intermediate code that can then be executed by the appropriate PL/SQL or SQL execution engine. This executable code, along with metadata about the PL/SQL blocks, is then stored in tables in the database.

When PL/SQL blocks are executed, the PL/SQL execution engine is invoked. As PL/SQL blocks in turn invoke SQL, the PL/SQL execution engine calls the TimesTen SQL compiler and the TimesTen SQL execution engine to handle SQL execution.

> **Note**
>
> The introduction of PL/SQL into TimesTen has little impact on applications that do not use it. If applications execute SQL directly, then requests are passed from the TimesTen ODBC driver to the TimesTen SQL compiler and execution engine in the same way as in previous releases.

PL/SQL in TimesTen Versus PL/SQL in Oracle Database

This section discusses PL/SQL processing and the differences between TimesTen and Oracle Database.

About PL/SQL Processing

PL/SQL processing in TimesTen is largely identical to the processing in Oracle Database.

The PL/SQL compiler and execution engine that are included with TimesTen originated in Oracle Database, and the relationship between PL/SQL components and the SQL compiler and execution engine is comparable. The tables used to store PL/SQL units are the same in TimesTen and Oracle Database, as are the views that are available to query information about stored PL/SQL units.

Beyond these basic similarities, however, are some potentially significant differences. These are detailed in the sections that follow

SQL Statements in PL/SQL Blocks

In TimesTen, as in Oracle Database, PL/SQL blocks may include SQL statements.

Consider the anonymous block in the following example:

```
Command> create table tab2 (x number, last_name VARCHAR2 (25) INLINE NOT
NULL);
Command> declare
            x number;
         begin
            select salary into x from employees where last_name = 'Whalen';
            insert into tab2 values(x, 'Whalen');
         end;
         /

PL/SQL procedure successfully completed.
```

The PL/SQL compiler in TimesTen calls a copy of the Oracle Database SQL parser to analyze and validate the syntax of such SQL statements. This Oracle Database parser is included in TimesTen for this purpose. As part of this processing, PL/SQL may rewrite parts of the SQL statements (for example, by removing `INTO` clauses or replacing PL/SQL variables with binds). This processing is identical in TimesTen and in Oracle Database. The rewritten SQL statements are then included in the executable code for the PL/SQL block. When the PL/SQL

block is executed, these SQL statements are compiled and executed by the TimesTen SQL subsystem.

In Oracle Database, the same SQL parser is used by the PL/SQL compiler and the SQL compiler. In TimesTen, however, different SQL parsers are used. TimesTen PL/SQL uses the Oracle Database SQL parser, while TimesTen SQL uses the native TimesTen SQL parser. This difference is typically, but not always, transparent to the end user. In particular, be aware of the following:

- SQL statements in TimesTen PL/SQL programs must obey Oracle Database SQL syntax. While TimesTen SQL is generally a subset of Oracle Database SQL, there are some expressions that are permissible in TimesTen SQL but not in Oracle Database SQL. Such TimesTen-specific SQL operations cannot be used within PL/SQL *except* by using dynamic SQL through `EXECUTE IMMEDIATE` statements or the `DBMS_SQL` package. See Dynamic SQL in PL/SQL (EXECUTE IMMEDIATE Statement).
- SQL statements that would be permissible in Oracle Database are accepted by the PL/SQL compiler as valid even if they cannot be executed by TimesTen. If SQL features are used that TimesTen does not support, compilation of a PL/SQL block may be successful, but a runtime error would occur when the PL/SQL block is executed.

Execution of PL/SQL from SQL

In Oracle Database, PL/SQL blocks can invoke SQL statements, and SQL statements can in turn invoke PL/SQL functions. For example, a stored procedure can invoke an `UPDATE` statement that employs a user-written PL/SQL function in its `WHERE` clause.

In TimesTen, a SQL statement cannot invoke a PL/SQL function.

In addition, TimesTen does not support triggers. (See XLA and TimesTen Event Management in *Oracle TimesTen In-Memory Database C Developer's Guide* for information about XLA, a high-performance, asynchronous TimesTen alternative to triggers.)

Audiences for This Document

There are two primary developer audiences for this document:

- Developers experienced with Oracle Database and Oracle Database PL/SQL who want to learn how to use PL/SQL in TimesTen: These readers want to learn the differences between PL/SQL in Oracle Database and PL/SQL in TimesTen.
- Developers experienced with TimesTen who are not familiar with PL/SQL: These readers need general information about PL/SQL.

These audiences are discussed in the sections that follow:

Developers Experienced with Oracle Database and Oracle Database PL/SQL

Developers experienced with Oracle Database PL/SQL can bypass much of this document, which covers many general concepts of PL/SQL.

Likely areas of interest, particularly differences in PL/SQL functionality between Oracle Database and TimesTen, include the following. Note that TimesTen-specific considerations are

discussed at the end of Programming Features in PL/SQL in TimesTen, Data Types in PL/SQL in TimesTen, and Errors and Exception Handling and throughout TimesTen PL/SQL Support: Reference Summary.

- Executing Procedures and Functions: This includes a comparison between how you can execute them in TimesTen and in Oracle Database.
- Differences in TimesTen: Transaction Behavior: This discusses cursor behavior when a transaction ends in TimesTen.
- Differences in TimesTen: Data Type Considerations: This includes TimesTen-specific conversions, and types that TimesTen does not support.
- Differences in TimesTen: Exception Handling and Error Behavior: This describes differences in error support, handling, and reporting.
- PL/SQL Environment: This includes discussion of TimesTen connection attributes.
- TimesTen Supplied PL/SQL Packages: This documents the subset of Oracle Database PL/SQL packages that TimesTen supports.
- TimesTen PL/SQL Support: Reference Summary: This reference chapter provides a detailed treatment of differences between TimesTen PL/SQL and Oracle Database PL/SQL.

Developers Experienced with TimesTen

Most of this document is targeted for readers without prior PL/SQL experience, especially prior TimesTen users who are not familiar with PL/SQL, and nearly the entire document should be useful.

In particular, Programming Features in PL/SQL in TimesTen, will help these readers get started and Examples Using TimesTen SQL in PL/SQL, includes some additional examples.

TimesTen PL/SQL Support: Reference Summary, lists differences between TimesTen PL/SQL and Oracle Database PL/SQL and may be of less interest.

About TimesTen Quick Start and Sample Applications

The TimesTen Quick Start and sample applications include a complete set of tutorials, how-to instructions, and sample applications.

The sample applications are available from the TimesTen GitHub location.

After you have configured your environment, you can confirm that everything is set up correctly by compiling and running the sample applications located in directory `quickstart/sample_code` directory. For instructions on compiling and running them, see the instructions in the subdirectories.

The following is included:

- Schema and setup: The `build_sampledb` script (`.sh` on Linux or UNIX or `.bat` on Windows) creates a sample database and schema. Run this script before using the sample applications.
- Environment and setup: The `ttquickstartenv` script (`.sh` or `.csh` on Linux or UNIX, `.bat` on Windows, or as applicable for your system), a superset of the `ttenv` script typically used for TimesTen setup, sets up the environment. Run this script each time you enter a session where you want to compile or run any of the sample applications.

- Sample applications and setup: The Quick Start provides sample applications and their source code for PL/SQL.

2

Programming Features in PL/SQL in TimesTen

This chapter surveys the main PL/SQL programming features providing examples.

See Overview of PL/SQL in . Unless otherwise noted, the examples have the same results in TimesTen as in Oracle Database.

See the end of the chapter for TimesTen-specific considerations. See TimesTen PL/SQL Components and Operations for an overview of how applications interact with TimesTen in general and PL/SQL in particular.

The following are the main topics of this chapter:

- PL/SQL Blocks
- PL/SQL Variables and Constants
- SQL Function Calls from PL/SQL
- PL/SQL Control Structures
- PL/SQL Procedures and Functions
- PL/SQL Packages
- How to Pass Data Between an Application and PL/SQL
- Use of SQL in PL/SQL Programs
- TimesTen PL/SQL with Cache
- Use of Cursors in PL/SQL Programs
- Wrapping PL/SQL Source Code
- Differences in TimesTen: Transaction Behavior

> **Note**
>
> Except where stated otherwise, the examples in this guide use the TimesTen `ttIsql` utility (which has the `Command>` prompt). In order to display output in the examples, the setting `SET SERVEROUTPUT ON` is used. See ttIsql in *Oracle TimesTen In-Memory Database Reference*.

PL/SQL Blocks

The basic unit of a PL/SQL source program is the *block*, or *anonymous block*, which groups related declarations and statements. TimesTen supports PL/SQL blocks.

A PL/SQL block is defined by the keywords `DECLARE`, `BEGIN`, `EXCEPTION`, and `END`. The example below shows the basic structure of a PL/SQL block.

> **Note**
>
> If you use cache, a PL/SQL block cannot be passed through to Oracle Database. (Also see "TimesTen PL/SQL with Cache".)

```
DECLARE   -- (optional)
          -- Variables, cursors, user-defined exceptions
BEGIN     -- (mandatory)
          -- PL/SQL statements
EXCEPTION -- (optional)
          -- Actions to perform when errors occur
END       -- (mandatory)
```

You can define either anonymous or named blocks in your PL/SQL programs. This example creates an anonymous block that queries the `employees` table and returns the data in a PL/SQL variable:

```
Command> SET SERVEROUTPUT ON;
Command>  DECLARE
            v_fname VARCHAR2 (20);
          BEGIN
            SELECT first_name
            INTO v_fname
            FROM employees
            WHERE employee_id = 100;
          DBMS_OUTPUT.PUT_LINE (v_fname);
          END;
          /
Steven

PL/SQL procedure successfully completed.
```

PL/SQL Variables and Constants

You can define variables and constants in PL/SQL and then use them in procedural statements and in SQL anywhere an expression can be used.

For example:

```
Command> DECLARE
           v_hiredate DATE;
           v_deptno   NUMBER (2) NOT NULL := 10;
           v_location VARCHAR2 (13) := 'San Francisco';
           c_comm     CONSTANT NUMBER := 1400;
```

You can use the `%TYPE` attribute to declare a variable according to either a TimesTen column definition or another declared variable. For example, use `%TYPE` to create variables `emp_lname` and `min_balance`:

```
Command> DECLARE
           emp_lname  employees.last_name%TYPE;
```

```
          balance    NUMBER (7,2);
          min_balance  balance%TYPE:= 1000;
        BEGIN
          SELECT last_name INTO emp_lname FROM employees WHERE employee_id =
100;
          DBMS_OUTPUT.PUT_LINE (emp_lname);
          DBMS_OUTPUT.PUT_LINE (min_balance);
        END;
        /
King
1000

PL/SQL procedure successfully completed.
```

You can assign a value to a variable in the following ways.

- With the assignment operator (`:=`).
- By selecting or fetching values into it.
- By passing the variable as an `OUT` or `IN OUT` parameter to a subprogram (procedure or function) and then assigning the value inside the subprogram.

> **Note**
>
> The `DBMS_OUTPUT` package used in these examples is supplied with TimesTen. For information on this and other supplied packages, refer to TimesTen Supplied PL/SQL Packages.

This example assigns a value to a variable with the assignment operator:

```
Command> DECLARE -- Assign values in the declarative section
          wages NUMBER;
          hours_worked NUMBER := 40;
          hourly_salary NUMBER := 22.50;
          bonus NUMBER := 150;
          country VARCHAR2(128);
          counter NUMBER := 0;
          done BOOLEAN;
          valid_id BOOLEAN;
          emp_rec1 employees%ROWTYPE;
          emp_rec2 employees%ROWTYPE;
          TYPE commissions IS TABLE OF NUMBER INDEX BY PLS_INTEGER;
          comm_tab commissions;
        BEGIN -- Assign values in the executable section
          wages := (hours_worked * hourly_salary) + bonus;
          country := 'France';
          country := UPPER('Canada');
          done := (counter   100);
          valid_id := TRUE;
          emp_rec1.first_name := 'Amy';
          emp_rec1.last_name := 'Feiner';
          emp_rec1 := emp_rec2;
          comm_tab(5) := 20000 * 0.15;
```

```
        END;
        /

PL/SQL procedure successfully completed.
```

> **Note**
>
> This example uses records, which are composite data structures that have fields with different data types. You can use the `%ROWTYPE` attribute, as shown, to declare a record that represents a row in a table or a row from a query result set. Records are further discussed under PL/SQL Composite Data Types.

The next example assigns a value to a variable by selecting or fetching values into it

Select 10% of an employee's salary into the `bonus` variable:

```
Command>  DECLARE
            bonus NUMBER(8,2);
            emp_id NUMBER(6) := 100;
          BEGIN
            SELECT salary * 0.10 INTO bonus FROM employees
              WHERE employee_id = emp_id;
            DBMS_OUTPUT.PUT_LINE (bonus);
          END;
          /
2400

PL/SQL procedure successfully completed.
```

The following example assigns a value to a variable by passing the variable as an `OUT` or `IN OUT` parameter to a subprogram (procedure or function) and then assigning the value inside the subprogram.

Declare the variable `new_sal` and then pass the variable as a parameter (`sal`) to procedure `adjust_salary`. Procedure `adjust_salary` computes the average salary for employees with `job_id='ST_CLERK'` and then updates `sal`. After the procedure is executed, the value of the variable is displayed to verify that the variable was correctly updated.

```
Command> DECLARE
            new_sal NUMBER(8,2);
            emp_id NUMBER(6) := 126;
          PROCEDURE adjust_salary (emp_id NUMBER, sal IN OUT NUMBER) IS
            emp_job VARCHAR2(10);
            avg_sal NUMBER(8,2);
          BEGIN
            SELECT job_id INTO emp_job FROM employees
              WHERE employee_id = emp_id;
            SELECT AVG(salary) INTO avg_sal FROM employees
              WHERE job_id = emp_job;
            DBMS_OUTPUT.PUT_LINE ('The average salary for ' || emp_job
              || ' employees: ' || TO_CHAR(avg_sal));
            sal := (sal + avg_sal)/2;
            DBMS_OUTPUT.PUT_LINE ('New salary is ' || sal);
```

```
          END;
          BEGIN
            SELECT AVG(salary) INTO new_sal FROM employees;
            DBMS_OUTPUT.PUT_LINE ('The average salary for all employees: '
              || TO_CHAR(new_sal));
            adjust_salary(emp_id, new_sal);
            DBMS_OUTPUT.PUT_LINE ('Salary should be same as new salary ' ||
              new_sal);
          END;
          /
The average salary for all employees: 6461.68
The average salary for ST_CLERK employees: 2785
New salary is 4623.34
Salary should be same as new salary 4623.34

PL/SQL procedure successfully completed.
```

> **Note**
>
> This example illustrates the ability to nest PL/SQL blocks within blocks. The outer anonymous block contains an enclosed procedure. This `PROCEDURE` statement is distinct from the `CREATE PROCEDURE` statement documented in PL/SQL Procedures and Functions, which creates a subprogram that remains stored in the user's schema.

SQL Function Calls from PL/SQL

Most SQL functions are supported for calls directly from PL/SQL.

In this first example, the function `RTRIM` is used as a PL/SQL function in a PL/SQL assignment statement.

```
Command> DECLARE p_var VARCHAR2(30);
          BEGIN
            p_var := RTRIM ('RTRIM Examplexxxyyyxyxy', 'xy');
            DBMS_OUTPUT.PUT_LINE (p_var);
          END;
          /
RTRIM Example

PL/SQL procedure successfully completed.
```

In this next example, for comparison, `RTRIM` is used as a SQL function in a static SQL statement.

```
Command>  DECLARE tt_var VARCHAR2 (30);
           BEGIN
             SELECT RTRIM ('RTRIM Examplexxxyyyxyxy', 'xy')
               INTO tt_var FROM DUAL;
             DBMS_OUTPUT.PUT_LINE (tt_var);
          END;
          /
RTRIM Example
```

```
PL/SQL procedure successfully completed.
```

You can refer to information about SQL functions in TimesTen under Expressions in *Oracle TimesTen In-Memory Database SQL Reference*. See SQL Functions in PL/SQL Expressions in .

PL/SQL Control Structures

Control structures are among the PL/SQL extensions to SQL. TimesTen supports the same control structures as Oracle Database.

The following control structures are discussed in this section.

- Conditional Control
- Iterative Control
- CONTINUE Statement

Conditional Control

The `IF-THEN-ELSE` and `CASE` constructs are examples of conditional control.

In the example below, an `IF-THEN-ELSE` construct is used to determine the salary raise of an employee based on the current salary. The `CASE` construct is also used to choose the course of action to take based on the `job_id` of the employee.

```
Command> DECLARE
           jobid employees.job_id%TYPE;
           empid employees.employee_id%TYPE := 115;
           sal employees.salary%TYPE;
           sal_raise NUMBER(3,2);
         BEGIN
           SELECT job_id, salary INTO jobid, sal from employees
             WHERE employee_id = empid;
           CASE
             WHEN jobid = 'PU_CLERK' THEN
               IF sal < 3000 THEN sal_raise := .12;
               ELSE sal_raise := .09;
               END IF;
             WHEN jobid = 'SH_CLERK' THEN
               IF sal < 4000 THEN sal_raise := .11;
               ELSE sal_raise := .08;
               END IF;
             WHEN jobid = 'ST_CLERK' THEN
               IF sal < 3500 THEN sal_raise := .10;
               ELSE sal_raise := .07;
               END IF;
             ELSE
               BEGIN
                 DBMS_OUTPUT.PUT_LINE('No raise for this job: ' || jobid);
               END;
           END CASE;
         DBMS_OUTPUT.PUT_LINE ('Original salary ' || sal);
         -- Update
```

```
          UPDATE employees SET salary = salary + salary * sal_raise
          WHERE employee_id = empid;
          END;
          /
Original salary 3100

PL/SQL procedure successfully completed.
```

Iterative Control

An iterative control construct executes a sequence of statements repeatedly, as long as a specified condition is true. Loop constructs are used to perform iterative operations.

There are three loop types:

- Basic loop
- `FOR` loop
- `WHILE` loop

The basic loop performs repetitive actions without overall conditions. The `FOR` loop performs iterative actions based on a count. The `WHILE` loops perform iterative actions based on a condition.

This example uses a `WHILE` loop:

```
Command> CREATE TABLE temp (tempid NUMBER(6),
          tempsal NUMBER(8,2),
          tempname VARCHAR2(25));
Command> DECLARE
            sal employees.salary%TYPE := 0;
            mgr_id employees.manager_id%TYPE;
            lname employees.last_name%TYPE;
            starting_empid employees.employee_id%TYPE := 120;
          BEGIN
            SELECT manager_id INTO mgr_id
              FROM employees
              WHERE employee_id = starting_empid;
            WHILE sal <= 15000 LOOP -- loop until sal > 15000
              SELECT salary, manager_id, last_name INTO sal, mgr_id, lname
                FROM employees WHERE employee_id = mgr_id;
            END LOOP;
            INSERT INTO temp VALUES (NULL, sal, lname);  -- insert NULL for
tempid
            COMMIT;
          EXCEPTION
            WHEN NO_DATA_FOUND THEN
              INSERT INTO temp VALUES (NULL, NULL, 'Not found');  -- insert
NULLs
              COMMIT;
          END;
          /

PL/SQL procedure successfully completed.

Command> SELECT * FROM temp;
```

```
< <NULL>, 24000, King >
1 row found.
```

CONTINUE Statement

The `CONTINUE` statement enables you to transfer control within a loop back to a new iteration.

In this example, the first `v_total` assignment is executed for each of the 10 iterations of the loop. The second `v_total` assignment is executed for the first five iterations of the loop. The `CONTINUE` statement transfers control within a loop back to a new iteration, so for the last five iterations of the loop, the second `v_total` assignment is not executed. The end `v_total` value is 70.

```
Command> DECLARE
           v_total  SIMPLE_INTEGER := 0;
         BEGIN
           FOR i IN 1..10 LOOP
             v_total := v_total + i;
             DBMS_OUTPUT.PUT_LINE ('Total is : ' || v_total);
             CONTINUE WHEN i > 5;
             v_total := v_total + i;
             DBMS_OUTPUT.PUT_LINE ('Out of loop  Total is: ' || v_total);
           END LOOP;
         END;
         /
Total is : 1
Out of loop  Total is: 2
Total is : 4
Out of loop  Total is: 6
Total is : 9
Out of loop  Total is: 12
Total is : 16
Out of loop  Total is: 20
Total is : 25
Out of loop  Total is: 30
Total is : 36
Total is : 43
Total is : 51
Total is : 60
Total is : 70

PL/SQL procedure successfully completed.
```

PL/SQL Procedures and Functions

Procedures and functions are PL/SQL blocks that have been defined with a specified name.

This section covers the following:

- Creating Procedures and Functions
- Executing Procedures and Functions
- Using Synonyms for Procedures and Functions
- Usage Notes for Procedures and Functions in TimesTen

Creating Procedures and Functions

In TimesTen, you can create standalone subprograms (stored procedures or functions) at the database level with the `CREATE PROCEDURE` or `CREATE FUNCTION` statement.

Optionally use `CREATE OR REPLACE PROCEDURE` or `CREATE OR REPLACE FUNCTION` if you want the subprogram to be replaced if it already exists.

Use `ALTER PROCEDURE` or `ALTER FUNCTION` to explicitly compile a procedure or function or modify the compilation options. (To recompile a procedure or function that is part of a package, recompile the package using the `ALTER PACKAGE` statement.)

In TimesTen, syntax for `CREATE PROCEDURE` and `CREATE FUNCTION` is a subset of what is supported in Oracle Database. For information on these statements and the `ALTER PROCEDURE` and `ALTER FUNCTION` statements in TimesTen, see SQL Statements in *Oracle TimesTen In-Memory Database SQL Reference*.

Executing Procedures and Functions

TimesTen supports execution of PL/SQL from client applications using ODBC, OCI, Pro*C/C++, ODP.NET, JDBC, or TimesTen TTClasses (for C++).

As noted earlier, a block is the basic unit of a PL/SQL source program. Anonymous blocks were also discussed earlier. By contrast, procedures and functions are PL/SQL blocks that have been defined with a specified name.

See PL/SQL Procedures and Functions for how to define and create them.

In TimesTen, a PL/SQL procedure or function that is standalone (created with `CREATE PROCEDURE` or `CREATE FUNCTION`) or part of a package can be executed using an anonymous block or a `CALL` statement. (See CALL in *Oracle TimesTen In-Memory Database SQL Reference* for details about `CALL` syntax.)

Consider the following function:

```
create or replace function mytest return number is
begin
  return 1;
end;
/
```

In TimesTen, you can execute `mytest` in either of the following ways.

- In an anonymous block:

```
Command> variable n number;
Command> begin
         :n := mytest();
         end;
         /

PL/SQL procedure successfully completed.

Command> print n;
N                    : 1
```

- In a CALL statement:

```
Command> variable n number;
Command> call mytest() into :n;
Command> print n;
N                    : 1
```

In Oracle Database, you could also execute mytest through a SQL statement, as follows. This execution mechanism is *not* supported in TimesTen.

- In a SELECT statement:

```
SQL> select mytest from dual;

    MYTEST
----------
         1
```

> **Note**
>
> A user's own procedure takes precedence over a TimesTen built-in procedure with the same name, but it is best to avoid such naming conflicts.

This example creates a procedure that uses OUT parameters, executes the procedure in an anonymous block, then displays the OUT values. The procedure takes an employee ID as input then outputs the salary and job ID for the employee.

```
Command>  CREATE OR REPLACE PROCEDURE get_employee
            (p_empid in employees.employee_id%TYPE,
             p_sal OUT employees.salary%TYPE,
             p_job OUT employees.job_id%TYPE) IS
          BEGIN
            SELECT salary,job_id
            INTO p_sal, p_job
            FROM employees
            WHERE employee_id = p_empid;
          END;
          /

Procedure created.

Command> VARIABLE v_salary NUMBER;
Command> VARIABLE v_job VARCHAR2(15);
Command> BEGIN
            GET_EMPLOYEE (120, :v_salary, :v_job);
          END;
          /

PL/SQL procedure successfully completed.

Command> PRINT
V_SALARY             : 8000
V_JOB                : ST_MAN
```

```
Command> SELECT salary, job_id FROM employees WHERE employee_id = 120;
< 8000, ST_MAN >
1 row found.
```

> **Note**
>
> Instead of using the anonymous block shown in the preceding example, you could use a `CALL` statement:
>
> ```
> Command> CALL GET_EMPLOYEE(120, :v_salary, :v_job);
> ```

The next example creates a function that returns the salary of the employee whose employee ID is specified as input, then calls the function and displays the result that was returned.

```
Command> CREATE OR REPLACE FUNCTION get_sal
           (p_id employees.employee_id%TYPE) RETURN NUMBER IS
            v_sal employees.salary%TYPE := 0;
         BEGIN
           SELECT salary INTO v_sal FROM employees
             WHERE employee_id = p_id;
           RETURN v_sal;
         END get_sal;
         /

Function created.

Command> variable n number;
Command> call get_sal(100) into :n;
Command> print n;
N                    : 24000
```

> **Note**
>
> Instead of using the `CALL` statement shown in the preceding example, you could use an anonymous block:
>
> ```
> Command> begin
>            :n := get_sal(100);
>          end;
>          /
> ```

Using Synonyms for Procedures and Functions

TimesTen supports private and public synonyms (aliases) for database objects, including PL/SQL procedures, functions, and packages. Synonyms are often used to mask object names and object owners or to simplify SQL statements.

Create a private synonym for procedure `foo` in your schema as follows:

```
CREATE SYNONYM synfoo FOR foo;
```

Create a public synonym as follows:

```
CREATE PUBLIC SYNONYM pubfoo FOR foo;
```

A private synonym exists in the schema of a specific user and shares the same namespace as database objects such as tables, views, and sequences. A private synonym cannot have the same name as a table or other object in the same schema.

A public synonym does not belong to any particular schema, is accessible to all users, and can have the same name as any private object.

To use a synonym you must have appropriate privileges to access the underlying object. For required privileges to create or drop a synonym, see Privileges for PL/SQL Statements and Operations in *Oracle TimesTen In-Memory Database Security Guide*.

For general information about synonyms, see Understanding Synonyms in *Oracle TimesTen In-Memory Database Operations Guide*. For information about the `CREATE SYNONYM` and `DROP SYNONYM` statements, see SQL Statements in *Oracle TimesTen In-Memory Database SQL Reference*.

In the following example, `USER1` creates a procedure in the user's schema and creates a public synonym for it. Then `USER2` executes the procedure through the public synonym. Assume the following:

- `USER1` has been granted `CREATE SESSION`, `CREATE PROCEDURE`, and `CREATE PUBLIC SYNONYM` privileges.
- `USER2` has been granted `CREATE SESSION` and `EXECUTE ANY PROCEDURE` privileges.
- Both users have connected to the database.
- `USER2` employs the `SET SERVEROUTPUT ON` setting.

USER1:

```
Command> create or replace procedure test is
         begin
         dbms_output.put_line('Running the test');
         end;
         /

Procedure created.

Command> create public synonym pubtest for test;

Synonym created.
```

USER2:

```
Command> begin
         pubtest;
         end;
         /
```

```
Running the test

PL/SQL procedure successfully completed.
```

Usage Notes for Procedures and Functions in TimesTen

Be aware of these usage notes for using PL/SQL procedures and functions in TimesTen.

- If you use replication: PL/SQL DDL statements, such as `CREATE` statements for PL/SQL functions, procedures, and packages, are not replicated. See Creating a New PL/SQL Object in an Existing Active Standby Pair and Adding a PL/SQL Object to an Existing Classic Replication Scheme in *Oracle TimesTen In-Memory Database Replication Guide* for steps to address this.
- If you use cache: A PL/SQL procedure or function resident in Oracle Database cannot be called in TimesTen by passthrough. Procedures and functions must be defined in TimesTen to be executable in TimesTen. (Also see TimesTen PL/SQL with Cache.)
- PL/SQL and database object names: TimesTen does not support non-ASCII or quoted non-uppercase names of PL/SQL objects (procedures, functions, and packages). Also, trailing spaces in the quoted names of PL/SQL objects are not supported. In addition, trailing spaces in the quoted names of objects such as tables and views that are passed to PL/SQL are silently removed.
- Definer's rights or invoker's rights determines access to SQL objects used by a PL/SQL procedure or function. Refer to Definer's Rights and Invoker's Rights (AUTHID Clause) in *Oracle TimesTen In-Memory Database Security Guide*.
- See Showing Errors in ttIsql for how to get information when you encounter errors in compiling a procedure or function.

PL/SQL Packages

This section discusses how to create and use PL/SQL packages in TimesTen.

- Package Concepts
- Creating and Using Packages
- Using Synonyms for Packages

For information about PL/SQL packages provided with TimesTen, refer to TimesTen Supplied PL/SQL Packages.

Package Concepts

A package is a database object that groups logically related PL/SQL types, variables, and subprograms. You specify the package and then define its body in separate steps.

The package specification is the interface to the package, declaring the public types, variables, constants, exceptions, cursors, and subprograms that are visible outside the immediate scope of the package. The body defines the objects declared in the specification, queries for the cursors, code for the subprograms, and private objects that are not visible to applications outside the package.

TimesTen stores the package specification separately from the package body in the database. Other schema objects that call or reference public program objects depend only on the package specification, not on the package body.

> **Note**
>
> The syntax for creating packages and package bodies is the same as in Oracle Database; however, while Oracle Database documentation mentions that you must run a script named `DBMSSTDX.SQL`, this does not apply to TimesTen.

Creating and Using Packages

In TimesTen, create packages and store them permanently in a TimesTen database by using the `CREATE PACKAGE` and `CREATE PACKAGE BODY` statements.

To create a new package, do the following:

1. Create the package specification with the `CREATE PACKAGE` statement.

   You can declare program objects in the package specification. Such objects are referred to as *public* objects and can be referenced outside the package, and by other objects in the package.

   Optionally use `CREATE OR REPLACE PACKAGE` if you want the package specification to be replaced if it already exists.

2. Create the package body with the `CREATE PACKAGE BODY` (or `CREATE OR REPLACE PACKAGE BODY`) statement.

   You can declare and define program objects in the package body.

   - You must define public objects declared in the package specification.
   - You can declare and define additional package objects, referred to as *private* objects. Private objects are declared in the package body rather than in the package specification, so they can be referenced only by other objects in the package. They cannot be referenced outside the package.

Use `ALTER PACKAGE` to explicitly compile the member procedures and functions of a package or modify the compilation options.

For more information on the `CREATE PACKAGE`, `CREATE PACKAGE BODY`, and `ALTER PACKAGE` statements, see SQL Statements in *Oracle TimesTen In-Memory Database SQL Reference*.

> **Note**
>
> - If you use replication: PL/SQL DDL statements, such as `CREATE` statements for PL/SQL functions, procedures, and packages, are not replicated. See Creating a New PL/SQL Object in an Existing Active Standby Pair and Adding a PL/SQL Object to an Existing Classic Replication Scheme in *Oracle TimesTen In-Memory Database Replication Guide* for steps to address this.
> - See Showing Errors in ttIsql for how to get information when you encounter errors in compiling a package.

For the following example, consider the case where you want to add a row to the employees tables when you hire a new employee and delete a row from the employees table when an employee leaves your company. The following example creates two procedures to accomplish these tasks and bundles the procedures in a package. The package also contains a function to

return the count of employees with a salary greater than that of a specific employee. The example then executes the function and procedures and verifies the results.

```
Command> CREATE OR REPLACE PACKAGE emp_actions AS
           PROCEDURE hire_employee (employee_id NUMBER,
             last_name VARCHAR2,
             first_name VARCHAR2,
             email VARCHAR2,
             phone_number VARCHAR2,
             hire_date DATE,
             job_id VARCHAR2,
             salary NUMBER,
             commission_pct NUMBER,
             manager_id NUMBER,
             department_id NUMBER);
           PROCEDURE remove_employee (emp_id NUMBER);
           FUNCTION num_above_salary (emp_id NUMBER) RETURN NUMBER;
         END emp_actions;
         /

Package created.

Command> -- Package body:
         CREATE OR REPLACE PACKAGE BODY emp_actions AS
         -- Code for procedure hire_employee:
           PROCEDURE hire_employee (employee_id NUMBER,
             last_name VARCHAR2,
             first_name VARCHAR2,
             email VARCHAR2,
             phone_number VARCHAR2,
             hire_date DATE,
             job_id VARCHAR2,
             salary NUMBER,
             commission_pct NUMBER,
             manager_id NUMBER,
             department_id NUMBER) IS
           BEGIN
             INSERT INTO employees VALUES (employee_id,
               last_name,
               first_name,
               email,
               phone_number,
               hire_date,
               job_id,
               salary,
               commission_pct,
               manager_id,
               department_id);
           END hire_employee;
         -- Code for procedure remove_employee:
           PROCEDURE remove_employee (emp_id NUMBER) IS
           BEGIN
             DELETE FROM employees WHERE employee_id = emp_id;
           END remove_employee;
         -- Code for function num_above_salary:
           FUNCTION num_above_salary (emp_id NUMBER) RETURN NUMBER IS
```

```
            emp_sal NUMBER(8,2);
            num_count NUMBER;
          BEGIN
            SELECT salary INTO emp_sal FROM employees
            WHERE employee_id = emp_id;
            SELECT COUNT(*) INTO num_count FROM employees
            WHERE salary > emp_sal;
            RETURN num_count;
          END num_above_salary;
        END emp_actions;
        /

Package body created.

Command> BEGIN
        /* call function to return count of employees with salary
           greater than salary of employee with employee_id = 120
        */
          DBMS_OUTPUT.PUT_LINE
            ('Number of employees with higher salary: ' ||
              TO_CHAR(emp_actions.num_above_salary(120)));
        END;
        /
Number of employees with higher salary: 33

PL/SQL procedure successfully completed.
```

Verify the count of 33.

```
Command> SELECT salary FROM employees WHERE employee_id = 120;
< 8000 >
1 row found.

Command> SELECT COUNT (*) FROM employees WHERE salary > 8000;
< 33 >
1 row found.
```

Now add an employee and verify results. Then, remove the employee and verify that the employee was deleted from the `employees` table.

```
Command> BEGIN
          emp_actions.hire_employee(300,
            'Belden',
            'Enrique',
            'EBELDEN',
            '555.111.2222',
            '31-AUG-04',
            'AC_MGR',
            9000,
            .1,
            101,
            110);
        END;
        /
```

```
PL/SQL procedure successfully completed.

Command> SELECT * FROM employees WHERE employee_id = 300;
< 300, Belden, Enrique, EBELDEN, 555.111.2222, 2004-08-31 00:00:00, AC_MGR,
9000,
.1, 101, 110 >
1 row found.
Command> BEGIN
           emp_actions.remove_employee (300);
         END;
         /

PL/SQL procedure successfully completed.

Command> SELECT * FROM employees WHERE employee_id = 300;
0 rows found.
```

Using Synonyms for Packages

TimesTen supports private and public synonyms (aliases) for database objects, including PL/SQL procedures, functions, and packages. Synonyms are often used to mask object names and object owners or to simplify SQL statements.

To create a private synonym for package `foopkg` in your schema:

```
CREATE SYNONYM synfoopkg FOR foopkg;
```

To create a public synonym for `foopkg`:

```
CREATE PUBLIC SYNONYM pubfoopkg FOR foopkg;
```

Also see Using Synonyms for Procedures and Functions in this document and Privileges for PL/SQL Statements and Operations in *Oracle TimesTen In-Memory Database Security Guide*.

> **Note**
>
> You cannot create synonyms for individual member subprograms of a package.
>
> This is valid:
>
> ```
> create or replace public synonym pubtestpkg for testpkg;
> ```
>
> This is not valid:
>
> ```
> create or replace public synonym pubtestproc for testpkg.testproc;
> ```

How to Pass Data Between an Application and PL/SQL

This section covers how to pass data between an application and PL/SQL.

- Using Bind Variables from an Application
- IN, OUT, and IN OUT Parameter Modes

Refer to Bind Variables in .

Using Bind Variables from an Application

You can use "`:`*var*" notation for bind variables to be passed between your application (such as a C or Java application) and PL/SQL. The term *bind variable* (or sometimes *host variable*) is used equivalently to how the term *parameter* has historically been used in TimesTen, and bind variables from an application would correspond to the parameters declared in a PL/SQL procedure or function specification.

Here is an example using `ttIsql` to call a PL/SQL procedure that retrieves the name and salary of the employee corresponding to a specified employee ID. In this example, `ttIsql` essentially acts as the calling application, and the name and salary are output from PL/SQL:

```
Command> VARIABLE b_name VARCHAR2 (25)
Command> VARIABLE b_sal  NUMBER

Command> BEGIN
          query_emp (171, :b_name, :b_sal);
         END;
         /

PL/SQL procedure successfully completed.

Command> PRINT b_name
B_NAME               : Smith
Command> PRINT b_sal
B_SAL                : 7400
```

See "Examples Using Input and Output Parameters and Bind Variables" for the complete example.

See "PL/SQL Procedures and Functions" for how to create and define procedures and functions.

See Parameter Binding and Statement Execution in *Oracle TimesTen In-Memory Database C Developer's Guide* and Preparing SQL Statements and Setting Input Parameters in *Oracle TimesTen In-Memory Database Java Developer's Guide* for additional information and examples for those languages.

> **Note**
>
> - The TimesTen binding mechanism (early binding) differs from that of Oracle Database (late binding). TimesTen requires the data types before preparing queries. As a result, there will be an error if the data type of each bind parameter is not specified or cannot be inferred from the SQL statement. This would apply, for example, to the following statement:
>
>   ```
>   SELECT 'x' FROM DUAL WHERE :a = :b;
>   ```
>
>   You could address the issue as follows, for example:
>
>   ```
>   SELECT 'x' from DUAL WHERE CAST(:a as VARCHAR2(10)) =
>                              CAST(:b as VARCHAR2(10));
>   ```
> - For duplicate parameters, the implementation in PL/SQL in TimesTen is no different than the implementation in PL/SQL in Oracle Database.
> - The term "bind parameter" as used in TimesTen developer guides (in keeping with ODBC terminology) is equivalent to the term "bind variable" as used in TimesTen PL/SQL documents (in keeping with Oracle Database PL/SQL terminology).

IN, OUT, and IN OUT Parameter Modes

Parameter modes define whether parameters declared in a PL/SQL subprogram (procedure or function) specification are used for input, output, or both. The three parameter modes are `IN` (the default), `OUT`, and `IN OUT`.

An `IN` parameter lets you pass a value to the subprogram being invoked. Inside the subprogram, an `IN` parameter acts like a constant and cannot be assigned a value. You can pass a constant, literal, initialized variable, or expression as an `IN` parameter.

An `OUT` parameter returns a value to the caller of a subprogram. Inside the subprogram, an `OUT` parameter acts like a variable. You can change its value and reference the value after assigning it.

An `IN OUT` parameter passes an initial value to a subprogram and returns an updated value to the caller. It can be assigned a value and its value can be read. Typically, an `IN OUT` parameter is a string buffer or numeric accumulator that is read inside the subprogram and then updated. The actual parameter that corresponds to an `IN OUT` formal parameter must be a variable, not a constant or an expression.

> **Note**
>
> TimesTen supports the binding of associative arrays (but not varrays or nested tables) as `IN`, `OUT`, or `IN OUT` parameters. See Using Associative Arrays from Applications.

See Examples Using Input and Output Parameters and Bind Variables.

Use of SQL in PL/SQL Programs

PL/SQL is tightly integrated with the TimesTen database through the SQL language.

This section covers use of the following SQL features in PL/SQL.

- Static SQL in PL/SQL for Queries and DML Statements
- Dynamic SQL in PL/SQL (EXECUTE IMMEDIATE Statement)
- FORALL and BULK COLLECT Operations
- RETURNING INTO Clause
- Large Objects (LOBs)

Static SQL in PL/SQL for Queries and DML Statements

From within PL/SQL, you can execute the following as static SQL.

- DML statements: `INSERT`, `UPDATE`, `DELETE`, and `MERGE`
- Queries: `SELECT`
- Transaction control: `COMMIT` and `ROLLBACK`

> **Note**
>
> - You must use dynamic SQL to execute DDL statements in PL/SQL. See the next section, Dynamic SQL in PL/SQL (EXECUTE IMMEDIATE Statement).
> - See Differences in TimesTen: Transaction Behavior for details about how TimesTen transaction behavior differs from Oracle Database behavior.

For information on these SQL statements, refer to SQL Statements in *Oracle TimesTen In-Memory Database SQL Reference*.

The example that follows shows how to execute a query. For additional examples using TimesTen SQL in PL/SQL, see Examples Using TimesTen SQL in PL/SQL.

Use the `SELECT... INTO` statement to retrieve exactly one row of data. TimesTen returns an error for any query that returns no rows or multiple rows. The example retrieves `hire_date` and `salary` for the employee with `employee_id=100` from the `employees` table of the `HR` schema.

```
Command> run selectinto.sql

DECLARE
   v_emp_hiredate employees.hire_date%TYPE;
   v_emp_salary   employees.salary%TYPE;

BEGIN
   SELECT hire_date, salary
   INTO   v_emp_hiredate, v_emp_salary
   FROM   employees
   WHERE  employee_id = 100;
   DBMS_OUTPUT.PUT_LINE(v_emp_hiredate || ' ' || v_emp_salary);
END;
/

1987-06-17 24000
```

```
PL/SQL procedure successfully completed.
```

Dynamic SQL in PL/SQL (EXECUTE IMMEDIATE Statement)

You can use native dynamic SQL, through the `EXECUTE IMMEDIATE` statement, to accomplish several operations.

- Execute a DML statement such as `INSERT`, `UPDATE`, or `DELETE`.
- Execute a DDL statement such as `CREATE` or `ALTER`. For example, you can use `ALTER SESSION` to change a PL/SQL first connection attribute.
- Execute a PL/SQL anonymous block.
- Call a PL/SQL stored procedure or function.
- Call a TimesTen built-in procedure. (See Built-In Procedures in *Oracle TimesTen In-Memory Database Reference*.)

One use case is if you do not know the full text of your SQL statement until execution time. For example, during compilation you may not know the name of the column to use in the `WHERE` clause of your `SELECT` statement. In such a situation, you can use the `EXECUTE IMMEDIATE` statement.

Another use case is for DDL, which cannot be executed in static SQL from within PL/SQL.

To call a TimesTen built-in procedure that returns a result set, create a record type and use `EXECUTE IMMEDIATE` with `BULK COLLECT` to fetch the results into an array.

See EXECUTE IMMEDIATE Statement in .

> **Note**
>
> - See Differences in TimesTen: Transaction Behavior.
> - As a DDL statement is being parsed to drop a procedure or a package, a timeout occurs if the procedure, or a procedure in the package, is still in use. After a call to a procedure, that procedure is considered to be in use until execution has returned to the user side. Any such deadlock times out after a short time.
> - You can also use the `DBMS_SQL` package for dynamic SQL. See DBMS_SQL.

Following is a set of brief independent examples of `EXECUTE IMMEDIATE`. For additional examples, see Examples Using EXECUTE IMMEDIATE.

Create a table and execute a DML statement on it within a PL/SQL block, specifying the input parameter through a `USING` clause. Then select the table to see the result:

```
Command> create table t(i int);
Command> declare
           i number := 1;
         begin
           execute immediate 'begin insert into t values(:j);end;' using i;
         end;
         /
```

```
PL/SQL procedure successfully completed.

Command> select * from t;
< 1 >
1 row found.
```

Create a PL/SQL procedure `foo` then execute it in a PL/SQL block, specifying the input parameter through a `USING` clause:

```
Command> create or replace procedure foo(message varchar2) is
         begin
            dbms_output.put_line(message);
         end;
         /

Procedure created.

Command> begin
            execute immediate 'begin foo(:b);end;' using 'hello';
         end;
         /
hello

PL/SQL procedure successfully completed.
```

Create a PL/SQL procedure `myprint` then execute it through a `CALL` statement, specifying the input parameter through a `USING` clause:

```
Command> declare
            a number := 1;
         begin
            execute immediate 'call myprint(:b)' using a;
         end;
         /
myprint procedure got number 1

PL/SQL procedure successfully completed.
```

Code that is executed through `EXECUTE IMMEDIATE` generally shares the same environment as the outer PL/SQL block, as in Oracle Database. In particular, be aware of the following. (These points apply to using `DBMS_SQL` as well as `EXECUTE IMMEDIATE`.)

- SQL and PL/SQL executed through `EXECUTE IMMEDIATE` run in the same transaction as the outer block.
- Any exception raised during execution of an `EXECUTE IMMEDIATE` statement is propagated to the outer block. Therefore, any errors on the error stack when the `EXECUTE IMMEDIATE` statement is executed are visible inside the outer block. This is useful for procedures such as `DBMS_UTILITY.FORMAT_ERROR_STACK`.
- Errors on the error stack before execution of a PL/SQL block in an `EXECUTE IMMEDIATE` statement are visible inside the block, for example by using `DBMS_UTILITY.FORMAT_ERROR_STACK`.

- The execution environment in which an EXECUTE IMMEDIATE statement executes is the same as for the outer block. PL/SQL and TimesTen parameters, REF CURSOR state, and package state from the EXECUTE IMMEDIATE statement are visible inside the outer block.

FORALL and BULK COLLECT Operations

Bulk binding is a powerful feature used in the execution of SQL statements from PL/SQL to move large amounts of data between SQL and PL/SQL. (This is different from binding parameters from an application program to PL/SQL.) With bulk binding, you bind arrays of values in a single operation rather than using a loop to perform FETCH, INSERT, UPDATE, and DELETE operations multiple times. TimesTen supports bulk binding, which can result in significant performance improvement.
Use the FORALL statement to bulk-bind input collections before sending them to the SQL engine. Use BULK COLLECT to bring back batches of results from SQL. You can bulk-collect into any type of PL/SQL collection, such as a varray, nested table, or associative array (index-by table). For additional information on collections, refer to Using Collections in PL/SQL.

You can use the %BULK_EXCEPTIONS cursor attribute and the SAVE EXCEPTIONS clause with FORALL statements. SAVE EXCEPTIONS allows an UPDATE, INSERT, or DELETE statement to continue executing after it issues an exception (for example, a constraint error). Exceptions are collected into an array that you can examine using %BULK_EXCEPTIONS after the statement has executed. When you use SAVE EXCEPTIONS, if exceptions are encountered during the execution of the FORALL statement, then all rows in the collection are processed. When the statement finishes, an error is issued to indicate that at least one exception occurred. If you do not use SAVE EXCEPTIONS, then when an exception is issued during a FORALL statement, the statement returns the exception immediately and no other rows are processed.

Refer to Using FORALL Statement and BULK COLLECT Clause Together in .

The following example shows basic use of bulk binding and the FORALL statement, increasing the salary for employees with IDs 100, 102, 104, or 110. The FORALL statement bulk-binds the collection. For more information and examples on bulk binding, see Examples Using FORALL and BULK COLLECT.

```
Command> CREATE OR REPLACE PROCEDURE raise_salary (p_percent NUMBER) IS
           TYPE numlist_type IS TABLE OF NUMBER
            INDEX BY BINARY_INTEGER;
           v_id  numlist_type;  -- collection
         BEGIN
           v_id(1) := 100; v_id(2) := 102; v_id (3) := 104; v_id (4) := 110;
           -- bulk-bind the associative array
           FORALL i IN v_id.FIRST .. v_id.LAST
            UPDATE employees
             SET salary = (1 + p_percent/100) * salary
             WHERE employee_id = v_id (i);
         END;
         /

Procedure created.
```

Find out salaries before executing the raise_salary procedure:

```
Command> SELECT salary FROM employees WHERE employee_id = 100 OR employee_id
=
102 OR employee_id = 104 OR employee_id = 100;
```

```
< 24000 >
< 17000 >
< 6000 >
3 rows found.
```

Execute the procedure and verify results:

```
Command> EXECUTE raise_salary (10);

PL/SQL procedure successfully completed.

Command> SELECT salary FROM employees WHERE employee_id = 100 or employee_id
=
102 OR employee_id = 104 OR employee_id = 100;
< 26400 >
< 18700 >
< 6600 >
3 rows found.
```

RETURNING INTO Clause

You can use a `RETURNING INTO` clause, sometimes referred to as *DML returning*, with an `INSERT`, `UPDATE`, or `DELETE` statement to return specified columns or expressions, optionally including rowids, from rows that were affected by the action. This eliminates the need for a subsequent `SELECT` statement and separate round trip, in case, for example, you want to confirm what was affected or want the rowid after an insert or update.
A `RETURNING INTO` clause can be used with dynamic SQL (with `EXECUTE IMMEDIATE`) or static SQL.

Through the PL/SQL `BULK COLLECT` feature, the clause can return items from a single row into either a set of parameters or a record, or can return columns from multiple rows into a PL/SQL collection such as a varray, nested table, or associative array (index-by table). Parameters in the `INTO` part of the clause must be output only, not input/output. For information on collections, refer to Using Collections in PL/SQL. For `BULK COLLECT`, see FORALL and BULK COLLECT Operations and Examples Using FORALL and BULK COLLECT.

SQL syntax and restrictions for the `RETURNING INTO` clause in TimesTen are documented as part of the INSERT, UPDATE, and DELETE documentation in *Oracle TimesTen In-Memory Database SQL Reference*.

Also see Examples Using RETURNING INTO.

Refer to RETURNING INTO Clause in for additional information about DML returning.

Large Objects (LOBs)

TimesTen supports LOBs (large objects). This includes CLOBs (character LOBs), NCLOBs (national character LOBs), and BLOBs (binary LOBs).

PL/SQL language features support LOBs in TimesTen as they do in Oracle Database, unless noted otherwise.

This section provides a brief overview of LOBs and discusses their use in PL/SQL, covering the following topics.

- About LOBs

- LOB Locators
- Temporary LOBs
- Differences Between TimesTen LOBs and Oracle Database LOBs
- Using LOBs
- PL/SQL Package Support for LOBs
- Passthrough LOBs

You can also refer to the following:

- LOB Data Types in *Oracle TimesTen In-Memory Database SQL Reference* for additional information about LOBs in TimesTen
- for general information about programming with LOBs (but not specific to TimesTen functionality)

About LOBs

A LOB is a large binary object (BLOB) or character object (CLOB or NCLOB). In TimesTen, a BLOB can be up to 16 MB and a CLOB or NCLOB up to 4 MB. LOBs in TimesTen have essentially the same functionality as in Oracle Database, except as noted otherwise.

See Differences Between TimesTen LOBs and Oracle Database LOBs.

LOBs may be either persistent or temporary. A persistent LOB exists in a LOB column in the database. A temporary LOB exists only within an application.

LOB Locators

In PL/SQL, a LOB consists of a LOB locator and a LOB value. The locator is an opaque structure that acts as a handle to the value. When an application uses a LOB in an operation such as passing a LOB as a parameter, it is passing the locator, not the actual value.

> **Tip**
>
> LOB manipulations through APIs that use LOB locators result in usage of TimesTen temporary space. Any significant number of such manipulations may necessitate a size increase for the TimesTen temporary data region. See TempSize in *Oracle TimesTen In-Memory Database Reference*.

To update a LOB, your transaction must have an exclusive lock on the row containing the LOB. You can accomplish this by selecting the LOB with a `SELECT ... FOR UPDATE` statement. This results in a writable locator. With a `SELECT` statement, the locator is read-only. Read-only and writable locators behave as follows.

- A read-only locator is *read consistent*, meaning that throughout its lifetime, it sees only the contents of the LOB as of the time it was selected. Note that this would include any uncommitted updates made to the LOB within the same transaction before the LOB was selected.
- A writable locator is updated with the latest data from the database each time a write is made through the locator. So each write is made to the most current data of the LOB, including updates that have been made through other locators.

The following example details behavior for two writable locators for the same LOB:

1. The LOB column contains "XY".
2. Select locator `L1` for update.
3. Select locator `L2` for update.
4. Write "Z" through `L1` at offset 1.
5. Read through locator `L1`. This would return "ZY".
6. Read through locator `L2`. This would return "XY", because `L2` remains read-consistent until it is used for a write.
7. Write "W" through `L2` at offset 2.
8. Read through locator `L2`. This would return "ZW". Before the write in the preceding step, the locator was updated with the latest data ("ZY").

Temporary LOBs

A PL/SQL block can create a temporary LOB explicitly, for it own use. In TimesTen, the lifetime of such a LOB does not extend past the end of the transaction in which it is created (as is the case with the lifetime of any LOB locator in TimesTen).

A temporary LOB may also be created implicitly by TimesTen. For example, if a `SELECT` statement selects a LOB concatenated with an additional string of characters, TimesTen implicitly creates a temporary LOB to contain the concatenated data. Note that a temporary LOB is a server-side object. TimesTen has no concept of client-side LOBs.

Temporary LOBs are stored in the TimesTen temporary data region.

See CREATETEMPORARY Procedures in *Oracle TimesTen In-Memory Database PL/SQL Packages Reference* for how to create temporary LOBs.

Differences Between TimesTen LOBs and Oracle Database LOBs

There are key differences between the TimesTen LOB implementation and the Oracle Database implementation.

Be aware of the following:

- A key difference between the TimesTen LOB implementation and the Oracle Database implementation is that in TimesTen, LOB locators do not remain valid past the end of the transaction. All LOB locators are invalidated after a commit or rollback, whether explicit or implicit. This includes after any DDL statement.
- TimesTen does not support BFILEs, SecureFiles, array reads and writes for LOBs, or callback functions for LOBs.
- In TimesTen, the `DBMS_LOB FRAGMENT` procedures are not supported, so you can write data into the middle of a LOB only by overwriting previous data. There is no functionality to insert data into the middle of a LOB and move previous data, beginning at that point, higher in the LOB correspondingly. Similarly, in TimesTen you can delete data from the middle of a LOB only by overwriting previous data with zeros or null data. There is no functionality to remove data from the middle of a LOB and move previous data, beginning at that point, lower in the LOB correspondingly. In either case in TimesTen, the size of the LOB does not change, except in the circumstance where from the specified offset there is less space available in the LOB than there is data to write. (In Oracle Database there is functionality for either mode, either overwriting and not changing the size of the LOB, or inserting or deleting and changing the size of the LOB.)
- TimesTen does not support binding arrays of LOBs.

- TimesTen does not support batch processing of LOBs.
- Relevant to BLOBs, there are differences in the usage of hexadecimal literals in TimesTen. See the description of *HexadecimalLiteral* in Constants in *Oracle TimesTen In-Memory Database SQL Reference*.

Using LOBs

The following shows basic use of a CLOB. Assume a table defined and populated as follows, with a BLOB column (not used here) and a CLOB column:

```
Command> create table t1 (a int, b blob, c clob);
Command> insert into t1(a,b,c) values(1, 0x123451234554321, 'abcde');
1 row inserted.
Command> commit;
```

Select a CLOB from the table and display it:

```
Command> declare
            myclob clob;
         begin
            select c into myclob from t1 where a=1;
            dbms_output.put_line('CLOB selected from table t1 is: ' ||
myclob);
         end;
         /
CLOB selected from table t1 is: abcde

PL/SQL procedure successfully completed.
```

The following tries to display the temporary CLOB again after a commit statement has ended the transaction, showing that the LOB locator becomes invalid from that point:

```
Command> declare
            myclob clob;
         begin
            select c into myclob from t1 where a=1;
            dbms_output.put_line('CLOB selected from table t1 is: ' ||
myclob);
            commit;
            dbms_output.put_line('CLOB after end of transaction is: ' ||
myclob);
         end;
         /
 1806: invalid LOB locator specified
 8507: ORA-06512: at line 8
CLOB selected from table t1 is: abcde
The command failed.
```

PL/SQL Package Support for LOBs

TimesTen supports subprograms of the DBMS_LOB package for manipulation of LOB data.

See DBMS_LOB in this document for a list and descriptions of these subprograms. See DBMS_LOB in *Oracle TimesTen In-Memory Database PL/SQL Packages Reference*.

Passthrough LOBs

Passthrough LOBs, which are LOBs in Oracle Database accessed through TimesTen, are exposed as TimesTen LOBs and are supported by TimesTen in much the same way that any TimesTen LOB is supported.

Note the following:

- TimesTen LOB size limitations do not apply to storage of passthrough LOBs, but do apply to binding. Also, if a passthrough LOB is copied to a TimesTen LOB, such as through `DBMS_LOB.COPY`, the size limit applies to the copy.

  An attempt to copy a passthrough LOB to a TimesTen LOB when the passthrough LOB is larger than the TimesTen LOB size limit results in an error.
- As with TimesTen local LOBs, a locator for a passthrough LOB does not remain valid past the end of the transaction.

See DBMS_LOB.

TimesTen PL/SQL with Cache

When PL/SQL programs execute SQL statements, the SQL statements are processed by TimesTen in the same manner as when SQL is executed from applications written in other programming languages. All standard behaviors of TimesTen SQL apply. In a cache environment, this includes the ability to use all cache features from PL/SQL. When PL/SQL accesses tables in cache groups, the same rules for those tables apply. For example, issuing a `SELECT` statement against a cache instance in a dynamic cache group may cause the instance to be automatically loaded into TimesTen from Oracle Database.

In particular, be aware of the following points about this functionality.

- When you use static SQL in PL/SQL, any tables accessed must exist in TimesTen or the PL/SQL will not compile successfully. In the following example, `ABC` must exist in TimesTen.

  ```
  begin
    insert into abc values(1, 'Y');
  end;
  ```

- In a cache environment, there is the capability to use the TimesTen passthrough facility to automatically route SQL statements from TimesTen to Oracle Database. (See Setting a Passthrough Level in *Oracle TimesTen In-Memory Database Cache Guide* for details of the passthrough facility.)

  With `passthrough=1`, a statement can be passed through to Oracle Database if any accessed table does not exist in TimesTen. In PL/SQL, however, the statement would have to be executed using dynamic SQL.

  Updating the preceding example, the following TimesTen PL/SQL block could be used to access `ABC` in Oracle Database with `passthrough=1`:

  ```
  begin
    execute immediate 'insert into abc values(1, 'Y')';
  end;
  ```

In this case, TimesTen PL/SQL can compile the block because the SQL statement is not examined at compile time.

- While PL/SQL can be executed in TimesTen, the TimesTen passthrough facility cannot be used to route PL/SQL blocks from TimesTen to Oracle Database. For example, when using cache with `passthrough=3`, statements executed on a TimesTen connection are routed to Oracle Database in most circumstances. In this scenario, you may not execute PL/SQL blocks from your application program, because TimesTen would attempt to forward them to Oracle Database, which is not supported. (In the `passthrough=1` example, it is just the SQL statement being routed to Oracle Database, not the block as a whole.)

Tip

PL/SQL procedures and functions can use any of the following cache operations with either definer's rights or invoker's rights:

- Loading or refreshing a cache group with commit every *n* rows
- DML on AWT cache groups
- DML on non-propagated cache groups (user managed cache groups without `PROPAGATE` enabled)
- `SELECT` on cache group tables that do not invoke passthrough or dynamic load
- `UNLOAD CACHE GROUP`

PL/SQL procedures or functions that use any of the following cache operations must use invoker's rights (`AUTHID CURRENT_USER`): passthrough, dynamic loading of a cache group, loading or refreshing a cache group using `WITH ID`, DDL on cache groups, DML on SWT cache groups, or `FLUSH CACHE GROUP`.

See Definer's Rights and Invoker's Rights (AUTHID Clause) in *Oracle TimesTen In-Memory Database Security Guide*.

Use of Cursors in PL/SQL Programs

A cursor, either explicit or implicit, is used to handle the result set of a `SELECT` statement.

As a programmer, you can declare an explicit cursor to manage queries that return multiple rows of data. PL/SQL declares and opens an implicit cursor for any `SELECT` statement that is not associated with an explicit cursor.

Note

In TimesTen, any operation that ends your transaction closes all cursors associated with the connection. This includes any `COMMIT` or `ROLLBACK` statement and any DDL statement. This results in autocommits of DDL statements. See Differences in TimesTen: Transaction Behavior.

The following example shows basic use of a cursor. See Examples Using Cursors for additional information and examples. Also see PL/SQL REF CURSORs.

Declare a cursor `c1` to retrieve the last name, salary, hire date, and job class for the employee whose employee ID is 120:

```
Command> DECLARE
           CURSOR c1 IS
             SELECT last_name, salary, hire_date, job_id FROM employees
             WHERE employee_id = 120;
         --declare record variable that represents a row
         --fetched from the employees table
           employee_rec c1%ROWTYPE;
         BEGIN
         -- open the explicit cursor
         -- and use it to fetch data into employee_rec
           OPEN c1;
           FETCH c1 INTO employee_rec;
           DBMS_OUTPUT.PUT_LINE('Employee name: ' || employee_rec.last_name);
           CLOSE c1;
         END;
         /
Employee name: Weiss

PL/SQL procedure successfully completed.
```

Wrapping PL/SQL Source Code

Wrapping is the process of hiding PL/SQL source code. You can wrap PL/SQL source code with the `wrap` utility, which processes an input SQL file and wraps only the PL/SQL units in the file, such as a package specifications, package bodies, functions, and procedures.

Consider the following example, which uses a file `wrap_test.sql` to define a procedure named `wraptest`. It then uses the `wrap` utility to process `wrap_test.sql`. The procedure is created with the source code hidden, and executes successfully. As a final step, the `ALL_OBJECTS` view is queried to see the wrapped source code.

Here are the contents of `wrap_test.sql`:

```
CREATE OR REPLACE PROCEDURE wraptest IS
   TYPE emp_tab IS TABLE OF employees%ROWTYPE INDEX BY PLS_INTEGER;
   all_emps emp_tab;
BEGIN
   SELECT * BULK COLLECT INTO all_emps FROM employees;
   FOR i IN 1..10
      LOOP
         DBMS_OUTPUT.PUT_LINE('Emp Id: ' || all_emps(i).employee_id);
      END LOOP;
END;
/
```

In the example that follows, "`%`" is the UNIX prompt, "`Command>`" is the `ttIsql` prompt, and user input is shown in bold.

```
% wrap iname=wrap_test.sql

PL/SQL Wrapper: Release 26ai.0- Production on Wed Sep 14 12:59:27 2019
```

```
Copyright (c) 1993, 2019, Oracle.  All rights reserved.

Processing wrap_test.sql to wrap_test.plb

% cat wrap_test.plb
CREATE OR REPLACE PROCEDURE wraptest wrapped
a000000
1
abcd
abcd
abcd
abcd
abcd
abcd
abcd
abcd
abcd
abcd
abcd
abcd
abcd
abcd
abcd
abcd
7
124 12c
YZ6L0v2ntFaqttW8hSJD5IHIYccwg+nwNfZqfHQCv/9kMJyznwdLh8FepNXpWS1fzVBDkTke
LWlhFdFzCMfmmJ5GGrCwrqgngEhfRpq7ck5Dzsf7sDlnQeE3QGmb/yu9Dec1+JO2kOMlx3dq
BuC7fR2f5sjDtBeDXiGCC0kJ5QBVregtoBckZNO9MoiWS4w0jF6T1CPY0Aoi/KUwxC8S8I8n
amF5xGQDCYTDajs77orIGEqtX747k0YAO+r1e9adGUsVgZK1ONcTM/+Wit+LYKi7b03eJxdB
+aaKn/Lh

/

% ttisql sampledb

Copyright (c) 1996-2011, Oracle.  All rights reserved.
Type ? or "help" for help, type "exit" to quit ttIsql.

connect "DSN=sampledb";
Connection successful:
DSN=sampledb;UID=myuserid;DataStore=.../install/info/DemoDataStore/
sampledb;DatabaseCharacterSet=US7ASCII;ConnectionCharacterSet=US7ASCII;DRIVER
=.../install/lib/libtten.so;PermSize=40;TempSize=32;
(Default setting AutoCommit=1)

Command> @wrap_test.plb

CREATE OR REPLACE PROCEDURE wraptest wrapped
a000000
1
abcd
abcd
abcd
abcd
abcd
```

```
abcd
abcd
abcd
abcd
abcd
abcd
abcd
abcd
abcd
abcd
7
124 12c
YZ6L0v2ntFaqttW8hSJD5IHIYccwg+nwNfZqfHQCv/9kMJyznwdLh8FepNXpWS1fzVBDkTke
LWlhFdFzCMfmmJ5GGrCwrqgngEhfRpq7ck5Dzsf7sDlnQeE3QGmb/yu9Dec1+JO2kOMlx3dq
BuC7fR2f5sjDtBeDXiGCC0kJ5QBVregtoBckZNO9MoiWS4w0jF6T1CPY0Aoi/KUwxC8S8I8n
amF5xGQDCYTDajs77orIGEqtX747k0YAO+r1e9adGUsVgZK1ONcTM/+Wit+LYKi7b03eJxdB
+aaKn/Lh

Procedure created.

Command> SET SERVEROUTPUT ON
Command> BEGIN
            wraptest();
         END;
         /
Emp Id: 100
Emp Id: 101
Emp Id: 102
Emp Id: 103
Emp Id: 104
Emp Id: 105
Emp Id: 106
Emp Id: 107
Emp Id: 108
Emp Id: 109

PL/SQL procedure successfully completed.

Command> SELECT text FROM all_source WHERE name = 'WRAPTEST';

< PROCEDURE wraptest wrapped
a000000
1
abcd
abcd
abcd
abcd
abcd
abcd
abcd
abcd
abcd
abcd
abcd
abcd
abcd
```

```
abcd
abcd
7
124 12c
YZ6L0v2ntFaqttW8hSJD5IHIYccwg+nwNfZqfHQCv/9kMJyznwdLh8FepNXpWS1fzVBDkTke
LWlhFdFzCMfmmJ5GGrCwrqgngEhfRpq7ck5Dzsf7sDlnQeE3QGmb/yu9Dec1+JO2kOMlx3dq
BuC7fR2f5sjDtBeDXiGCC0kJ5QBVregtoBckZNO9MoiWS4w0jF6T1CPY0Aoi/KUwxC8S8I8n
amF5xGQDCYTDajs77orIGEqtX747k0YAO+r1e9adGUsVgZK1ONcTM/+Wit+LYKi7b03eJxdB
+aaKn/Lh

 >
1 row found.
```

Differences in TimesTen: Transaction Behavior

In TimesTen, any operation that ends your transaction closes all cursors associated with the connection.

This includes the following:

- Any `COMMIT` or `ROLLBACK` statement
- Any DDL statement

For example, consider the following scenario, where you want to recompile a set of procedures. This would not work, because the first time `ALTER PROCEDURE` is executed, the cursor (`pnamecurs`) would be closed:

```
declare
   cursor pnamecurs is select * from all_objects where object_name like
'MYPROC%';
begin
   for rec in pnamecurs loop
     execute immediate 'alter procedure ' || rec.object_name || ' compile';
   end loop;
end;
```

Instead, you can do something like the following, which fetches all the procedure names into an internal table then executes `ALTER PROCEDURE` on them with no active cursor.

```
declare
   cursor pnamecurs is select * from all_objects where object_name like
'MYPROC%';
   type tbl is table of c%rowtype index by binary_integer;
   myprocs tbl;

begin
   open pnamecurs;
   fetch pnamecurs bulk collect into myprocs;
   close pnamecurs;
   for i in 1..myprocs.count loop
     execute immediate 'alter procedure ' || myprocs(i).object_name || '
compile';
   end loop;
end;
```

3

Data Types in PL/SQL in TimesTen

There is a range of data types available to you for manipulating data in PL/SQL, TimesTen SQL, and your application programs.

Understanding the Data Type Environments

TimesTen supports PL/SQL data types and the interactions between PL/SQL data types, TimesTen data types, and client application program data types. Data type conversions and data type mappings are supported.

There are three distinct environments to consider when discussing data types:

- PL/SQL programs that contain variables and constants that use PL/SQL data types
- TimesTen SQL statements that use database rows, columns, and constants

  These elements are expressed using TimesTen SQL data types.
- Application programs that interact with the database and the PL/SQL programming language

  Application programs are written in programming languages such as C and Java and contain variables and constants that use data types from these programming languages.

Table 3-1 summarizes the environments and gives examples of data types for each environment.

Table 3-1 Summarizing the Data Type Environments

Environment	Data Type Examples
PL/SQL programs	`NUMBER`, `PLS_INTEGER`, `VARCHAR2`, `STRING`, `DATE`, `TIMESTAMP`
TimesTen SQL statements	`TT_BIGINT`, `TT_INTEGER`, `BINARY_FLOAT`, `VARCHAR2`, `DATE`, `TIMESTAMP`
Application programs	`int`, `double`, `String`

Understanding and Using PL/SQL Data Types

This section describes the PL/SQL data types that are supported in PL/SQL programs. It does not describe the data types supported in TimesTen SQL statements. For information on data types supported in TimesTen SQL statements, see Data Types in *Oracle TimesTen In-Memory Database SQL Reference*.

The following topics are covered in this section:

- PL/SQL Data Type Categories
- Predefined PL/SQL Scalar Data Types
- PL/SQL Composite Data Types
- PL/SQL REF CURSORs

For additional information see PL/SQL Data Types in .

PL/SQL Data Type Categories

In a PL/SQL block, every constant, variable, and parameter has a data type. PL/SQL provides predefined data types and subtypes and lets you define your own PL/SQL subtypes.

Table 3-2 lists the categories of the predefined PL/SQL data types.

Table 3-2 Predefined PL/SQL Data Type Categories

Data type category	Description
Scalar	Single values with no internal components
Composite	Internal components that are either scalar or composite
Reference	Pointers to other data items such as REF CURSORs

> **Note**
>
> See Unsupported Data Types.

Predefined PL/SQL Scalar Data Types

Scalar data types store single values with no internal components.

These are covered in the following sections:

- Scalar Data Types and Type Families
- Declaring Variables of Scalar Data Types
- PLS_INTEGER and BINARY_INTEGER Data Types
- SIMPLE_INTEGER Data Type
- ROWID Data Type
- LOB Data Types

> **Note**
>
> See Unsupported Data Types.

Scalar Data Types and Type Families

There are predefined PL/SQL scalar data types and type families.

Table 3-3 lists predefined PL/SQL scalar data types of interest, grouped by data type families.

Table 3-3 Predefined PL/SQL Scalar Data Types

Data Type Family	Data Type Name
NUMERIC	NUMBER PLS_INTEGER BINARY_FLOAT BINARY_DOUBLE
CHARACTER	CHAR[ACTER] VARCHAR2 NCHAR (national character CHAR) NVARCHAR2 (national character VARCHAR2)
BINARY	RAW
BOOLEAN	BOOLEAN **Note**: You cannot bind BOOLEAN types in SQL statements.
DATETIME	DATE TIMESTAMP
INTERVAL	INTERVAL YEAR TO MONTH INTERVAL DAY TO SECONDS
ROWID	ROWID
LOB	BLOB (binary LOB) CLOB (character LOB) NCLOB (national character LOB)

Declaring Variables of Scalar Data Types

This examples declares PL/SQL variables.

```
Command> DECLARE
            v_emp_job     VARCHAR2 (9);
            v_count_loop  BINARY_INTEGER := 0;
            v_dept_total_sal NUMBER (9,2) := 0;
            v_orderdate   DATE := SYSDATE + 7;
            v_valid       BOOLEAN NOT NULL := TRUE;
         ...
```

PLS_INTEGER and BINARY_INTEGER Data Types

The PLS_INTEGER and BINARY_INTEGER data types are identical and are used interchangeably in this document.

The PLS_INTEGER data type stores signed integers in the range -2,147,483,648 through 2,147,483,647 represented in 32 bits. It has the following advantages over the NUMBER data type and subtypes:

- PLS_INTEGER values require less storage.
- PLS_INTEGER operations use hardware arithmetic, so they are faster than NUMBER operations, which use library arithmetic.

For efficiency, use PLS_INTEGER values for all calculations that fall within its range. For calculations outside the PLS_INTEGER range, use INTEGER, a predefined subtype of the NUMBER data type.

See PLS_INTEGER and BINARY_INTEGER Data Types in .

> **Note**
>
> When a calculation with two PLS_INTEGER data types overflows the PLS_INTEGER range, an overflow exception is raised even if the result is assigned to a NUMBER data type.

SIMPLE_INTEGER Data Type

SIMPLE_INTEGER is a predefined subtype of the PLS_INTEGER data type that has the same range as PLS_INTEGER (-2,147,483,648 through 2,147,483,647) and has a NOT NULL constraint. It differs from PLS_INTEGER in that it does not overflow.

You can use SIMPLE_INTEGER when the value is never null and overflow checking is unnecessary. Without the overhead of checking for null values and overflow, SIMPLE_INTEGER provides better performance than PLS_INTEGER.

See SIMPLE_INTEGER Subtype of PLS_INTEGER in .

ROWID Data Type

Each row in a table has a unique identifier known as its *rowid*.

An application can specify literal rowid values in SQL statements, such as in WHERE clauses, as CHAR constants enclosed in single quotes.

Also refer to ROWID Data Type and ROWID Pseudocolumn in *Oracle TimesTen In-Memory Database SQL Reference*.

LOB Data Types

The LOB (large object) type family includes CLOB (character LOBs), NCLOB (national character LOBs), and BLOB (binary LOBs).

A LOB consists of a LOB locator and a LOB value. The locator acts as a handle to the value. When an application selects a LOB or passes a LOB as a parameter, for example, it is using the locator, not the actual value.

LOBs may be either persistent or temporary. A persistent LOB exists in the database, in a particular row of a LOB column. A temporary LOB is used internally within a program, but could then be inserted into a LOB column in the database to become a persistent LOB.

See LOB Data Types in *Oracle TimesTen In-Memory Database SQL Reference* for additional information about LOBs in TimesTen Classic.

Also see Large Objects (LOBs).

PL/SQL Composite Data Types

Composite types have internal components that can be manipulated individually, such as the elements of an array, record, or table.

The following sections discuss the use of composite data types:

- TimesTen Support for Composite Data Types
- Using Collections in PL/SQL
- Using Records in PL/SQL
- Using Associative Arrays from Applications

See PL/SQL Collections and Records in .

TimesTen Support for Composite Data Types

TimesTen supports these composite data types.

- Associative array (index-by table)
- Nested table
- Varray
- Record

Associative arrays, nested tables, and varrays are also referred to as *collections*.

Using Collections in PL/SQL

You can declare collection data types similar to arrays, sets, and hash tables found in other languages. A collection is an ordered group of elements, all of the same type. Each element has a unique subscript that determines its position in the collection.

In PL/SQL, array types are known as *varrays* (variable size arrays), set types are known as *nested tables*, and hash table types are known as *associative arrays* or *index-by tables*. These are all collection types.

The following example declares collection type `staff_list` as a table of `employee_id`, then uses the collection type in a loop and in the `WHERE` clause of the `SELECT` statement.

```
Command> DECLARE
           TYPE staff_list IS TABLE OF employees.employee_id%TYPE;
           staff staff_list;
           lname employees.last_name%TYPE;
           fname employees.first_name%TYPE;
         BEGIN
           staff := staff_list(100, 114, 115, 120, 122);
           FOR i IN staff.FIRST..staff.LAST LOOP
             SELECT last_name, first_name INTO lname, fname FROM employees
               WHERE employees.employee_id = staff(i);
             DBMS_OUTPUT.PUT_LINE (TO_CHAR(staff(i)) ||
               ': ' || lname || ', ' || fname );
```

```
            END LOOP;
          END;
          /
100: King, Steven
114: Raphaely, Den
115: Khoo, Alexander
120: Weiss, Matthew
122: Kaufling, Payam

PL/SQL procedure successfully completed.
```

Any collections can be passed between PL/SQL subprograms as parameters. In TimesTen, however, only associative arrays can be passed between PL/SQL and applications written in other languages. (See Using Associative Arrays from Applications below.)

You can use collections to move data in and out of TimesTen tables using bulk SQL.

Using Records in PL/SQL

Records are composite data structures that have fields with different data types. You can pass records to subprograms with a single parameter.

You can also use the `%ROWTYPE` attribute to declare a record that represents a row in a table or a row from a query result set, without specifying the names and types for the fields, as shown in an example in PL/SQL Variables and Constants.

This example declares record types:

```
Command> DECLARE
           TYPE timerec IS RECORD (hours SMALLINT, minutes SMALLINT);
           TYPE meetin_typ IS RECORD (
           date_held DATE,
           duration timerec, -- nested record
           location VARCHAR2(20),
           purpose VARCHAR2(50));
         BEGIN
           ...
         END;
         /
```

Using Associative Arrays from Applications

Associative arrays, formerly known as index-by tables or PL/SQL tables, are supported as `IN`, `OUT`, or `IN OUT` bind parameters in TimesTen PL/SQL, such as from an OCI, Pro*C/C++, or JDBC application. This enables arrays of data to be passed efficiently between an application and the database.

An associative array is a set of key-value pairs. In TimesTen, for associative array binding (but not for use of associative arrays only within PL/SQL), the keys, or indexes, must be integers (`BINARY_INTEGER` or `PLS_INTEGER`). The values must be simple scalar values of the same data type. For example, there could be an array of department managers indexed by department numbers. Indexes are stored in sort order, not creation order.

You can declare an associative array type and then an associative array in PL/SQL as in the following example (note the `INDEX BY`):

```
declare
   TYPE VARCHARARRTYP IS TABLE OF VARCHAR2(30) INDEX BY BINARY_INTEGER;
   x VARCHARARRTYP;
   ...
```

See below and Using Associative Arrays for examples.

Also see Binding Associative Arrays in TimesTen OCI and Associative Array Bindings in TimesTen Pro*C/C++ in *Oracle TimesTen In-Memory Database C Developer's Guide*, and Working with Associative Arrays in *Oracle TimesTen In-Memory Database Java Developer's Guide*.

For general information about associative arrays, see Associative Arrays in .

> **Note**
>
> Note the following restrictions in TimesTen:
>
> - The following types are not supported in binding associative arrays: LOBs, REF CURSORs, `TIMESTAMP`, `ROWID`.
> - Associative array binding is not allowed in passthrough statements.
> - General bulk binding of arrays is not supported in TimesTen programmatic APIs. Varrays and nested tables are not supported as bind parameters.

The following example manipulates an associative array, effectively binding it from `ttIsql` and printing the array.

```
Command> var lngvc[1000] varchar2(30);
Command> declare
            TYPE VARCHARARRTYP IS TABLE OF VARCHAR2(30) INDEX BY BINARY_INTEGER;
            x VARCHARARRTYP;
         begin
            x := :lngvc;
            x ( 1 ) := 'One';
            x ( 10 ) := 'Ten';
            :lngvc := x;
         end;
         /

PL/SQL procedure successfully completed.

Command> print lngvc;
LNGVC                : ARRAY [ 1000 ] (Current Size 10)
LNGVC[1] : One
LNGVC[2] : <NULL>
LNGVC[3] : <NULL>
LNGVC[4] : <NULL>
LNGVC[5] : <NULL>
LNGVC[6] : <NULL>
LNGVC[7] : <NULL>
LNGVC[8] : <NULL>
LNGVC[9] : <NULL>
LNGVC[10] : Ten
```

PL/SQL REF CURSORs

A REF CURSOR is a handle to a cursor over a SQL result set that can be passed as a parameter between PL/SQL and an application.

TimesTen supports `OUT` REF CURSORs, from PL/SQL to the application. The application would open the REF CURSOR within PL/SQL, pass it from there through the applicable API, and fetch the result set.

TimesTen supports REF CURSORs in ODBC, JDBC, ODP.NET, OCI, Pro*C/C++, and TTClasses for either direct connections or client/server connections. REF CURSORs are also discussed in the following TimesTen documents:

- Working with REF CURSORs in *Oracle TimesTen In-Memory Database C Developer's Guide*
- Working with REF CURSORs in *Oracle TimesTen In-Memory Database Java Developer's Guide*
- Working with REF CURSORs in *Oracle TimesTen In-Memory Database TTClasses Guide*

You can define a REF CURSOR in PL/SQL in TimesTen as you would in Oracle Database. (See Cursor Variables in .) It is typical to use REF CURSOR as a metatype, where you define a "strong" (specific) REF CURSOR type tailored to your data, then declare a cursor variable of that type. For example:

```
Command> DECLARE
           TYPE DeptCurTyp IS REF CURSOR RETURN departments%ROWTYPE;
           dept_cv  DeptCurTyp; -- declare cursor variable
         ...
```

The following example creates a procedure `GET_EMP` in a package `FOO_PACK` to retrieve information about employees from the `employees` table. The procedure declares a REF CURSOR type `cursor_out`, then uses that type for the output parameter.

First specify the package definition, REF CURSOR type, and procedure definition:

```
create or replace package foo_pack is
   type cursor_out is ref cursor;
   procedure get_emp (results out cursor_out);
end foo_pack;
```

Then specify the package body and procedure implementation:

```
create or replace package body foo_pack as
   procedure get_emp (results out cursor_out) is
      begin
         open results for select employee_id, last_name from employees
                          where employee_id < 110 order by last_name;
      end get_emp;
end foo_pack;
```

Declare a REF CURSOR variable for the output, execute the procedure, and display the results. Note that outside of PL/SQL, you can declare only "weak" (generic) REF CURSORs:

```
Command> var proc_result refcursor;
Command> exec foo_pack.get_emp(:proc_result);

PL/SQL procedure successfully completed.

Command> print proc_result;
PROC_RESULT          :
< 105, Austin >
< 102, De Haan >
< 104, Ernst >
< 109, Faviet >
< 108, Greenberg >
< 103, Hunold >
< 100, King >
< 101, Kochhar >
< 107, Lorentz >
< 106, Pataballa >
10 rows found.
```

Alternatively, you could declare a weakly typed REF CURSOR variable in `FOO_PACK`:

```
create or replace package foo_pack is
   procedure get_emp (results out sys_refcursor);
end foo_pack;

create or replace package body foo_pack as
   procedure get_emp (results out sys_refcursor) is
      begin
         open results for select employee_id, last_name from employees
                          where employee_id < 110 order by last_name;
      end get_emp;
end foo_pack;
```

Data Type Conversion

There are several kinds of data type conversions.

- Conversion Between PL/SQL Data Types
- Conversion Between Application Data Types and PL/SQL or SQL Data Types

Also see type conversion information under Differences in TimesTen: Data Type Considerations.

Conversion Between PL/SQL Data Types

TimesTen supports implicit and explicit conversions between PL/SQL data types.

Consider this example: The variable `v_sal_hike` is of type `VARCHAR2`. When calculating the total salary, PL/SQL first converts `v_sal_hike` to `NUMBER` then performs the operation. The result is of type `NUMBER`. PL/SQL uses implicit conversion to obtain the correct result.

```
Command> DECLARE
           v_salary NUMBER (6) := 6000;
           v_sal_hike VARCHAR2(5) := '1000';
           v_total_salary v_salary%TYPE;
         BEGIN
         v_total_salary := v_salary + v_sal_hike;
         DBMS_OUTPUT.PUT_LINE (v_total_salary);
         end;
         /
7000

PL/SQL procedure successfully completed.
```

> **Note**
>
> Also see Date and Timestamp Formats: NLS_DATE_FORMAT and NLS_TIMESTAMP_FORMAT.

Conversion Between Application Data Types and PL/SQL or SQL Data Types

TimesTen supports data type conversions between application program data types and PL/SQL data types, and between application program data types and TimesTen SQL data types.

This section includes the following:

- Application Data Type Conversion Mappings
- Application Data Type Conversion Examples

Application Data Type Conversion Mappings

Data types from an application using the ODBC API can be mapped to PL/SQL program data types.

For more information about ODBC-to-PL/SQL type mappings, refer to Parameter Type Assignments and Type Conversions in *Oracle TimesTen In-Memory Database C Developer's Guide*.

Table 3-4 Sampling of ODBC SQL to PL/SQL Type Mapping

ODBC Type	PL/SQL Type
SQL_BINARY	RAW (Bound precision is used.)
SQL_CHAR	CHAR (Bound precision is used.)
SQL_DATE	DATE

Table 3-4 (Cont.) Sampling of ODBC SQL to PL/SQL Type Mapping

ODBC Type	PL/SQL Type
SQL_DECIMAL	NUMBER
SQL_DOUBLE	NUMBER
SQL_FLOAT	BINARY_DOUBLE
SQL_INTEGER	PLS_INTEGER
SQL_REFCURSOR	REF CURSOR
SQL_TIMESTAMP	TIMESTAMP (Bound scale is used.)
SQL_VARCHAR	VARCHAR2 (Bound precision is used.)

Application Data Type Conversion Examples

Consider a scenario where your C program uses the ODBC API and your goal is to bind your C variable of type VARCHAR2 to a PL/SQL variable of type NUMBER. TimesTen performs the implicit conversion for you.

```
Command> VARIABLE c_var VARCHAR2 (30) := '961';
Command> DECLARE v_var NUMBER;
         BEGIN
           v_var := :c_var;
           DBMS_OUTPUT.PUT_LINE (v_var);
         END;
         /
961

PL/SQL procedure successfully completed.
```

The next example creates a table with a column of type TT_BIGINT and uses PL/SQL to invoke the TimesTen SQL INSERT statement. A bind variable of type SQL_VARCHAR is used in the INSERT statement. The conversions are the same as the conversions that would occur if your application invoked the INSERT statement directly.

```
Command> CREATE TABLE conversion_test2 (Col1 TT_BIGINT);
Command>  VARIABLE v_var VARCHAR2 (100) := '1000';
Command>  BEGIN
           INSERT INTO conversion_test2 VALUES (:v_var);
          END;
          /

PL/SQL procedure successfully completed.

Command> SELECT * FROM conversion_test2;
< 1000 >
1 row found.
```

> **Note**
>
> For SQL, the conversions are the same whether SQL is invoked by your PL/SQL program or is invoked directly by your application.

Differences in TimesTen: Data Type Considerations

There are TimesTen-specific considerations regarding data type support and type conversions.

- Conversion Between PL/SQL and TimesTen SQL Data Types
- Date and Timestamp Formats: NLS_DATE_FORMAT and NLS_TIMESTAMP_FORMAT
- Unsupported Data Types

Conversion Between PL/SQL and TimesTen SQL Data Types

TimesTen supports conversions between PL/SQL data types and TimesTen SQL data types.

This support is described in the following sections:

- Supported PL/SQL to SQL Conversions
- Suggested PL/SQL to SQL Mappings
- PL/SQL to SQL Conversion Example

Supported PL/SQL to SQL Conversions

You can convert certain PL/SQL data types to SQL data types.

Table 3-5 shows supported data type conversions, with PL/SQL types along the top and SQL types down the left side. The data types are grouped by data type families, with columns referring to PL/SQL type families and rows referring to TimesTen type families. "Yes" indicates that a conversion is possible between the two families. Supported conversions are bidirectional.

> **Note**
>
> Also see Unsupported Data Types.

Table 3-5 Supported Conversions Between PL/SQL and TimesTen SQL Data Types

Type Family	NUMERIC	CHARACTER	BINARY	DATETIME	INTERVAL	ROWID
NUMERIC	Yes	Yes	No	No	No	No
CHARACTER	Yes	Yes	Yes	Yes	Yes	Yes
DATETIME	No	Yes	No	Yes	No	No
TIME	No	Yes	No	No	No	No
ROWID	No	Yes	No	No	No	Yes
BINARY	No	Yes	Yes	No	No	Yes

Suggested PL/SQL to SQL Mappings

There are suggestions for mapping TimesTen data types to PL/SQL.

Table 3-6 summarizes TimesTen data types with suggestions for type mappings to PL/SQL.

Table 3-6 Data Type Usage and Sizes

TimesTen Data Type	Description
TT_TINYINT	This is for unsigned integers ranging from 0 to 255. Numeric overflows can occur if you insert a value with type PL/SQL NUMBER or PL/SQL PLS_INTEGER (or BINARY_INTEGER) into a TT_TINYINT column.
TT_SMALLINT	This is for signed 16-bit integers in the range -32,768 to 32,767. Numeric overflows can occur if you insert a value with type PL/SQL NUMBER or PL/SQL PLS_INTEGER (or BINARY_INTEGER) into a TT_SMALLINT column.
TT_INTEGER	This is for signed integers in the range -2,147,483,648 to 2,147,483,647. This is equivalent to PLS_INTEGER.
TT_BIGINT	This is for signed eight-byte integers in the range -9,223,372,036,854,775,808 to 9,223,372,036,854,775,807. Use PL/SQL NUMBER. A PL/SQL PLS_INTEGER (or BINARY_INTEGER) variable could overflow.
NUMBER, BINARY_FLOAT, BINARY_DOUBLE	Use when floating point precision is required.
Character types	All PL/SQL character types can hold up to 32,767 bytes of data. • TimesTen CHAR can hold up to 8300 bytes. • TimesTen NCHAR can hold up to 4150 characters (8300 bytes). • TimesTen VARCHAR2 can hold up to 4,194,304 bytes. • TimesTen NVARCHAR2 can hold up to 2,097,152 characters (4,194,304 bytes).
Datetime, interval, and time types	Use the TO_CHAR and TO_DATE built-in functions when you require a format that is different than the default format used when converting these types to and from character types.
Binary types	• TimesTen BINARY can hold up to 8300 bytes. • TimesTen VARBINARY can hold up to 4,194,304 bytes. • RAW and LONG RAW can hold up to 32,767 bytes.

PL/SQL to SQL Conversion Example

This is an example of converting PL/SQL to SQL.

Consider the case where you have a table with two columns. Col1 has a data type of TT_INTEGER and Col2 has a data type of NUMBER. In your PL/SQL program, you declare two variables: v_var1 of type PLS_INTEGER and v_var2 of type VARCHAR2. The goal is to SELECT the row of data from your table into the two PL/SQL variables.

Data type conversions occur when you execute the `SELECT` statement. `Col1` is converted from a TimesTen SQL `TT_INTEGER` type into a `PLS_INTEGER` type. `Col2` is converted from a TimesTen SQL `NUMBER` type into a PL/SQL `VARCHAR2` type. The query executes successfully.

```
Command> CREATE TABLE test_conversion (Col1 TT_INTEGER, Col2 NUMBER);
Command> INSERT INTO test_conversion VALUES (100, 20);
1 row inserted.

Command>  DECLARE
           v_var1 PLS_INTEGER;
           v_var2 VARCHAR2 (100);
          BEGIN
           SELECT Col1, Col2 INTO v_var1, v_var2 FROM test_conversion;
          DBMS_OUTPUT.PUT_LINE (v_var1);
          DBMS_OUTPUT.PUT_LINE (v_var2);
         END;
         /
100
20

PL/SQL procedure successfully completed.
```

Date and Timestamp Formats: NLS_DATE_FORMAT and NLS_TIMESTAMP_FORMAT

TimesTen does not support user-specified `NLS_DATE_FORMAT` and `NLS_TIMESTAMP_FORMAT` settings.

- `NLS_DATE_FORMAT` is always '*yyyy-mm-dd*'.
- `NLS_TIMESTAMP_FORMAT` is always '*yyyy-mm-dd hh:mi:ss.ff6*' (fractional seconds to six decimal places).

You can use the SQL and PL/SQL `TO_DATE` and `TO_CHAR` functions to specify other desired formats. See Expressions in *Oracle TimesTen In-Memory Database SQL Reference*.

Unsupported Data Types

There are unsupported data types.

- PL/SQL data type categories: PL/SQL in TimesTen does not support Internet data types (`XMLType`, `URIType`, `HttpURIType`) or "Any" data types (`AnyType`, `AnyData`, `AnyDataSet`).
- PL/SQL scalar data types: TimesTen does not support the PL/SQL data types `TIMESTAMP WITH [LOCAL] TIME ZONE` and `UROWID`.

4

Errors and Exception Handling

This chapter describes flexible error trapping and error handling you can use in your PL/SQL programs.

See PL/SQL Error Handling in .

See the end of this chapter for TimesTen-specific considerations.

The following topics are covered:

Understanding Exceptions

This section provides an overview of exceptions in PL/SQL programming.

About Exceptions

An exception is a PL/SQL error that is raised during program execution, either implicitly by TimesTen or explicitly by your program. Handle an exception by trapping it with a handler or propagating it to the calling environment.

For example, if your `SELECT` statement returns multiple rows, TimesTen returns an error (exception) at runtime. As the following example shows, you would see TimesTen error 8507, then the associated `ORA` error message. (`ORA` messages, originally defined for Oracle Database, are similarly implemented by TimesTen.)

```
Command> DECLARE
          v_lname VARCHAR2 (15);
         BEGIN
          SELECT last_name INTO v_lname
          FROM employees
          WHERE first_name = 'John';
           DBMS_OUTPUT.PUT_LINE ('Last name is :' || v_lname);
          END;
          /

 8507: ORA-01422: exact fetch returns more than requested number of rows
 8507: ORA-06512: at line 4
The command failed.
```

You can handle such exceptions in your PL/SQL block so that your program completes successfully. For example:

```
Command> DECLARE
          v_lname VARCHAR2 (15);
         BEGIN
          SELECT last_name INTO v_lname
          FROM employees
          WHERE first_name = 'John';
           DBMS_OUTPUT.PUT_LINE ('Last name is :' || v_lname);
         EXCEPTION
           WHEN TOO_MANY_ROWS THEN
           DBMS_OUTPUT.PUT_LINE (' Your SELECT statement retrieved multiple
           rows. Consider using a cursor.');
         END;
         /
 Your SELECT statement retrieved multiple rows. Consider using a cursor.

PL/SQL procedure successfully completed.
```

Exception Types

There are three types of exceptions.

- Predefined exceptions are error conditions that are defined by PL/SQL.
- Non-predefined exceptions include any standard TimesTen errors.
- User-defined exceptions are exceptions specific to your application.

In TimesTen, these three types of exceptions are used in the same way as in Oracle Database.

Exception	Description	How to Handle
Predefined TimesTen error	One of approximately 20 errors that occur most often in PL/SQL code	You are not required to declare these exceptions. They are predefined by TimesTen. TimesTen implicitly raises the error.
Non-predefined TimesTen error	Any other standard TimesTen error	These must be declared in the declarative section of your application. TimesTen implicitly raises the error and you can use an exception handler to catch the error.
User-defined error	Error defined and raised by the application	These must be declared in the declarative section. The developer raises the exception explicitly.

Trapping Exceptions

This section describes how to trap predefined TimesTen errors or user-defined errors.

- Trapping Predefined TimesTen Errors
- Trapping User-Defined Exceptions

Trapping Predefined TimesTen Errors

Trap a predefined TimesTen error by referencing its predefined name in your exception-handling routine. PL/SQL declares predefined exceptions in the `STANDARD` package.

Refer to the following for details:

- Predefined Exceptions Reference
- Predefined Exception Example

Predefined Exceptions Reference

There are predefined exceptions supported by TimesTen.

Table 4-1 provides associated `ORA` error numbers and `SQLCODE` values, and descriptions of the exceptions.

Also see Unsupported Predefined Errors.

Table 4-1 Predefined Exceptions

Exception name	Oracle Database Error Number	SQLCODE	Description
`ACCESS_INTO_NULL`	`ORA-06530`	-6530	Program attempted to assign values to the attributes of an uninitialized object.
`CASE_NOT_FOUND`	`ORA-06592`	-6592	None of the choices in the `WHEN` clauses of a `CASE` statement is selected and there is no `ELSE` clause.
`COLLECTION_IS_NULL`	`ORA-06531`	-6531	Program attempted to apply collection methods other than EXISTS to an uninitialized nested table or varray, or program attempted to assign values to the elements of an uninitialized nested table or varray.
`CURSOR_ALREADY_OPENED`	`ORA-06511`	-6511	Program attempted to open an already opened cursor.
`DUP_VAL_ON_INDEX`	`ORA-00001`	-1	Program attempted to insert duplicate values in a column that is constrained by a unique index.
`INVALID_CURSOR`	`ORA-01001`	-1001	There is an invalid cursor operation.
`INVALID_NUMBER`	`ORA-01722`	-1722	Conversion of character string to number failed.
`NO_DATA_FOUND`	`ORA-01403`	+100	Single row `SELECT` returned no rows or your program referenced a deleted element in a nested table or an uninitialized element in an associative array (index-by table).
`PROGRAM_ERROR`	`ORA-06501`	-6501	PL/SQL has an internal problem.

Table 4-1 (Cont.) Predefined Exceptions

Exception name	Oracle Database Error Number	SQLCODE	Description
ROWTYPE_MISMATCH	ORA-06504	-6504	Host cursor variable and PL/SQL cursor variable involved in an assignment statement have incompatible return types.
STORAGE_ERROR	ORA-06500	-6500	PL/SQL ran out of memory or memory was corrupted.
SUBSCRIPT_BEYOND_COUNT	ORA-06533	-6533	A program referenced a nested table or varray using an index number larger than the number of elements in the collection.
SUBSCRIPT_OUTSIDE_LIMIT	ORA-06532	-6532	A program referenced a nested table or varray element using an index number that is outside the valid range (for example, -1).
SYS_INVALID_ROWID	ORA-01410	-1410	The conversion of a character string into a universal rowid failed because the character string does not represent a ROWID value.
TOO_MANY_ROWS	ORA-01422	-1422	Single row SELECT returned multiple rows.
VALUE_ERROR	ORA-06502	-6502	An arithmetic, conversion, truncation, or size constraint error occurred.
ZERO_DIVIDE	ORA-01476	-1476	A program attempted to divide a number by zero.

Predefined Exception Example

In this example, a PL/SQL program attempts to divide by 0. The ZERO_DIVIDE predefined exception is used to trap the error in an exception-handling routine.

```
Command> DECLARE v_invalid PLS_INTEGER;
         BEGIN
           v_invalid := 100/0;
         EXCEPTION
         WHEN ZERO_DIVIDE THEN
           DBMS_OUTPUT.PUT_LINE ('Attempt to divide by 0');
         END;
         /
Attempt to divide by 0

PL/SQL procedure successfully completed.
```

Trapping User-Defined Exceptions

You can define your own exceptions in PL/SQL in TimesTen, and you can raise user-defined exceptions explicitly with either the PL/SQL RAISE statement or the RAISE_APPLICATION_ERROR procedure.

These processes are described in the following sections:

- Using the RAISE Statement
- Using the RAISE_APPLICATION_ERROR Procedure

Using the RAISE Statement

The `RAISE` statement stops execution of a PL/SQL block or subprogram and transfers control to an exception handler. `RAISE` statements can raise predefined exceptions, or user-defined exceptions whose names you decide.

In the example that follows, the department number 500 does not exist, so no rows are updated in the `departments` table. The `RAISE` statement is used to explicitly raise an exception and display an error message, returned by the `SQLERRM` built-in function, and an error code, returned by the `SQLCODE` built-in function. Use the `RAISE` statement by itself within an exception handler to raise the same exception again and propagate it back to the calling environment.

```
Command> DECLARE
           v_deptno NUMBER := 500;
           v_name VARCHAR2 (20) := 'Testing';
           e_invalid_dept EXCEPTION;
         BEGIN
          UPDATE departments
          SET department_name = v_name
          WHERE department_id = v_deptno;
         IF SQL%NOTFOUND THEN
            RAISE e_invalid_dept;
         END IF;
         ROLLBACK;
         EXCEPTION
           WHEN e_invalid_dept THEN
           DBMS_OUTPUT.PUT_LINE ('No such department');
           DBMS_OUTPUT.PUT_LINE (SQLERRM);
           DBMS_OUTPUT.PUT_LINE (SQLCODE);
        END;
        /
No such department
User-Defined Exception
1

PL/SQL procedure successfully completed.

The command succeeded.
```

> **Note**
>
> Given the same error condition in TimesTen and Oracle Database, `SQLCODE` returns the same error code, but `SQLERRM` does not necessarily return the same error message. This is also noted in TimesTen Error Messages and SQL Codes.

Using the RAISE_APPLICATION_ERROR Procedure

Use the `RAISE_APPLICATION_ERROR` procedure in the executable section or exception section (or both) of your PL/SQL program. TimesTen reports errors to your application so you can avoid returning unhandled exceptions.

Use an error number between -20,000 and -20,999. Specify a character string up to 2,048 bytes for your message.

The following example attempts to delete from the `employees` table where `last_name=Patterson`. The `RAISE_APPLICATION_ERROR` procedure raises the error, using error number -20201.

```
Command> DECLARE
           v_last_name employees.last_name%TYPE := 'Patterson';
         BEGIN
         DELETE FROM employees WHERE last_name = v_last_name;
         IF SQL%NOTFOUND THEN
           RAISE_APPLICATION_ERROR (-20201, v_last_name || ' does not exist');
         END IF;
         END;
         /
 8507: ORA-20201: Patterson does not exist
 8507: ORA-06512: at line 6
The command failed.
```

Retrying After Transient Errors (PL/SQL)

TimesTen automatically resolves most transient errors.

However, if your application detects the following error, it is suggested to retry the failing transaction:

- `ORA-57005`: Transient transaction failure due to unavailability of resource. Roll back the transaction and try it again.

> **Note**
>
> Search the entire error stack for errors returning these error types before deciding whether it is appropriate to retry.

Using the PL/SQL pragma `EXCEPTION_INIT`, declare an exception to correspond to this error, and retry the transaction when the exception is encountered.

Here is an example:

```
declare
  retry_stmt exception;
  pragma exception_init(retry_stmt, -57007);
  retry_txn exception;
  pragma exception_init(retry_txn, -57005);
begin
```

```
  -- Execute SQL
exception
when retry_stmt then
  -- Re-execute the failing SQL statemment
when retry_txn then
  -- Re-execute the failing transaction
end;
```

Showing Errors in ttIsql

You can use the `show errors` command in `ttIsql` to see details about errors you encounter in executing anonymous blocks or compiling packages, procedures, or functions.

This is shown in the following example.

Again consider the example in Creating and Using Packages. Assume the same package specification shown there, which declares the procedures and functions `hire_employee`, `remove_employee`, and `num_above_salary`. But instead of the body definition shown there, consider the following, which defines `hire_employee` and `num_above_salary` but not `remove_employee`:

```
CREATE OR REPLACE PACKAGE BODY emp_actions AS
-- Code for procedure hire_employee:
  PROCEDURE hire_employee (employee_id NUMBER,
    last_name VARCHAR2,
    first_name VARCHAR2,
    email VARCHAR2,
    phone_number VARCHAR2,
    hire_date DATE,
    job_id VARCHAR2,
    salary NUMBER,
    commission_pct NUMBER,
    manager_id NUMBER,
    department_id NUMBER) IS
  BEGIN
    INSERT INTO employees VALUES (employee_id,
      last_name,
      first_name,
      email,
      phone_number,
      hire_date,
      job_id,
      salary,
      commission_pct,
      manager_id,
      department_id);
  END hire_employee;
-- Code for function num_above_salary:
  FUNCTION num_above_salary (emp_id NUMBER) RETURN NUMBER IS
    emp_sal NUMBER(8,2);
    num_count NUMBER;
  BEGIN
    SELECT salary INTO emp_sal FROM employees
    WHERE employee_id = emp_id;
    SELECT COUNT(*) INTO num_count FROM employees
```

```
    WHERE salary > emp_sal;
    RETURN num_count;
  END num_above_salary;
END emp_actions;
/
```

Attempting this body definition after the original package specification results in the following:

```
Warning: Package body created with compilation errors.
```

To get more information, run `ttIsql` and use the command `show errors`. In this example, `show errors` provides the following:

```
Command> show errors;
Errors for PACKAGE BODY EMP_ACTIONS:

LINE/COL ERROR
-------- -----------------------------------------------------------------
13/13    PLS-00323: subprogram or cursor 'REMOVE_EMPLOYEE' is declared in a
package specification and must be defined in the package body
```

Differences in TimesTen: Exception Handling and Error Behavior

You should be aware of some error-related behaviors that differ between TimesTen PL/SQL and Oracle Database PL/SQL.

- TimesTen PL/SQL Transaction and Rollback Behavior for Unhandled Exceptions
- TimesTen Error Messages and SQL Codes
- Warnings Not Visible in PL/SQL
- Unsupported Predefined Errors
- Possibility of Runtime Errors After Clean Compile (Use of Oracle Database SQL Parser)
- Use of TimesTen Expressions at Runtime

TimesTen PL/SQL Transaction and Rollback Behavior for Unhandled Exceptions

TimesTen PL/SQL differs from Oracle Database PL/SQL in a scenario where an application executes PL/SQL in the middle of a transaction, and an unhandled exception occurs during execution of the PL/SQL. Oracle Database rolls back to the beginning of the anonymous block. TimesTen does not roll back.

An application should always handle any exception that results from execution of a PL/SQL block, as in the following example, run with autocommit disabled:

```
create table mytable (num int not null primary key);
set serveroutput on

insert into mytable values(1);
begin
 insert into mytable values(2);
```

```
 insert into mytable values(1);
exception
 when dup_val_on_index then
  dbms_output.put_line('oops:' || sqlerrm);
  rollback;
end;

select * from mytable;

commit;
```

The second `INSERT` fails because values must be unique, so an exception occurs and the program performs a rollback. Running this in TimesTen results in this:

```
oops:TT0907: Unique constraint (MYTABLE) violated at Rowid
<BMUFVUAAABQAAAADjq>

select * from mytable;
0 rows found.
```

The result is equivalent in Oracle Database, with the `SELECT` results showing no rows.

Now consider a TimesTen example where the exception is not handled, again run with autocommit disabled:

```
create table mytable (num int not null primary key);
set serveroutput on

insert into mytable values(1);
begin
 insert into mytable values(2);
 insert into mytable values(1);
end;

select * from mytable;

commit;
```

In TimesTen, the `SELECT` query indicates execution of the first two inserts:

```
  907: Unique constraint (MYTABLE) violated at Rowid <BMUFVUAAABQAAAADjq>
 8507: ORA-06512: at line 3
The command failed.

select * from mytable;
< 1 >
< 2 >
2 rows found.
```

If you execute this in Oracle Database, there is a rollback to the beginning of the PL/SQL block, so the results of the `SELECT` indicate execution of only the first insert:

```
ORA-00001: unique constraint (SYSTEM.SYS_C004423) violated
ORA-06512: at line 3
```

```
       NUM
----------
         1
```

> **Note**
>
> - If there *is* an unhandled exception in a PL/SQL block, TimesTen leaves the transaction open only to allow the application to assess its state and determine appropriate action.
> - An application in TimesTen should not execute a PL/SQL block while there are uncommitted changes in the current transaction, unless those changes together with the PL/SQL operations really do constitute a single logical unit of work and the application can determine appropriate action. Such action, for example, might consist of a rollback to the beginning of the transaction.
> - If autocommit is enabled and an unhandled exception occurs in TimesTen, the entire transaction is rolled back.

TimesTen Error Messages and SQL Codes

Given the same error condition, TimesTen does not guarantee that the error message returned by TimesTen is the same as the message returned by Oracle Database, although the SQL code is the same. Therefore, the information returned by the `SQLERRM` function may be different, but that returned by the `SQLCODE` function is the same.
For further information:

- The example in Using the RAISE Statement uses `SQLERRM` and `SQLCODE`.
- Refer to the Error Help portal for information about specific TimesTen error messages.
- Refer to SQLERRM Function and SQLCODE Function in for general information.

Warnings Not Visible in PL/SQL

Oracle Database does not have the concept of runtime warnings, so Oracle Database PL/SQL does not support warnings. TimesTen does have the concept of warnings, but because the TimesTen PL/SQL implementation is based on the Oracle Database PL/SQL implementation, TimesTen PL/SQL does not support warnings.
As a result, in TimesTen you could execute a SQL statement and see a resulting warning, but if you execute the same statement through PL/SQL you would not see the warning.

Unsupported Predefined Errors

Trapping Predefined TimesTen Errors lists predefined exceptions supported by TimesTen, the associated `ORA` error numbers and `SQLCODE` values, and descriptions of the exceptions.

Table 4-2 notes predefined exceptions that are *not* supported by TimesTen.

Table 4-2 Predefined Exceptions Not Supported by TimesTen

Exception Name	Oracle Database Error Number	SQLCODE	Description
LOGIN_DENIED	ORA-01017	-1017	User name or password is invalid.
NOT_LOGGED_ON	ORA-01012	-1012	Program issued a database call without being connected to the database.
SELF_IS_NULL	ORA-30625	-30625	Program attempted to invoke a MEMBER method, but the object was not initialized.
TIMEOUT_ON_RESOURCE	ORA-00051	-51	Timeout occurred while the database was waiting for a resource.

Possibility of Runtime Errors After Clean Compile (Use of Oracle Database SQL Parser)

The TimesTen PL/SQL implementation uses the Oracle Database SQL parser in compiling PL/SQL programs.

This is discussed in PL/SQL in TimesTen Versus PL/SQL in Oracle Database.

As a result, if your program uses Oracle Database syntax or built-in procedures that are not supported by TimesTen, the issue is not discovered during compilation. A runtime error occurs during program execution, however.

Use of TimesTen Expressions at Runtime

TimesTen SQL includes several constructs that are not present in Oracle Database SQL. The PL/SQL language does not include these constructs. To use TimesTen-specific SQL from PL/SQL, execute the SQL statements using the `EXECUTE IMMEDIATE` statement. This avoids compilation errors.

For lists of TimesTen-specific SQL and expressions, see Compatibility Between TimesTen and Oracle Databases in *Oracle TimesTen In-Memory Database Cache Guide*.

For more information about `EXECUTE IMMEDIATE`, refer to Dynamic SQL in PL/SQL (EXECUTE IMMEDIATE Statement).

5

Examples Using TimesTen SQL in PL/SQL

There are additional examples to further explore the tight integration of TimesTen SQL in PL/SQL.

- Examples Using the SELECT...INTO Statement in PL/SQL
- Example Using the INSERT Statement
- Examples Using Input and Output Parameters and Bind Variables
- Examples Using Cursors
- Examples Using FORALL and BULK COLLECT
- Examples Using EXECUTE IMMEDIATE
- Examples Using RETURNING INTO
- Example Querying a System View

> **Note**
>
> Except where stated otherwise, the examples in this guide use the TimesTen `ttIsql` utility (which has the `Command>` prompt). In order to display output in the examples, the setting `SET SERVEROUTPUT ON` is used. See ttIsql in *Oracle TimesTen In-Memory Database Reference*.

Examples Using the SELECT...INTO Statement in PL/SQL

Use the `SELECT... INTO` statement to retrieve exactly one row of data. TimesTen returns an error for any query that returns no rows or multiple rows.

The section provides the following examples:

- Using SELECT... INTO to Return Sum of Salaries
- Using SELECT...INTO to Query Another User's Table

Using SELECT... INTO to Return Sum of Salaries

This example uses a `SELECT...INTO` statement to calculate the sum of salaries for all employees in the department where `department_id` is 60.

```
Command> DECLARE
           v_sum_sal  NUMBER (10,2);
           v_dept_no  NUMBER NOT NULL := 60;
         BEGIN
           SELECT SUM(salary) -- aggregate function
           INTO v_sum_sal FROM employees
           WHERE department_id = v_dept_no;
           DBMS_OUTPUT.PUT_LINE ('Sum is ' || v_sum_sal);
```

```
          END;
          /
Sum is 28800

PL/SQL procedure successfully completed.
```

Using SELECT...INTO to Query Another User's Table

This example provides two users, `USER1` and `USER2`, to show one user employing `SELECT...INTO` to query another user's table.

The following privileges are assumed:

```
grant create session to user1;
grant create session to user2;
grant create table to user1;
grant select on user1.test to user2;
```

USER1:

```
Command> create table test(name varchar2(20), id number);
Command> insert into test values('posey', 363);
1 row inserted.
```

USER2:

```
Command> declare
            targetid number;
         begin
            select id into targetid from user1.test where name='posey';
            dbms_output.put_line('Target ID is ' || targetid);
         end;
         /
Target ID is 363

PL/SQL procedure successfully completed.
```

Example Using the INSERT Statement

This section consists of an example using the `INSERT` statement.

- Using the INSERT Statement

Using the INSERT Statement

TimesTen supports the TimesTen DML statements `INSERT`, `UPDATE`, `DELETE`, and `MERGE`.

This example uses the `AS SELECT` query clause to create table `emp_copy`, sets `AUTOCOMMIT` off, creates a sequence to increment `employee_id`, and uses the `INSERT` statement in PL/SQL to insert a row of data in table `emp_copy`.

```
Command> CREATE TABLE emp_copy AS SELECT * FROM employees;
107 rows inserted.
Command> SET AUTOCOMMIT OFF;

Command> CREATE SEQUENCE emp_copy_seq
         START WITH 207
         INCREMENT BY 1;

Command>  BEGIN
            INSERT INTO emp_copy
              (employee_id, first_name, last_name, email, hire_date, job_id,
               salary)
            VALUES (emp_copy_seq.NEXTVAL, 'Parker', 'Cores', 'PCORES',
SYSDATE,
              'AD_ASST', 4000);
          END;
          /

PL/SQL procedure successfully completed.
```

Continuing, the example confirms the row was inserted, then rolls back the transaction.

```
Command> SELECT * FROM EMP_COPY WHERE first_name = 'Parker';
< 207, Parker, Cores, PCORES, <NULL>, 2008-07-19 21:49:55, AD_ASST, 4000,
<NULL>, <NULL>, <NULL> >
1 row found.
Command> ROLLBACK;
Command>  SELECT * FROM emp_copy WHERE first_name = 'Parker';
0 rows found.
```

Now `INSERT` is executed again, then the transaction is rolled back in PL/SQL. Finally, the example verifies that TimesTen did not insert the row.

```
Command> BEGIN
           INSERT INTO emp_copy
             (employee_id, first_name, last_name, email, hire_date, job_id,
              salary)
           VALUES (emp_copy_seq.NEXTVAL, 'Parker', 'Cores', 'PCORES', SYSDATE,
                   'AD_ASST',4000);
         ROLLBACK;
         END;
         /

PL/SQL procedure successfully completed.

Command> SELECT * FROM emp_copy WHERE first_name = 'Parker';
0 rows found.
```

Examples Using Input and Output Parameters and Bind Variables

The examples in this section use `IN`, `OUT`, and `IN OUT` parameters, including bind variables (host variables) from outside PL/SQL.

Using IN and OUT Parameters

This example creates a procedure `query_emp` to retrieve information about an employee, passes the `employee_id` value 171 to the procedure, and retrieves the name and salary into two `OUT` parameters.

```
Command> CREATE OR REPLACE PROCEDURE query_emp
           (p_id IN employees.employee_id%TYPE,
            p_name  OUT employees.last_name%TYPE,
            p_salary OUT employees.salary%TYPE) IS
         BEGIN
           SELECT last_name, salary INTO p_name, p_salary
           FROM employees
           WHERE employee_id = p_id;
         END query_emp;
         /

Procedure created.

Command> -- Execute the procedure
         DECLARE
          v_emp_name employees.last_name%TYPE;
          v_emp_sal  employees.salary%TYPE;
         BEGIN
          query_emp (171, v_emp_name, v_emp_sal);
          DBMS_OUTPUT.PUT_LINE (v_emp_name || ' earns ' ||
           TO_CHAR (v_emp_sal, '$999,999.00'));
         END;
         /
Smith earns    $7,400.00

PL/SQL procedure successfully completed.
```

Using IN OUT Parameters

Consider a situation where you want to format a phone number. This example takes a 10-character string containing digits for a phone number and passes this unformatted string to a

procedure as an `IN OUT` parameter. After the procedure is executed, the `IN OUT` parameter contains the formatted phone number value.

```
Command> CREATE OR REPLACE PROCEDURE format_phone
           (p_phone_no IN OUT VARCHAR2 ) IS
         BEGIN
          p_phone_no := '('  || SUBSTR (p_phone_no,1,3) ||
                        ') ' || SUBSTR (p_phone_no,4,3) ||
                        '-'  || SUBSTR (p_phone_no,7);
         END format_phone;
         /

Procedure created.
```

Create the bind variable, execute the procedure, and verify the results.

```
Command> VARIABLE b_phone_no VARCHAR2 (15);
Command> EXECUTE :b_phone_no := '8006330575';

PL/SQL procedure successfully completed.

Command> PRINT b_phone_no;
B_PHONE_NO           : 8006330575
Command> BEGIN
           format_phone (:b_phone_no);
         END;
         /

PL/SQL procedure successfully completed.

Command> PRINT b_phone_no
B_PHONE_NO           : (800) 633-0575
```

Using Associative Arrays

This example uses `ttIsql` to bind a `NUMBER` array and a `VARCHAR2` array to corresponding `OUT` associative arrays in a PL/SQL procedure.

See Using Associative Arrays from Applications.

Assume the following SQL setup.

```
DROP TABLE FOO;

CREATE TABLE FOO (CNUM INTEGER,
                  CVC2 VARCHAR2(20));

INSERT INTO FOO VALUES ( null,
     'VARCHAR  1');
INSERT INTO FOO VALUES (-102,
     null);
INSERT INTO FOO VALUES ( 103,
     'VARCHAR  3');
INSERT INTO FOO VALUES (-104,
     'VARCHAR  4');
```

```
INSERT INTO FOO VALUES ( 105,
     'VARCHAR  5');
INSERT INTO FOO VALUES ( 106,
     'VARCHAR  6');
INSERT INTO FOO VALUES ( 107,
     'VARCHAR  7');
INSERT INTO FOO VALUES ( 108,
     'VARCHAR  8');

COMMIT;
```

Assume the following PL/SQL package definition. This includes the `INTEGER` associative array type `NUMARRTYP` and the `VARCHAR2` associative array type `VCHARRTYP`, used for output associative arrays `c1` and `c2`, respectively, in the definition of procedure `P1`.

```
CREATE OR REPLACE PACKAGE PKG1 AS
  TYPE NUMARRTYP IS TABLE OF INTEGER INDEX BY BINARY_INTEGER;
  TYPE VCHARRTYP IS TABLE OF VARCHAR2(20) INDEX BY BINARY_INTEGER;

  PROCEDURE P1(c1 OUT NUMARRTYP,c2 OUT VCHARRTYP);

END PKG1;
/

CREATE OR REPLACE PACKAGE BODY PKG1 AS

  CURSOR CUR1 IS SELECT CNUM, CVC2 FROM FOO;

  PROCEDURE P1(c1 OUT NUMARRTYP,c2 OUT VCHARRTYP) IS
  BEGIN
    IF NOT CUR1%ISOPEN  THEN
      OPEN CUR1;
    END IF;
    FOR i IN 1..8 LOOP
      FETCH CUR1 INTO c1(i), c2(i);
      IF CUR1%NOTFOUND THEN
        CLOSE CUR1;
        EXIT;
      END IF;
    END LOOP;
  END P1;

END PKG1;
```

Now `ttIsql` calls `PKG1.P1`, binds arrays to the `P1` output associative arrays, and prints the contents of those associative arrays.

```
Command> var c1[10] number;
Command> var c2[10] varchar2(20);
Command> print;
C1                   : ARRAY [ 10 ] (Current Size 0)
C2                   : ARRAY [ 10 ] (Current Size 0)
Command> BEGIN PKG1.P1(:c1, :c2); END; /

PL/SQL procedure successfully completed.
```

```
Command> print
C1                   : ARRAY [ 10 ] (Current Size 8)
C1[1] : <NULL>
C1[2] : -102
C1[3] : 103
C1[4] : -104
C1[5] : 105
C1[6] : 106
C1[7] : 107
C1[8] : 108
C2                   : ARRAY [ 10 ] (Current Size 8)
C2[1] : VARCHAR  1
C2[2] : <NULL>
C2[3] : VARCHAR  3
C2[4] : VARCHAR  4
C2[5] : VARCHAR  5
C2[6] : VARCHAR  6
C2[7] : VARCHAR  7
C2[8] : VARCHAR  8
```

Examples Using Cursors

TimesTen supports cursors. Use a cursor to handle the result set of a `SELECT` statement.

See Use of Cursors in PL/SQL Programs.

Examples in this section cover the following:

- Fetching Values
- Using the %ROWCOUNT and %NOTFOUND Attributes
- Using Cursor FOR Loops

See Explicit Cursor Attributes in for information about the cursor attributes used in these examples.

Fetching Values

This section provides examples of how to fetch values from a cursor, including how to fetch the values into a record.

The following example uses a cursor to select `employee_id` and `last_name` from the `employees` table where `department_id` is 30 Two variables are declared to hold the fetched values from the cursor, and the `FETCH` statement retrieves rows one at a time in a loop to retrieve all rows. Execution stops when there are no remaining rows in the cursor, illustrating use of the `%NOTFOUND` cursor attribute.

`%NOTFOUND` yields `TRUE` if an `INSERT`, `UPDATE`, or `DELETE` statement affected no rows, or a `SELECT INTO` statement returned no rows.

```
Command>  DECLARE
            CURSOR c_emp_cursor IS
              SELECT employee_id, last_name FROM employees
              WHERE department_id = 30;
            v_empno  employees.employee_id%TYPE;
```

```
            v_lname  employees.last_name%TYPE;
          BEGIN
            OPEN c_emp_cursor;
            LOOP
             FETCH c_emp_cursor INTO v_empno, v_lname;
            EXIT WHEN c_emp_cursor%NOTFOUND;
            DBMS_OUTPUT.PUT_LINE (v_empno || ' ' || v_lname);
            END LOOP;
            CLOSE c_emp_cursor;
          END;
          /

114 Raphaely
115 Khoo
116 Baida
117 Tobias
118 Himuro
119 Colmenares
```

This next example is similar to the preceding one, with the same results, but fetches the values into a PL/SQL record instead of PL/SQL variables.

```
Command> DECLARE
           CURSOR c_emp_cursor IS
             SELECT employee_id, last_name FROM employees
             WHERE department_id = 30;
           v_emp_record  c_emp_cursor%ROWTYPE;
         BEGIN
           OPEN c_emp_cursor;
           LOOP
             FETCH c_emp_cursor INTO v_emp_record;
           EXIT WHEN c_emp_cursor%NOTFOUND;
           DBMS_OUTPUT.PUT_LINE (v_emp_record.employee_id || ' ' |
             v_emp_record.last_name);
           END LOOP;
           CLOSE c_emp_cursor;
         END;
         /

114 Raphaely
115 Khoo
116 Baida
117 Tobias
118 Himuro
119 Colmenares

PL/SQL procedure successfully completed.
```

Using the %ROWCOUNT and %NOTFOUND Attributes

This example shows how to use the `%ROWCOUNT` cursor attribute as well as the `%NOTFOUND` cursor attribute shown in the examples in the preceding section, Fetching Values. `%ROWCOUNT` yields

the number of rows affected by an INSERT, UPDATE, or DELETE statement or returned by a SELECT...INTO or FETCH...INTO statement.

```
Command> DECLARE
           CURSOR c_emp_cursor IS
             SELECT employee_id, last_name FROM employees
             WHERE department_id = 30;
           v_emp_record  c_emp_cursor%ROWTYPE;
         BEGIN
         OPEN c_emp_cursor;
         LOOP
           FETCH c_emp_cursor INTO v_emp_record;
           EXIT WHEN c_emp_cursor%ROWCOUNT > 10 OR c_emp_cursor%NOTFOUND;
           DBMS_OUTPUT.PUT_LINE (v_emp_record.employee_id || ' ' ||
             v_emp_record.last_name);
           END LOOP;
           CLOSE c_emp_cursor;
          END;
          /
114 Raphaely
115 Khoo
116 Baida
117 Tobias
118 Himuro
119 Colmenares

PL/SQL procedure successfully completed.
```

Using Cursor FOR Loops

PL/SQL in TimesTen supports cursor FOR loops.

In the first example, PL/SQL implicitly declares emp_record. No OPEN and CLOSE statements are necessary. The results are the same as in the example in the preceding section, Using the %ROWCOUNT and %NOTFOUND Attributes.

```
Command> DECLARE
           CURSOR c_emp_cursor IS
            SELECT employee_id, last_name FROM employees
            WHERE department_id = 30;
         BEGIN
           FOR emp_record IN c_emp_cursor
            LOOP
              DBMS_OUTPUT.PUT_LINE (emp_record.employee_id || ' ' ||
                 emp_record.last_name);
            END LOOP;
         END;
         /
114 Raphaely
115 Khoo
116 Baida
117 Tobias
118 Himuro
119 Colmenares
```

```
PL/SQL procedure successfully completed.
```

This second example illustrates a `FOR` loop using subqueries. The results are the same as in the preceding example and the example in the previous section, Using the %ROWCOUNT and %NOTFOUND Attributes.

```
Command> BEGIN
          FOR emp_record IN (SELECT employee_id, last_name FROM
           employees WHERE department_id = 30)
          LOOP
            DBMS_OUTPUT.PUT_LINE (emp_record.employee_id || ' ' ||
              emp_record.last_name);
           END LOOP;
         END;
         /
114 Raphaely
115 Khoo
116 Baida
117 Tobias
118 Himuro
119 Colmenares

PL/SQL procedure successfully completed.
```

Examples Using FORALL and BULK COLLECT

TimesTen supports bulk binding and the `FORALL` statement and `BULK COLLECT` feature.

See FORALL and BULK COLLECT Operations.

Examples in this section cover the following:

- Using FORALL with SQL%BULK_ROWCOUNT
- Using BULK COLLECT INTO with Queries
- Using BULK COLLECT INTO with Cursors
- Using SAVE EXCEPTIONS with BULK COLLECT

Using FORALL with SQL%BULK_ROWCOUNT

The `%BULK_ROWCOUNT` cursor attribute is a composite structure designed for use with the `FORALL` statement.

The attribute acts like an associative array (index-by table). Its *i*th element stores the number of rows processed by the *i*th execution of the `INSERT` statement. If the *i*th execution affects no rows, then `%BULK_ROWCOUNT(`*i*`)` returns zero.

This is demonstrated in the following example.

```
Command> DECLARE
           TYPE num_list_type IS TABLE OF NUMBER
              INDEX BY BINARY_INTEGER;
         v_nums num_list_type;
         BEGIN
```

```
            v_nums (1) := 1;
            v_nums (2) := 3;
            v_nums (3) := 5;
            v_nums (4) := 7;
            v_nums (5) := 11;
              FORALL i IN v_nums.FIRST .. v_nums.LAST
               INSERT INTO num_table (n) VALUES (v_nums (i));
             FOR i IN v_nums.FIRST .. v_nums.LAST
             LOOP
                DBMS_OUTPUT.PUT_LINE ('Inserted '||
                  SQL%BULK_ROWCOUNT (i) || ' row (s)' ||
                   ' on iteration  ' || i );
             END LOOP;
          END;
          /
Inserted 1 row (s) on iteration  1
Inserted 1 row (s) on iteration  2
Inserted 1 row (s) on iteration  3
Inserted 1 row (s) on iteration  4
Inserted 1 row (s) on iteration  5

PL/SQL procedure successfully completed.
```

Using BULK COLLECT INTO with Queries

Use `BULK COLLECT` with the `SELECT` statement in PL/SQL to retrieve rows without using a cursor.

This example selects all rows from the `departments` table for a specified location into a nested table, then uses a `FOR LOOP` to output data.

```
Command> CREATE OR REPLACE PROCEDURE get_departments (p_loc NUMBER) IS
             TYPE dept_tab_type IS
           TABLE OF departments%ROWTYPE;
            v_depts dept_tab_type;
           BEGIN
             SELECT * BULK COLLECT INTO v_depts
            FROM departments
           where location_id = p_loc;
           FOR i IN 1 .. v_depts.COUNT
           LOOP
              DBMS_OUTPUT.PUT_LINE (v_depts(i).department_id
                || ' ' || v_depts (i).department_name);
           END LOOP;
           END;
           /

Procedure created.
```

The following executes the procedure and verifies the results:

```
Command> EXECUTE GET_DEPARTMENTS (1700);
10 Administration
30 Purchasing
```

```
90 Executive
100 Finance
110 Accounting
120 Treasury
130 Corporate Tax
140 Control And Credit
150 Shareholder Services
160 Benefits
170 Manufacturing
180 Construction
190 Contracting
200 Operations
210 IT Support
220 NOC
230 IT Helpdesk
240 Government Sales
250 Retail Sales
260 Recruiting
270 Payroll

PL/SQL procedure successfully completed.

Command> SELECT department_id, department_name FROM departments WHERE
         location_id = 1700;
< 10, Administration >
< 30, Purchasing >
< 90, Executive >
< 100, Finance >
< 110, Accounting >
< 120, Treasury >
< 130, Corporate Tax >
< 140, Control And Credit >
< 150, Shareholder Services >
< 160, Benefits >
< 170, Manufacturing >
< 180, Construction >
< 190, Contracting >
< 200, Operations >
< 210, IT Support >
< 220, NOC >
< 230, IT Helpdesk >
< 240, Government Sales >
< 250, Retail Sales >
< 260, Recruiting >
< 270, Payroll >
21 rows found.
```

Using BULK COLLECT INTO with Cursors

This example uses a cursor to bulk-collect rows from the `departments` table with a specified `location_id`. value.

Results are the same as in the preceding section, Using BULK COLLECT INTO with Queries.

```
Command> CREATE OR REPLACE PROCEDURE get_departments2 (p_loc NUMBER) IS
           CURSOR cur_dept IS
            SELECT * FROM departments
            WHERE location_id = p_loc;
          TYPE dept_tab_type IS TABLE OF cur_dept%ROWTYPE;
          v_depts dept_tab_type;
         BEGIN
           OPEN cur_dept;
           FETCH cur_dept BULK COLLECT INTO v_depts;
           CLOSE cur_dept;
         FOR i IN 1 .. v_depts.COUNT
          LOOP
            DBMS_OUTPUT.PUT_LINE (v_depts (i).department_id
            || ' ' || v_depts (i).department_name );
         END LOOP;
         END;
         /

Procedure created.

Command> EXECUTE GET_DEPARTMENTS2 (1700);
10 Administration
30 Purchasing
90 Executive
100 Finance
110 Accounting
120 Treasury
130 Corporate Tax
140 Control And Credit
150 Shareholder Services
160 Benefits
170 Manufacturing
180 Construction
190 Contracting
200 Operations
210 IT Support
220 NOC
230 IT Helpdesk
240 Government Sales
250 Retail Sales
260 Recruiting
270 Payroll

PL/SQL procedure successfully completed.
```

Using SAVE EXCEPTIONS with BULK COLLECT

`SAVE EXCEPTIONS` enables an `UPDATE`, `INSERT`, or `DELETE` statement to continue executing after it issues an exception. When the statement finishes, an error is issued to signal that at least one exception occurred. Exceptions are collected into an array that you can examine using `%BULK_EXCEPTIONS` after the statement has executed.

In this example, PL/SQL raises predefined exceptions because some new values are too large for the `job_id` column. After the `FORALL` statement, `SQL%BULK_EXCEPTIONS.COUNT` returns 2, and

the contents of SQL%BULK_EXCEPTIONS are (7, 01401) and (13, 01401), indicating the error number and the line numbers where the error was detected. To get the error message, the negative of SQL%BULK_EXCEPTIONS(i).ERROR_CODE is passed to the error-reporting function SQLERRM (which expects a negative number).

The following script is executed using ttIsql:

```
-- create a temporary table for this example
CREATE TABLE emp_temp AS SELECT * FROM employees;

DECLARE
   TYPE empid_tab IS TABLE OF employees.employee_id%TYPE;
   emp_sr empid_tab;
-- create an exception handler for ORA-24381
   errors NUMBER;
   dml_errors EXCEPTION;
   PRAGMA EXCEPTION_INIT(dml_errors, -24381);

BEGIN
   SELECT employee_id
      BULK COLLECT INTO emp_sr FROM emp_temp
      WHERE hire_date < '1994-12-30';
-- add '_SR' to the job_id of the most senior employees
   FORALL i IN emp_sr.FIRST..emp_sr.LAST SAVE EXCEPTIONS
      UPDATE emp_temp SET job_id = job_id || '_SR'
      WHERE emp_sr(i) = emp_temp.employee_id;
-- If any errors occurred during the FORALL SAVE EXCEPTIONS,
-- a single exception is raised when the statement completes.

EXCEPTION
-- Figure out what failed and why
   WHEN dml_errors THEN
      errors := SQL%BULK_EXCEPTIONS.COUNT;
      DBMS_OUTPUT.PUT_LINE
         ('Number of statements that failed: ' || errors);
      FOR i IN 1..errors LOOP
         DBMS_OUTPUT.PUT_LINE('Error #' || i || ' occurred during '||
                 'iteration #' || SQL%BULK_EXCEPTIONS(i).ERROR_INDEX);
         DBMS_OUTPUT.PUT_LINE('Error message is ' ||
         SQLERRM(-SQL%BULK_EXCEPTIONS(i).ERROR_CODE));
   END LOOP;
END;
/

DROP TABLE emp_temp;
```

Results are as follows:

```
Number of statements that failed: 2
Error #1 occurred during iteration #7
Error message is ORA-01401: inserted value too large for column
Error #2 occurred during iteration #13
Error message is ORA-01401: inserted value too large for column

PL/SQL procedure successfully completed.
```

Examples Using EXECUTE IMMEDIATE

TimesTen supports the `EXECUTE IMMEDIATE` statement.

See Dynamic SQL in PL/SQL (EXECUTE IMMEDIATE Statement). This section provides these additional examples to consider as you develop your PL/SQL applications in TimesTen:

- Using EXECUTE IMMEDIATE to Create a Table
- Using EXECUTE IMMEDIATE with a Single Row Query
- Using EXECUTE IMMEDIATE to Alter a Connection Attribute
- Using EXECUTE IMMEDIATE to Call a TimesTen Built-In Procedure
- Using EXECUTE IMMEDIATE with TimesTen-Specific Syntax

Using EXECUTE IMMEDIATE to Create a Table

Consider a situation where you do not know your table definition at compilation. By using an `EXECUTE IMMEDIATE` statement, you can create your table at execution time.

This example shows a procedure that creates a table using the `EXECUTE IMMEDIATE` statement. The procedure is executed with the table name and column definitions passed as parameters, then creation of the table is verified.

```
Command> CREATE OR REPLACE PROCEDURE create_table
           (p_table_name VARCHAR2, p_col_specs VARCHAR2) IS
         BEGIN
           EXECUTE IMMEDIATE 'CREATE TABLE ' || p_table_name
             || ' (' || p_col_specs|| ' )';
         END;
         /

Procedure created.
```

Execute the procedure and verify the table is created.

```
Command> BEGIN
         create_table ('EMPLOYEES_NAMES', 'id NUMBER (4)
          PRIMARY KEY, name VARCHAR2 (40)');
         END;
         /

PL/SQL procedure successfully completed.

Command> DESCRIBE employees_names;

Table USER.EMPLOYEES_NAMES:
  Columns:
   *ID                             NUMBER (4) NOT NULL
    NAME                           VARCHAR2 (40) INLINE

1 table found.
(primary key columns are indicated with *)
```

Using EXECUTE IMMEDIATE with a Single Row Query

You can use the EXECUTE IMMEDIATE SQL statement within your query.

In this example, the function `get_emp` retrieves an employee record. The function is executed and returns the results in `v_emprec`.

```
Command> CREATE OR REPLACE FUNCTION get_emp (p_emp_id NUMBER)
           RETURN employees%ROWTYPE IS
           v_stmt VARCHAR2 (200);
           v_emprec employees%ROWTYPE;
         BEGIN
           v_stmt:= 'SELECT * FROM EMPLOYEES '||
           'WHERE employee_id = :p_emp_id';
            EXECUTE IMMEDIATE v_stmt INTO v_emprec USING p_emp_id;
            RETURN v_emprec;
         END;
         /

Function created.

Command> DECLARE
           v_emprec employees%ROWTYPE := GET_EMP (100);
         BEGIN
          DBMS_OUTPUT.PUT_LINE ('Employee: ' || v_emprec.last_name);
         END;
         /
Employee: King

PL/SQL procedure successfully completed.
```

Using EXECUTE IMMEDIATE to Alter a Connection Attribute

This example uses an `EXECUTE IMMEDIATE` statement with `ALTER SESSION` to alter the `PLSQL_OPTIMIZE_LEVEL` setting, calling the `ttConfiguration` built-in procedure before and after to verify the results.

The next example calls `ttConfiguration` from inside an `EXECUTE IMMEDIATE` statement. Refer to ttConfiguration in *Oracle TimesTen In-Memory Database Reference*.

```
Command> call ttconfiguration;
...
< PLSQL_CCFLAGS, <NULL> >
< PLSQL_CODE_TYPE, INTERPRETED >
< PLSQL_CONN_MEM_LIMIT, 100 >
< PLSQL_MEMORY_ADDRESS, 0x10000000 >
< PLSQL_MEMORY_SIZE, 128 >
< PLSQL_OPTIMIZE_LEVEL, 2 >
< PLSQL_TIMEOUT, 30 >
...
54 rows found.

Command> begin
            execute immediate 'alter session set PLSQL_OPTIMIZE_LEVEL=3';
```

```
         end;
         /
PL/SQL procedure successfully completed.

Command> call ttconfiguration;
...
< PLSQL_CCFLAGS, <NULL> >
< PLSQL_CODE_TYPE, INTERPRETED >
< PLSQL_CONN_MEM_LIMIT, 100 >
< PLSQL_MEMORY_ADDRESS, 0x10000000 >
< PLSQL_MEMORY_SIZE, 128 >
< PLSQL_OPTIMIZE_LEVEL, 3 >
< PLSQL_TIMEOUT, 30 >
...
54 rows found.
```

Using EXECUTE IMMEDIATE to Call a TimesTen Built-In Procedure

In PL/SQL, you can use an `EXECUTE IMMEDIATE` statement with `CALL` syntax to call a TimesTen built-in procedure.

For example, to call the built-in procedure `ttConfiguration` and return its output result set, create a PL/SQL record type then use `EXECUTE IMMEDIATE` with `BULK COLLECT` to fetch the result set into an array.

See Built-In Procedures in *Oracle TimesTen In-Memory Database Reference*.

```
Command> DECLARE
           TYPE ttConfig_record IS RECORD
               (name varchar2(255), value varchar2 (255));
           TYPE ttConfig_table IS TABLE OF ttConfig_record;
         v_ttConfigs ttConfig_table;
         BEGIN
           EXECUTE IMMEDIATE 'CALL ttConfiguration'
             BULK COLLECT into v_ttConfigs;
           DBMS_OUTPUT.PUT_LINE ('Name: ' || v_ttConfigs(7).name
             || ' Value: ' || v_ttConfigs(7).value);
         END;
         /
Name: CommitBufferSizeMax Value: 10

PL/SQL procedure successfully completed.
```

Using EXECUTE IMMEDIATE with TimesTen-Specific Syntax

This example uses an `EXECUTE IMMEDIATE` statement to execute a TimesTen `SELECT FIRST` *n* statement. This syntax is specific to TimesTen.

```
Command> DECLARE v_empid NUMBER;
         BEGIN
           EXECUTE IMMEDIATE 'SELECT FIRST 1 employee_id FROM employees'
            INTO v_empid;
          DBMS_OUTPUT.PUT_LINE ('Employee id: ' || v_empid);
         END;
```

```
         /
Employee id: 100

PL/SQL procedure successfully completed.
```

Examples Using RETURNING INTO

This section includes examples using the `RETURNING INTO` clause.

- Using the RETURNING INTO Clause with a Record
- Using BULK COLLECT INTO with the RETURNING INTO Clause

See RETURNING INTO Clause for an overview.

Using the RETURNING INTO Clause with a Record

The following example uses `ttIsql` to run a SQL script that uses a `RETURNING INTO` clause to return data into a record. The example gives a raise to a specified employee, returns the employee's name and new salary into a record, then outputs the data from the record. For reference, the original salary is shown before running the script.

```
Command> SELECT SALARY,LAST_NAME FROM EMPLOYEES WHERE EMPLOYEE_ID = 100;
< 24000, King >
1 row found.

Command> run ReturnIntoWithRecord.sql;

CREATE TABLE emp_temp AS SELECT * FROM employees;
107 rows inserted.

DECLARE
   TYPE EmpRec IS RECORD (last_name employees.last_name%TYPE,
                          salary employees.salary%TYPE);
   emp_info EmpRec;
   emp_id NUMBER := 100;
BEGIN
   UPDATE emp_temp SET salary = salary * 1.1
      WHERE employee_id = emp_id
      RETURNING last_name, salary INTO emp_info;
   DBMS_OUTPUT.PUT_LINE
      ('Just gave a raise to ' || emp_info.last_name ||
       ', who now makes ' || emp_info.salary);
   ROLLBACK;
END;
/

Just gave a raise to King, who now makes 26400

PL/SQL procedure successfully completed.
```

Using BULK COLLECT INTO with the RETURNING INTO Clause

The following example uses `ttIsql` to run a SQL script that uses a `RETURNING INTO` clause with `BULK COLLECT` to return data into nested tables, a type of PL/SQL collection.

The example deletes all the employees from a specified department, then, using one nested table for employee IDs and one for last names, outputs the employee ID and last name of each deleted employee. For reference, the IDs and last names of employees in the department are also displayed before execution of the script.

```
Command> select employee_id, last_name from employees where department_id=30;
< 114, Raphaely >
< 115, Khoo >
< 116, Baida >
< 117, Tobias >
< 118, Himuro >
< 119, Colmenares >
6 rows found.
Command> run ReturnIntoWithBulkCollect.sql;

CREATE TABLE emp_temp AS SELECT * FROM employees;
107 rows inserted.

DECLARE
   TYPE NumList IS TABLE OF employees.employee_id%TYPE;
   enums NumList;
   TYPE NameList IS TABLE OF employees.last_name%TYPE;
   names NameList;
BEGIN
   DELETE FROM emp_temp WHERE department_id = 30
     RETURNING employee_id, last_name
     BULK COLLECT INTO enums, names;
   DBMS_OUTPUT.PUT_LINE
      ('Deleted ' || SQL%ROWCOUNT || ' rows:');
   FOR i IN enums.FIRST .. enums.LAST
   LOOP
      DBMS_OUTPUT.PUT_LINE
         ('Employee #' || enums(i) || ': ' || names(i));
   END LOOP;
END;
/
Deleted 6 rows:
Employee #114: Raphaely
Employee #115: Khoo
Employee #116: Baida
Employee #117: Tobias
Employee #118: Himuro
Employee #119: Colmenares

PL/SQL procedure successfully completed.
```

Example Querying a System View

This section includes an example querying a system view.

Querying a System View

You can query a system view using procedures.

This example queries the `USER_SOURCE` system view to examine the source code of procedure `query_emp` from the example in Using IN and OUT Parameters. You must create that procedure before completing this example.

```
Command> SELECT SUBSTR (text, 1, LENGTH(text)-1)
         FROM user_source
         WHERE name = 'QUERY_EMP' AND type = 'PROCEDURE';
```

This produces the following output:

```
< PROCEDURE query_emp >
< (p_id IN employees.employee_id%TYPE, >
<  p_name OUT employees.last_name%TYPE, >
<  p_salary OUT employees.salary%TYPE) IS >
< BEGIN >
< SELECT last_name, salary INTO p_name, p_salary >
< FROM employees >
< WHERE employee_id = p_id; >
< END query_emp; >
9 rows found.
```

> **Note**
>
> As with other `USER_*` system views, all users have `SELECT` privilege for the `USER_SOURCE` system view.

6

PL/SQL Environment

This chapter shows you how to manage PL/SQL in your TimesTen database.

Topics include:

- PL/SQL Connection Attributes
- PL/SQL Database Configuration Parameters
- PL/SQL Performance Statistics

PL/SQL Connection Attributes

This section describes PL/SQL connection attributes and provides examples for setting and altering them.

- PL/SQL Connection Attributes Reference
- Creating a Database with PL/SQL Default Connection Attributes
- Using ALTER SESSION to Change Connection Attribute Settings

See PL/SQL First Connection Attributes and PL/SQL General Connection Attributes in *Oracle TimesTen In-Memory Database Reference*.

PL/SQL Connection Attributes Reference

There are several TimesTen connection attributes specific to PL/SQL. See Table 6-1.
The table also notes any required privileges and whether each connection attribute is a first connection attribute or a general connection attribute. First connection attributes are set when the database is first loaded, and persist for all connections. Only the instance administrator can load a database with changes to first connection attribute settings. A general connection attribute setting applies to one connection only, and requires no special privilege.

Table 6-1 PL/SQL Connection Attributes

Attribute	Summary

PLSQL_CCFLAGS	General connection attribute
	Required privilege: None
	Use this to set inquiry directives to control conditional compilation of PL/SQL units, which enables you to customize the functionality of a PL/SQL program depending on conditions that are checked. This is especially useful when applications may be deployed to multiple database environments. For example, to activate debugging features:
	`PLSQL_CCFLAGS='DEBUG:TRUE'`
	PL/SQL conditional compilation flags are similar in concept to flags on a C compiler command line, such as the following:
	`% cc -DEBUG=TRUE ...`
	You can use the `ALTER SESSION` statement to change `PLSQL_CCFLAGS` within your session.
	See Conditional Compilation in .
	Also see PLSQL_CCFLAGS in *Oracle TimesTen In-Memory Database Reference*.

PLSQL_CONN_MEM_LIMIT	General connection attribute Required privilege: None Specifies the maximum amount of PL/SQL shared memory (process heap memory) that PL/SQL can allocate for the current connection. (Note that this memory is not actually allocated until needed.) This is memory used for runtime data, such as large PL/SQL collections, as opposed to cached executable code. This limit setting protects other parts of your application, such as C or Java components, when PL/SQL might otherwise take all available runtime memory. The `PLSQL_CONN_MEM_LIMIT` value is a number specified in megabytes. A setting of 0 means no limit. You can use the `ALTER SESSION` statement to change this value within your session. Also see PLSQL_CONN_MEM_LIMIT in *Oracle TimesTen In-Memory Database Reference*. **Note**: In `ttPLSQLMemoryStats` output, the related value `CurrentConnectionMemory` indicates how much process heap memory PL/SQL has actually acquired through `malloc()`. (Also see PL/SQL Performance Statistics.)

Table 6-1 (Cont.) PL/SQL Connection Attributes

Attribute	Summary
PLSQL_MEMORY_ADDRESS	First connection attribute Required privilege: Instance administrator Specifies the virtual address, as a hexadecimal value, at which the PL/SQL shared memory segment is loaded into each process that uses the TimesTen direct drivers. This memory address must be identical in all connections to a given database and in all processes that connect to that database. If a single application simultaneously makes direct connections to multiple databases, then you must set different values for each of the databases. Refer to PLSQL_MEMORY_ADDRESS in *Oracle TimesTen In-Memory Database Reference* for platform-specific information.
PLSQL_MEMORY_SIZE	First connection attribute Required privilege: Instance administrator Determines the size, in megabytes, of memory allocated for the PL/SQL shared memory segment, which is shared by all connections. This memory is used to hold recently executed PL/SQL code and metadata about PL/SQL objects. Refer to PLSQL_MEMORY_SIZE in *Oracle TimesTen In-Memory Database Reference* for information about calculating the PL/SQL memory size and for platform-specific values and tuning information.
PLSQL_OPEN_CURSORS	First connection attribute Required privilege: Instance administrator Specifies the maximum number of PL/SQL cursors that can be open in a session at one time. Note that this attribute has the same functionality as `OPEN_CURSORS` in Oracle Database. Also see PLSQL_OPEN_CURSORS in *Oracle TimesTen In-Memory Database Reference*. At the database level, you can use the `ttDBConfig` built-in procedure to set this parameter. See PL/SQL Database Configuration Parameters.
PLSQL_OPTIMIZE_LEVEL	General connection attribute Required privilege: None Specifies the optimization level used to compile PL/SQL library units. The higher the setting, the more effort the compiler makes to optimize PL/SQL library units. Possible values are 0, 1, 2, or 3. You can use the `ALTER SESSION` statement to change this value within your session. Also see PLSQL_OPTIMIZE_LEVEL in *Oracle TimesTen In-Memory Database Reference*.

Table 6-1 (Cont.) PL/SQL Connection Attributes

Attribute	Summary
PLSQL_SESSION_CACHED_CURSORS	General connection attribute Required privilege: None Specifies the number of session cursors to cache. This attribute has the same functionality as SESSION_CACHED_CURSORS in Oracle Database. You can use the ALTER SESSION statement to change this value within your session. Also see PLSQL_SESSION_CACHED_CURSORS in *Oracle TimesTen In-Memory Database Reference*. At the database level, you can use the ttDBConfig built-in procedure to set this parameter. See PL/SQL Database Configuration Parameters.
PLSQL_TIMEOUT	General connection attribute Required privilege: None Controls how long PL/SQL program units are allowed to run, in seconds, before being terminated. A new value impacts PL/SQL programs currently running. Possible values are 0 (meaning no time limit) or any positive integer. You can use the ALTER SESSION statement to change this value within your session. Also see PLSQL_TIMEOUT in *Oracle TimesTen In-Memory Database Reference*. Be aware of TimesTen SQL query timeout settings, as discussed in Setting a Timeout Duration for SQL Statements in *Oracle TimesTen In-Memory Database C Developer's Guide*, and the TimesTen TTC_Timeout setting (relevant for client/server), discussed in TTC_Timeout in *Oracle TimesTen In-Memory Database Reference*. If you use TimesTen client/server, PLSQL_TIMEOUT should be significantly less than TTC_Timeout, and cannot be 0 (for no timeout) if TTC_Timeout is greater than 0. For details, see the TTC_Timeout documentation referenced above. For additional information about the relationship between timeout values, see Choose SQL and PL/SQL Timeout Values in *Oracle TimesTen In-Memory Database Operations Guide*. **Note**: The frequency with which PL/SQL programs check execution time against this timeout value is variable. It is possible for programs to run significantly longer than the timeout value before being terminated.

> **Note**
>
> There are additional TimesTen connection attributes you should consider for PL/SQL. For more information about them, refer to the indicated sections in *Oracle TimesTen In-Memory Database Reference*.
>
> - If the `LockLevel` general connection attribute is set to 1 (database-level locking), certain PL/SQL internal functions cannot be performed. Therefore, set `LockLevel` to 0 for your connection. You can then use the `ttLockLevel` built-in procedure to selectively switch to database-level locking for those transactions that require it. See LockLevel and ttLockLevel.
> - The PL/SQL shared memory segment is not subject to the `MemoryLock` first connection attribute. See MemoryLock.

Creating a Database with PL/SQL Default Connection Attributes

This section provides an example that defines a database `pldef` without specifying PL/SQL connection attributes. (Be aware that only an instance administrator can create a database.)

Sample `odbc.ini` entry:

```
[pldef]
Driver=/mypath/install/lib/libtten.so
DataStore=/mypath/install/info/DemoDataStore/pldef
DatabaseCharacterSet=AL32UTF8
ConnectionCharacterSet=AL32UTF8
```

Connect to database `pldef`:

```
% ttisql pldef

Copyright (c) 1996-2011, Oracle.  All rights reserved.
Type ? or "help" for help, type "exit" to quit ttIsql.

connect "DSN=pldef";
Connection successful: DSN=pldef;UID=myuser;DataStore=/mypath/install/info/
DemoDataStore/pldef;
DatabaseCharacterSet=AL32UTF8;ConnectionCharacterSet=AL32UTF8;
DRIVER=/mypath/install/lib/libtten.so;
(Default setting AutoCommit=1)
```

Call the `ttConfiguration` built-in procedure to display settings, which shows you the default PL/SQL settings:

```
Command> call ttconfiguration;
...
< PLSQL_CCFLAGS, <NULL> >
...
< PLSQL_CONN_MEM_LIMIT, 100 >
< PLSQL_MEMORY_ADDRESS, 0x0000005000000000 >
< PLSQL_MEMORY_SIZE, 128 >
< PLSQL_OPTIMIZE_LEVEL, 2 >
```

```
< PLSQL_TIMEOUT, 30 >
...
< PLSQL_SESSION_CACHED_CURSORS, 50 >
...
88 rows found.
```

Using ALTER SESSION to Change Connection Attribute Settings

This section provides an example using `ALTER SESSION` to change general connection attribute values. Also see ALTER SESSION in *Oracle TimesTen In-Memory Database SQL Reference*.

This example alters PL/SQL connection attributes, changing the settings of `PLSQL_CONN_MEM_LIMIT` and `PLSQL_OPTIMIZE_LEVEL`. It then calls the `ttConfiguration` built-in procedure to display the new values.

```
Command> ALTER SESSION SET PLSQL_CONN_MEM_LIMIT=200;

Session altered.

Command> ALTER SESSION SET PLSQL_OPTIMIZE_LEVEL=3;

Session altered.

Command> call ttconfiguration;
...
< DataStore, /mypath/install/info/DemoDataStore/pldef >
...
< PLSQL_CONN_MEM_LIMIT, 200 >
...
< PLSQL_OPTIMIZE_LEVEL, 3 >
...
< UID, MYUSER >
61 rows found.
```

PL/SQL Database Configuration Parameters

You can use the `ttDBConfig` built-in procedure to display or set the values of the database configuration parameters `PLSQL_OPEN_CURSORS` and `PLSQL_SESSION_CACHED_SURSORS`.

Using `ttDBConfig` sets the value for the current connection and future connections. For information about these parameters, which are also available as connection attributes, see PL/SQL Connection Attributes Reference.

For example, to retrieve the current value of `PLSQL_OPEN_CURSORS`:

```
call ttdbconfig('PLSQL_OPEN_CURSORS');
< PLSQL_OPEN_CURSORS, 50 >
1 row found.
```

To set the value to 75:

```
call ttdbconfig('PLSQL_OPEN_CURSORS', '75');
< PLSQL_OPEN_CURSORS, 75 >
1 row found.
```

Refer to ttDBConfig in *Oracle TimesTen In-Memory Database Reference*.

PL/SQL Performance Statistics

The `ttPLSQLMemoryStats` built-in procedure returns statistics about PL/SQL library cache performance and activity.

The example that follows shows some sample output. Refer to ttPLSQLMemoryStats in *Oracle TimesTen In-Memory Database Reference* for information about this procedure.

```
Command> call ttplsqlmemorystats;
< Gets, 5.000000 >
< GetHits, 0.000000e+00 >
< GetHitRatio, 0.000000e+00 >
< Pins, 4.000000 >
< PinHits, 0.000000e+00 >
< PinHitRatio, 0.000000e+00 >
< Reloads, 0.000000e+00 >
< Invalidations, 0.000000e+00 >
< CurrentConnectionMemory, 0.000000e+00 >
< DeferredCleanups, 0.000000e+00 >
10 rows found.
```

> **Note**
>
> `CurrentConnectionMemory` is related to the `PLSQL_CONN_MEM_LIMIT` connection attribute documented in PL/SQL Connection Attributes, indicating the amount of heap memory that has actually been acquired by PL/SQL.

7

TimesTen Supplied PL/SQL Packages

TimesTen supplies public PL/SQL packages, listed immediately below, to extend database functionality and provide PL/SQL access to SQL features.

TimesTen installs these packages automatically for your use. Packages that are part of the PL/SQL language itself or are for TimesTen or Oracle Database internal use only are not shown here or described in this chapter.

This chapter lists and briefly describes the subprograms that comprise each package. For details on these PL/SQL packages, refer to *Oracle TimesTen In-Memory Database PL/SQL Packages Reference*.

DBMS_LOB

The DBMS_LOB package provides subprograms to operate on BLOBs, CLOBs, and NCLOBs, including temporary LOBs, in TimesTen Classic.

> **Note**
>
> - TimesTen does not support DBMS_LOB subprograms intended specifically for BFILEs, SecureFiles (including Database File System features), or inserting or deleting data fragments in the middle of a LOB.
> - DBMS_LOB procedures and functions are supported for both TimesTen LOBs and passthrough LOBs, which are LOBs in Oracle Database accessed through TimesTen and exposed as TimesTen LOBs. Note, however, that CREATETEMPORARY can only be used to create a temporary LOB in TimesTen. If a temporary passthrough LOB is created using some other mechanism, such as SQL, ISTEMPORARY and FREETEMPORARY can be used on that LOB.
>
>   As with TimesTen local LOBs, a locator for a passthrough LOB does not remain valid past the end of the transaction.
>
>   In addition to copying from one TimesTen LOB to another, COPY can copy from a TimesTen LOB to a passthrough LOB, from a passthrough LOB to a TimesTen LOB, or from one passthrough LOB to another passthrough LOB. An attempt to copy a passthrough LOB to a TimesTen LOB when the passthrough LOB is larger than the TimesTen LOB size limit results in an error. (COPY Procedures in *Oracle TimesTen In-Memory Database PL/SQL Packages Reference* provides examples for copying LOBs.)
>
>   See Passthrough LOBs.

Table 7-1 describes the supported DBMS_LOB subprograms.

Table 7-1 DBMS_LOB Subprograms

Subprogram	Description
APPEND procedures	Appends the contents of the source LOB to the destination LOB.
CLOSE procedures	Closes a previously opened LOB.
COMPARE functions	Compares two entire LOBs or parts of two LOBs.
CONVERTTOBLOB procedure	Reads character data from a source CLOB or NCLOB instance, converts the character data to the specified character set, writes the converted data to a destination BLOB instance in binary format, and returns the new offsets.
CONVERTTOCLOB procedure	Takes a source BLOB instance, converts the binary data in the source instance to character data using the specified character set, writes the character data to a destination CLOB or NCLOB instance, and returns the new offsets.
COPY procedures	Copies all or part of the source LOB to the destination LOB.

Table 7-1 (Cont.) DBMS_LOB Subprograms

Subprogram	Description
CREATETEMPORARY procedures	Creates a temporary LOB in the temporary data region. Any of the durations supported by Oracle Database is permitted (SESSION, TRANSACTION, or CALL). In TimesTen, however, LOB duration cannot extend past the end of the transaction.
ERASE procedures	Erases all or part of a LOB.
FREETEMPORARY procedures	Frees a temporary LOB in the temporary data region.
GET_STORAGE_LIMIT functions	Returns the storage limit for the LOB type of the specified LOB.
GETCHUNKSIZE functions	In TimesTen, this simply returns the value 32 KB for interoperability. Do not rely on this value for performance tuning.
GETLENGTH functions	Returns the length of the LOB value, in bytes for a BLOB or characters for a CLOB or NCLOB.
INSTR functions	Returns the matching position of the *nth* occurrence of the pattern in the LOB.
ISOPEN functions	Checks to see if the LOB was already opened using the input locator.
ISTEMPORARY functions	Checks whether the locator is pointing to a temporary LOB.
OPEN procedures	Opens a LOB (persistent or temporary) in the indicated mode, read/write or read-only. **Note**: Opening a LOB is similar conceptually, but not technically, to opening a file. Opening a LOB is more like a hint regarding resources to be required.
READ procedures	Reads data from the LOB starting at the specified offset.
SUBSTR functions	Returns part of the LOB value starting at the specified offset.
TRIM procedures	Trims the LOB value to the specified shorter length.
WRITE procedures	Writes data to the LOB from a specified offset.
WRITEAPPEND procedures	Writes a buffer to the end of a LOB.

DBMS_LOCK

The DBMS_LOCK package provides an interface to lock-management services. In the current release, TimesTen supports only the sleep feature.

Table 7-2 describes the supported DBMS_LOCK subprogram.

Table 7-2 DBMS_LOCK Subprograms

Subprogram	Description
SLEEP procedure	This procedure suspends the session for a given duration. Specify the amount of time in seconds. The smallest supported increment is a hundredth of a second. For example: `DBMS_LOCK.SLEEP(1.95);` **Notes:** • The actual sleep time may be somewhat longer than specified, depending on system activity. • If PLSQL_TIMEOUT is set to a positive value that is less than this sleep time, the timeout takes effect first. Be sure that either the sleep value is less than the timeout value, or PLSQL_TIMEOUT=0 (no timeout). See PL/SQL Connection Attributes for information about PLSQL_TIMEOUT.

DBMS_OUTPUT

The DBMS_OUTPUT package enables you to send messages from stored procedures and packages. The package is useful for displaying PL/SQL debugging information.

Table 7-3 describes the DBMS_OUTPUT subprograms.

Table 7-3 DBMS_OUTPUT Subprograms

Subprogram	Description
DISABLE procedure	Disables message output.
ENABLE procedure	Enables message output.
GET_LINE procedure	Retrieves one line from the buffer.
GET_LINES procedure	Retrieves an array of lines from the buffer.
NEW_LINE procedure	Terminates a line created with PUT.
PUT procedure	Places a line in the buffer.
PUT_LINE procedure	Places a partial line in the buffer.

DBMS_PREPROCESSOR

The DBMS_PREPROCESSOR package provides an interface to print or retrieve the source text of a PL/SQL unit after processing of conditional compilation directives.

Table 7-4 describes the DBMS_PREPROCESSOR subprograms.

Table 7-4 DBMS_PREPROCESSOR Subprograms

Subprogram	Description
GET_POST_PROCESSED_SOURCE function	Returns post-processed source text.
PRINT_POST_PROCESSED_SOURCE procedure	Prints post-processed source text.

DBMS_RANDOM

The DBMS_RANDOM package provides a built-in random number generator.

Table 7-5 describes the DBMS_RANDOM subprograms.

Table 7-5 DBMS_RANDOM Subprograms

Subprogram	Description
INITIALIZE procedure	Initializes the package with a seed value (deprecated).
NORMAL function	Returns random numbers in a normal distribution.
RANDOM procedure	Generates a random number (deprecated).
SEED procedure	Resets the seed.
STRING function	Gets a random string.
TERMINATE procedure	Terminates the package (deprecated).
VALUE function	There are two overloaded versions. In the first, it gets a random number greater than or equal to 0 and less than 1, with 38 digits to the right of the decimal point (38-digit precision). In the second, it gets a random number within specified low and high limits.

DBMS_SQL

The DBMS_SQL package provides an interface for using dynamic SQL to accomplish any of the following:

- Execute data manipulation language (DML) and data definition language (DDL) statements.
- Execute PL/SQL anonymous blocks.
- Call PL/SQL stored procedures and functions.

This package does not support pre-defined data types and overloads with data types that are not supported in TimesTen, such as UROWID, time zone features, ADT, database-level collections, and edition overloads. For more information on the supported data types in TimesTen PL/SQL, see Understanding the Data Type Environments.

Table 7-6 describes the DBMS_SQL subprograms.

Table 7-6 DBMS_SQL Subprograms

Subprogram	Description
BIND_ARRAY procedure	Binds a given value to a given collection.
BIND_VARIABLE procedure	Binds a given value to a given variable.
CLOSE_CURSOR procedure	Closes a given cursor and frees memory.
COLUMN_VALUE procedure	Returns the value of the cursor element for a given position in a cursor.

Table 7-6 (Cont.) DBMS_SQL Subprograms

Subprogram	Description
COLUMN_VALUE_LONG procedure	Returns a selected part of a LONG column that has been defined using DEFINE_COLUMN_LONG. **Important**: Because TimesTen does not support the LONG data type, attempting to use this procedure in TimesTen results in an ORA-01018 error at runtime.
DEFINE_ARRAY procedure	Defines a collection to be selected from the given cursor. Use with SELECT statements.
DEFINE_COLUMN procedure	Defines a column to be selected from the given cursor. Use with SELECT statements.
DEFINE_COLUMN_LONG procedure	Defines a LONG column to be selected from the given cursor. Use with SELECT statements. **Important**: Because TimesTen does not support the LONG data type, attempting to use the COLUMN_VALUE_LONG procedure in TimesTen results in an ORA-01018 error at runtime. DEFINE_COLUMN_LONG would be used with COLUMN_VALUE_LONG.
DESCRIBE_COLUMNS procedure	Describes the columns for a cursor opened and parsed through the DBMS_SQL package.
DESCRIBE_COLUMNS2 procedure	Describes the specified column. Use as an alternative to DESCRIBE_COLUMNS procedure.
DESCRIBE_COLUMNS3 procedure	Describes the specified column. Use as an alternative to DESCRIBE_COLUMNS procedure.
EXECUTE function	Executes a given cursor.
EXECUTE_AND_FETCH function	Executes a given cursor and fetches rows.
FETCH_ROWS function	Fetches a row from a given cursor.
IS_OPEN function	Returns TRUE if a given cursor is open.
LAST_ERROR_POSITION function	Returns the byte offset in the SQL statement text where the error occurred.
LAST_ROW_COUNT function	Returns a cumulative count of the number of rows fetched.
LAST_ROW_ID function	Returns NULL. TimesTen does not support ROWID of the last row operated on by a DML statement.
LAST_SQL_FUNCTION_CODE function	Returns the SQL function code for the statement.
OPEN_CURSOR function	Returns the cursor ID number of a new cursor.
PARSE procedures	Parses a given statement.
TO_CURSOR_NUMBER function	Takes an opened (by OPEN) strongly or weakly typed REF CURSOR and transforms it into a DBMS_SQL cursor number.
TO_REFCURSOR function	Takes an opened, parsed, and executed cursor (by OPEN, PARSE, and EXECUTE) and transforms or migrates it into a PL/SQL manageable REF CURSOR (a weakly typed cursor) that can be consumed by PL/SQL native dynamic SQL and switched to use native dynamic SQL.
VARIABLE_VALUE procedures	Returns value of a named variable for a given cursor.

DBMS_UTILITY

The DBMS_UTILITY package provides a variety of utility subprograms.

Subprograms are not supported (and not listed here) for features that TimesTen does not support.

Table 7-7 describes DBMS_UTILITY subprograms.

Table 7-7 DBMS_UTILITY Subprograms

Subprogram	Description
CANONICALIZE procedure	Canonicalizes a given string.
COMMA_TO_TABLE procedure	Converts a comma-delimited list of names into an associative array (index-by table) of names.
COMPILE_SCHEMA	Compiles all procedures, functions, packages, and views in the specified database schema.
DB_VERSION procedure	Returns version information for the database. The procedure returns NULL for the compatibility setting because TimesTen does not support the system parameter COMPATIBLE.
FORMAT_CALL_STACK function	Formats the current call stack.
FORMAT_ERROR_BACKTRACE function	Formats the backtrace from the point of the current error to the exception handler where the error is caught.
FORMAT_ERROR_STACK function	Formats the current error stack.
GET_CPU_TIME function	Returns the current CPU time in hundredths of a second.
GET_DEPENDENCY procedure	Shows the dependencies on the objects passed in.
GET_ENDIANNESS function	Returns the endianness of your database platform.
GET_HASH_VALUE function	Computes a hash value for a given string.
GET_SQL_HASH function	Computes the hash value for a given string using the MD5 algorithm.
GET_TIME function	Returns the current time in hundredths of a second.
INVALIDATE procedure	Invalidates a database object and optionally modifies the PL/SQL compiler parameter settings for the object.
IS_BIT_SET function	Checks the setting of a specified bit in a RAW value.
NAME_RESOLVE procedure	Resolves the given name of the following form: *[[a.]b.]c[@dblink]* Where *a*, *b*, and *c* are SQL identifiers and *dblink* is a dblink (database link). Do not use *@dblink*. TimesTen does not support dblinks.

Table 7-7 (Cont.) DBMS_UTILITY Subprograms

Subprogram	Description
NAME_TOKENIZE procedure	Calls the parser to parse the given name of the following form: "*a* [.*b* [.*c*]][@*dblink*]" Strips double quotes or converts to uppercase if there are no quotes. Ignores comments and does not perform semantic analysis. Missing values are NULL. Do not use *@dblink*. TimesTen does not support dblinks.
TABLE_TO_COMMA procedures	Converts an associative array (index-by table) of names into a comma-delimited list of names.
VALIDATE procedure	Validates the object described by either owner, name and namespace, or object ID.

TT_DB_VERSION

The TT_DB_VERSION package contains boolean constants indicating the current TimesTen release.

Table 7-8 describes the TT_DB_VERSION constants.

The primary use case for the TT_DB_VERSION and UTL_IDENT packages is for conditional compilation.

Table 7-8 TT_DB_VERSION Constants

Name	Description
VER_LE_1121	Boolean that is TRUE if this package ships with TimesTen Release 11.2.1 or prior. FALSE for TimesTen 11*g* Release 2 (11.2.2) or higher.
VER_LE_1122	Boolean that is TRUE if this package ships with TimesTen 11*g* Release 2 (11.2.2) or prior. FALSE for TimesTen Release 18.1 or higher.
VER_LE_1801	Boolean that is TRUE if this package ships with TimesTen Release 18.1 or prior. FALSE for TimesTen Release 22.1
VER_LE_2201	Boolean that is TRUE if this package ships with TimesTen Release 22.1 or prior.

See Examples in *Oracle TimesTen In-Memory Database PL/SQL Packages Reference* for an example that uses TT_DB_VERSION and UTL_IDENT.

TT_STATS

The TT_STATS package provides features for collecting and comparing snapshots of TimesTen system metrics, according to the capture level. Each snapshot can consist of what TimesTen considers to be basic metrics, typical metrics, or all available metrics.

For those familiar with Oracle Database performance analysis tools, these reports are similar in nature to Oracle Automatic Workload Repository (AWR) reports.

Table 7-9 TT_STATS Subprograms

Subprogram	Description
CAPTURE_SNAPSHOT procedure and function	Takes a snapshot of TimesTen metrics. The function also returns the snapshot ID.
DROP_SNAPSHOTS_RANGE function	Deletes snapshots according to a specified range of snapshot IDs or timestamps.
GENERATE_REPORT_HTML procedure	Produces a report in HTML format based on the data from two specified snapshots.
GENERATE_REPORT_TEXT procedure	Produces a report in plain text format based on the data from two specified snapshots.
GET_CONFIG function	Retrieves the value of a specified TT_STATS configuration parameter or the values of all configuration parameters.
SET_CONFIG procedure	Sets a specified value for a specified TT_STATS configuration parameter.
SHOW_SNAPSHOTS function	Shows the snapshot IDs and timestamps of all snapshots currently stored in the database.

UTL_FILE

The UTL_FILE package enables PL/SQL programs the ability to read and write operating system text files.

In the current release, this package is restricted to access of a pre-defined temporary directory only. Refer to the *Oracle TimesTen In-Memory Database Release Notes*.

> **Note**
>
> Users do not have execute permission on UTL_FILE by default. To use UTL_FILE in TimesTen, an ADMIN user or instance administrator must explicitly grant EXECUTE permission on it, such as in the following example:
>
> ```
> GRANT EXECUTE ON SYS.UTL_FILE TO scott;
> ```

Table 7-10 describes the UTL_FILE subprograms.

Table 7-10 UTL_FILE Subprograms

Subprogram	Description
FCLOSE procedure	Closes a file.
FCLOSE_ALL procedure	Closes all file handles.
FCOPY procedure	Copies a contiguous portion of a file to a newly created file.
FFLUSH procedure	Physically writes all pending output to a file.
FGETATTR procedure	Reads and returns the attributes of a file.
FGETPOS procedure	Returns the current relative offset position (in bytes) within a file.
FOPEN function	Opens a file for input or output.
FOPEN_NCHAR function	Opens a file in Unicode for input or output.
FREMOVE procedure	With sufficient privilege, deletes a file.
FRENAME procedure	Renames an existing file to a new name (similar to the UNIX mv command).
FSEEK procedure	Adjusts the file pointer forward or backward within the file by the number of bytes specified.
GET_LINE procedure	Reads text from an open file.
GET_LINE_NCHAR procedure	Reads text in Unicode from an open file.
GET_RAW function	Reads a RAW string value from a file and adjusts the file pointer ahead by the number of bytes read.
IS_OPEN function	Determines if a file handle refers to an open file.
NEW_LINE procedure	Writes one or more operating system-specific line terminators to a file.
PUT procedure	Writes a string to a file.
PUT_LINE procedure	Writes a line to a file and appends an operating system-specific line terminator.
PUT_LINE_NCHAR procedure	Writes a Unicode line to a file.
PUT_NCHAR procedure	Writes a Unicode string to a file.
PUT_RAW function	Accepts as input a RAW data value and writes the value to the output buffer.
PUTF procedure	This is similar to the PUT procedure, but with formatting.
PUTF_NCHAR procedure	This is similar to the PUT_NCHAR procedure, but with formatting. Writes a Unicode string to a file with formatting.

UTL_IDENT

The UTL_IDENT package indicates whether PL/SQL is running on TimesTen, an Oracle database client, an Oracle database server, or Oracle Forms. Each of these has its own version of UTL_IDENT with appropriate settings for the constants.

Table 7-11 shows the UTL_IDENT settings for TimesTen.

The primary use case for the UTL_IDENT package is for conditional compilation, resembling the following:

```
$if utl_ident.is_oracle_server $then
    [...Run code supported for Oracle Database...]
$elsif utl_ident.is_timesten $then
    [...code supported for TimesTen Database...]
$end
```

Table 7-11 UTL_IDENT Constants

Name	Description
IS_ORACLE_CLIENT	BOOLEAN set to FALSE
IS_ORACLE_SERVER	BOOLEAN set to FALSE
IS_ORACLE_FORMS	BOOLEAN set to FALSE
IS_TIMESTEN	BOOLEAN set to TRUE

See Examples in *Oracle TimesTen In-Memory Database PL/SQL Packages Reference* for an example that uses TT_DB_VERSION and UTL_IDENT.

UTL_RAW

The UTL_RAW package provides SQL functions for manipulating RAW data types.

Table 7-12 describes the UTL_RAW subprograms.

Table 7-12 UTL_RAW Subprograms

Subprogram	Description
BIT_AND function	Performs bitwise logical "and" of two RAW values and returns the resulting RAW.
BIT_COMPLEMENT function	Performs bitwise logical "complement" of a RAW value and returns the resulting RAW.
BIT_OR function	Performs bitwise logical "or" of two RAW values and returns the resulting RAW.
BIT_XOR function	Performs bitwise logical "exclusive or" of two RAW values and returns the resulting RAW.
CAST_FROM_BINARY_DOUBLE function	Returns the RAW binary representation of a BINARY_DOUBLE value.
CAST_FROM_BINARY_FLOAT function	Returns the RAW binary representation of a BINARY_FLOAT value.
CAST_FROM_BINARY_INTEGER function	Returns the RAW binary representation of a BINARY_INTEGER value.
CAST_FROM_NUMBER function	Returns the RAW binary representation of a NUMBER value.
CAST_TO_BINARY_DOUBLE function	Casts the RAW binary representation of a BINARY_DOUBLE value into a BINARY_DOUBLE.
CAST_TO_BINARY_FLOAT function	Casts the RAW binary representation of a BINARY_FLOAT value into a BINARY_FLOAT.

Table 7-12 (Cont.) UTL_RAW Subprograms

Subprogram	Description
CAST_TO_BINARY_INTEGER function	Casts the RAW binary representation of a BINARY_INTEGER value into a BINARY_INTEGER.
CAST_TO_NUMBER function	Casts the RAW binary representation of a NUMBER value into a NUMBER.
CAST_TO_NVARCHAR2 function	Casts a RAW value represented using *n* data bytes into an NVARCHAR2 value with *n* data bytes.
CAST_TO_RAW function	Casts a VARCHAR2 value represented using *n* data bytes into a RAW with *n* data bytes.
CAST_TO_VARCHAR2 function	Casts a RAW value represented using *n* data bytes into a VARCHAR2 value with *n* data bytes.
COMPARE function	Compares two RAW values.
CONCAT function	Concatenates up to 12 RAW values into a single RAW value.
CONVERT function	Converts a RAW value from one character set to another and returns the resulting RAW.
COPIES function	Copies a RAW value a specified number of times and returns the concatenated RAW value.
LENGTH function	Returns the length in bytes of a RAW value.
OVERLAY function	Overlays the specified portion of a target RAW value with an overlay RAW value, starting from a specified byte position and proceeding for a specified number of bytes.
REVERSE function	Reverses a byte-sequence in a RAW value.
SUBSTR function	Returns a substring of a RAW value for a specified number of bytes from a specified starting position.
TRANSLATE function	Translates the specified bytes from an input RAW value according to the bytes in a specified translation RAW value.
TRANSLITERATE function	Converts the specified bytes from an input RAW value according to the bytes in a specified transliteration RAW value.
XRANGE function	Returns a RAW value containing the succession of one-byte encodings beginning and ending with the specified byte-codes.

UTL_RECOMP

The UTL_RECOMP package recompiles invalid PL/SQL modules. This is particularly useful after a major-version upgrade that typically invalidates all PL/SQL objects.

Table 7-13 describes the UTL_RECOMP subprograms.

> **Tip**
>
> To use this package, you must be the instance administrator and specify `SYS.UTL_RECOMP`.

Table 7-13 UTL_RECOMP Subprograms

Name	Description
`RECOMP_PARALLEL` procedure	Recompiles invalid objects in a given schema, or all invalid objects in the database, in parallel. **Note**: Because TimesTen does not support `DBMS_SCHEDULER`, the number of recompile threads to run in parallel is always 1, regardless of what the user specifies. Therefore there is no effective difference between `RECOMP_PARALLEL` and `RECOMP_SERIAL` in TimesTen.
`RECOMP_SERIAL` procedure	Recompiles invalid objects in a given schema, or all invalid objects in the database, serially.

8

TimesTen PL/SQL Support: Reference Summary

This chapter lists PL/SQL language elements and features supported in TimesTen.

In the Oracle Database documentation, many of these features are covered in PL/SQL Language Elements in .)

These topics are covered:

- Language Elements and Features Supported by TimesTen
- Language Elements and Features Not Supported by TimesTen

Language Elements and Features Supported by TimesTen

This section describes language elements and features supported by TimesTen, with any special notes along with references for additional information and examples.

Table 8-1 PL/SQL Language Element and Feature Support in TimesTen

Feature Name	Description	Example/Comment
`ALTER {PROCEDURE| FUNCTION | PACKAGE}` statements	Recompiles a PL/SQL procedure, function, or package.	Syntax and semantics are the same as in Oracle Database. See SQL Statements in *Oracle TimesTen In-Memory Database SQL Reference*.
`ALTER SESSION` statement	Changes session parameters dynamically.	In TimesTen, you can use `ALTER SESSION` to set some PL/SQL connection attributes as discussed in PL/SQL Connection Attributes. See ALTER SESSION in *Oracle TimesTen In-Memory Database SQL Reference*.
Assignment statement	Sets current value of a variable, parameter, or element.	See PL/SQL Variables and Constants.
Block declaration	Declares a block, the basic unit of a PL/SQL source program.	See PL/SQL Blocks.
`BULK COLLECT` clause	Select multiple rows.	This clause can be used with the `SELECT` statement in PL/SQL to retrieve rows without using a cursor. See FORALL and BULK COLLECT Operations and Examples Using FORALL and BULK COLLECT.
`CALL` statement	Executes a routine from within SQL.	In TimesTen, use the `CALL` statement to execute PL/SQL stored procedures and functions, as in Oracle Database, or TimesTen built-in procedures. (For TimesTen built-in procedures, use `EXECUTE IMMEDIATE` if `CALL` is inside PL/SQL.) See Executing Procedures and Functions and the example in Using EXECUTE IMMEDIATE to Call a TimesTen Built-In Procedure.

Table 8-1 (Cont.) PL/SQL Language Element and Feature Support in TimesTen

Feature Name	Description	Example/Comment
`CASE` statement	Evaluates an expression, compares it against several values, and takes action according to the comparison that is true.	See PL/SQL Control Structures.
`CLOSE` statement	Closes a cursor or cursor variable.	See the example in Use of Cursors in PL/SQL Programs (among others).
Collection definition	Specifies a collection, which is an ordered group of elements that are all of the same type.	Examples include associative arrays (index-by tables or PL/SQL tables), nested tables, and varrays. TimesTen supports all three of these collection types in PL/SQL programs, but supports only associative arrays as bound parameters between PL/SQL and applications written in other languages (such as OCI or JDBC). See Using Collections in PL/SQL.
Collection methods	Built-in subprograms that operate on collections and are called using "dot" notation.	See Collection Methods in . Examples include `COUNT`, `DELETE`, `EXISTS`, `EXTEND`, `FIRST`, `LAST`, `LIMIT`, `NEXT`, `PRIOR`, and `TRIM`.
Comments	Text included within your code for explanatory purposes.	Single-line and multi-line comments are supported.
`COMMIT` statement	Ends the current transaction and makes permanent all changes performed in the transaction.	See COMMIT in *Oracle TimesTen In-Memory Database SQL Reference*. **Important**: `COMMIT` and `ROLLBACK` statements close all cursors in TimesTen.
Connection attributes	Equivalent to initialization parameters in Oracle Database.	See PL/SQL Connection Attributes. Also see PL/SQL First Connection Attributes and PL/SQL General Connection Attributes in *Oracle TimesTen In-Memory Database Reference*.
Constant and variable declarations	Specify constants and variables to be used in PL/SQL code, in the declarative part of any PL/SQL block, subprogram, or package.	See PL/SQL Variables and Constants.
`CONTINUE` statement	Exits the current iteration of a loop and transfers control to the next iteration.	See CONTINUE Statement.
`CREATE FUNCTION` statement	Creates a PL/SQL function.	`CREATE FUNCTION` is supported in TimesTen Classic, but the `AS LANGUAGE`, `AS EXTERNAL`, and `PIPELINED` clauses are not supported. The `ACCESSIBLE BY` clause is supported. See PL/SQL Procedures and Functions. Also see CREATE FUNCTION in *Oracle TimesTen In-Memory Database SQL Reference*. You are not required to run `DBMSSTDX.SQL` in TimesTen.

Table 8-1 (Cont.) PL/SQL Language Element and Feature Support in TimesTen

Feature Name	Description	Example/Comment
`CREATE PACKAGE` statement `CREATE PACKAGE BODY` statement	These statements are used together to create a PL/SQL package definition and package body.	`CREATE PACKAGE` is supported in TimesTen Classic. Syntax and semantics are the same as in Oracle Database. The `ACCESSIBLE BY` clause is supported. See PL/SQL Packages. Also see CREATE PACKAGE and CREATE PACKAGE BODY in *Oracle TimesTen In-Memory Database SQL Reference*. You are not required to run `DBMSSTDX.SQL` in TimesTen.
`CREATE PROCEDURE` statement	Creates a PL/SQL procedure.	`CREATE PROCEDURE` is supported in TimesTen Classic, but the `AS LANGUAGE` and `AS EXTERNAL` clauses are not supported. The `ACCESSIBLE BY` clause is supported. See PL/SQL Procedures and Functions. Also see CREATE PROCEDURE in *Oracle TimesTen In-Memory Database SQL Reference*. **Note**: You are not required to run `DBMSSTDX.SQL` in TimesTen.
`CURRENT_DATE` function	Returns the current date in the session time zone.	In TimesTen, this returns the current date in UTC (universal time). TimesTen does not support local time zones.
Cursor attributes	Appended to the cursor or cursor variable to return useful information about the execution of a data manipulation statement.	Explicit cursors and cursor variables have four attributes: `%FOUND`, `%ISOPEN`, `%NOTFOUND`, and `%ROWCOUNT`. The implicit cursor (SQL) has additional attributes: `%BULK_ROWCOUNT` and `%BULK_EXCEPTIONS`. See Using the %ROWCOUNT and %NOTFOUND Attributes and Using FORALL with SQL%BULK_ROWCOUNT. Also see Named Cursor Attribute in .
Cursor declaration	Declares a cursor. To execute a multi-row query, TimesTen opens an unnamed work area that stores processing information. A cursor lets you name the work area, access the information, and process the rows individually.	See Use of Cursors in PL/SQL Programs.
Cursor variables (REF CURSORs)	Act as handles to cursors over SQL result sets.	TimesTen supports `OUT` REF CURSORs. See PL/SQL REF CURSORs.
`DELETE` statement	Deletes rows from a table.	See DELETE in *Oracle TimesTen In-Memory Database SQL Reference*.
`DROP { PROCEDURE | FUNCTION | PACKAGE }` statement	Removes a PL/SQL procedure, function, or package, as specified.	Syntax and semantics are the same as in Oracle Database. You can refer to information about these statements in SQL Statements in *Oracle TimesTen In-Memory Database SQL Reference*.

Table 8-1 (Cont.) PL/SQL Language Element and Feature Support in TimesTen

Feature Name	Description	Example/Comment
Error reporting	(This is self-explanatory.)	TimesTen applications report errors using Oracle Database error codes instead of TimesTen error codes. The error messages that accompany the error codes are either TimesTen error messages or Oracle Database error messages.
`EXCEPTION_INIT` pragma	Associates a user-defined exception with a TimesTen error number.	See EXCEPTION_INIT Pragma in .
Exception definition	Specifies an exception, which is a runtime error or warning condition. Can be predefined or user-defined.	Predefined conditions are raised implicitly. User-defined exceptions are raised explicitly by the `RAISE` statement. To handle raised exceptions, write separate routines called *exception handlers*. See Errors and Exception Handling.
`EXECUTE IMMEDIATE` statement	Builds and executes a dynamic SQL statement.	TimesTen supports this as Oracle Database does to execute a SQL DML or DDL statement, execute a PL/SQL anonymous block, or call a PL/SQL stored procedure or function. See Dynamic SQL in PL/SQL (EXECUTE IMMEDIATE Statement). In TimesTen, the `EXECUTE IMMEDIATE` statement can also be used to execute TimesTen built-in procedures and TimesTen-specific SQL features (such as `SELECT FIRST`).
`EXIT` statement	Exits a loop and transfers control to the end of the loop.	See the example in Fetching Values (among other examples in that chapter).
Expression definition	Specifies an expression, which is a combination of operands (variables, constants, literals, operators, and so on) and operators. The simplest expression is a single variable.	See Expressions in .
`FETCH` statement	Retrieves rows of data from the result set of a multi-row query.	See the example in Use of Cursors in PL/SQL Programs (among others).
`FORALL` statement	Bulk-binds input collections before sending them to the SQL engine.	See FORALL and BULK COLLECT Operations.
Function declaration and definition	Specifies a subprogram or stored program that can be declared and defined in a PL/SQL block or package and returns a single value.	In TimesTen, a stored function or procedure can be executed in an anonymous block or through a `CALL` statement, but not from any other SQL statement. See Executing Procedures and Functions. In TimesTen Classic, use the `CREATE FUNCTION` statement in TimesTen SQL to create stored functions. See PL/SQL Procedures and Functions. Also see CREATE FUNCTION in *Oracle TimesTen In-Memory Database SQL Reference*. Also refer to the table entry below for Procedure Declaration and Definition.
`GOTO` statement	Branches unconditionally to a statement label or block label.	See GOTO Statement in .

Table 8-1 (Cont.) PL/SQL Language Element and Feature Support in TimesTen

Feature Name	Description	Example/Comment
`IF` statement	Executes or skips a sequence of statements depending on the value of the associated boolean expression.	See Conditional Control.
`INLINE` pragma	Specifies whether a subprogram call is to be inline.	See INLINE Pragma in .
`INSERT` statement	Inserts one or more rows of data into a table.	See Example Using the INSERT Statement. Also see INSERT in *Oracle TimesTen In-Memory Database SQL Reference*.
Literal declaration	Specifies a numeric, character string, or boolean value.	Examples: Numeric literal: 135 String literal: 'TimesTen'
`LOOP` statement	Executes a sequence of statements multiple times. Can be used, for example, in implementing a `FOR` loop or `WHILE` loop.	See the example in Iterative Control. Also see Basic LOOP Statement in .
`MERGE` statement	Allows you to select rows from one or more sources for update or insertion into a target table.	See MERGE in *Oracle TimesTen In-Memory Database SQL Reference*.
Native dynamic SQL execution	Processes most dynamic SQL statements through the `EXECUTE IMMEDIATE` statement.	See the `EXECUTE IMMEDIATE` entry above.
`NULL` statement	This is a no-operation statement. Control is passed to the next statement without any action.	See NULL Statement in .
`OPEN` statement	Executes the query associated with a cursor. Allocates database resources to process the query, and identifies the result set.	See the example in Use of Cursors in PL/SQL Programs.
`OPEN FOR` statement	Executes the `SELECT` statement associated with a cursor variable (REF CURSOR). Positions the cursor variable before the first row in the result set.	See OPEN FOR Statement in .
Package declaration	Specifies a package, which is a database object that groups logically related PL/SQL types, items, and subprograms.	In TimesTen Classic, use SQL statements `CREATE PACKAGE` and `CREATE PACKAGE BODY`. See PL/SQL Packages. Also see SQL Statements in *Oracle TimesTen In-Memory Database SQL Reference* for information about the `CREATE` statements.

Table 8-1 (Cont.) PL/SQL Language Element and Feature Support in TimesTen

Feature Name	Description	Example/Comment
Procedure declaration and definition	Specifies a subprogram or stored program that can be declared and defined in a PL/SQL block or package and performs a specific action.	In TimesTen, a stored procedure or function can be executed in an anonymous block or through a `CALL` statement, but not from any other SQL statement. See Executing Procedures and Functions. In TimesTen Classic, use the `CREATE PROCEDURE` statement in TimesTen SQL to create stored procedures. See PL/SQL Procedures and Functions. Also see CREATE PROCEDURE in *Oracle TimesTen In-Memory Database SQL Reference*. Also refer to the table entry above for Function Declaration and Definition.
`RAISE` statement	Stops execution of a PL/SQL block or subprogram and transfers control to an exception handler.	See Using the RAISE Statement.
Record definition	Defines a record, which is a composite variable that stores data values of different types (similar to a database row).	See Using Records in PL/SQL.
`RETURN` statement	Immediately completes the execution of a subprogram and returns control to the invoker. Execution resumes with the statement following the subprogram call.	See RETURN Statement in .
`RETURNING INTO` clause	Specifies the variables in which to store the values returned by the statement to which the clause belongs.	See RETURNING INTO Clause and Examples Using RETURNING INTO.
`ROLLBACK` statement	Undoes database changes made during the current transaction.	See ROLLBACK in *Oracle TimesTen In-Memory Database SQL Reference*. **Important**: `COMMIT` and `ROLLBACK` statements close all cursors in TimesTen.
`%ROWTYPE` attribute	Provides a record type that represents a row in a database table.	See the example in PL/SQL Variables and Constants.
`SELECT INTO` statement	Retrieves values from one row of a table (`SELECT`) and then stores the values in either variables or a record. With the `BULK COLLECT` clause (discussed above), this statement retrieves an entire result set.	See the `SELECT INTO` example in PL/SQL Variables and Constants. Also see Processing Query Result Sets in .
`SOUNDEX` SQL function	Returns a character string containing the phonetic representation of a `char`.	See SOUNDEX in *Oracle TimesTen In-Memory Database SQL Reference*.
SQL cursor	Either explicit or implicit, handles the result set of a `SELECT` statement.	See Use of Cursors in PL/SQL Programs.
`SQLCODE` function	Returns number code of the most recent exception.	Given the same error condition, error codes returned by the built-in function `SQLCODE` are the same in TimesTen as in Oracle Database, although the `SQLERRM` returns may be different. This is also noted in TimesTen Error Messages and SQL Codes.

Table 8-1 (Cont.) PL/SQL Language Element and Feature Support in TimesTen

Feature Name	Description	Example/Comment
`SQLERRM` function	Returns the error message associated with the error-number argument.	Given the same error condition, error messages returned by the built-in function `SQLERRM` are not necessarily the same in TimesTen as in Oracle Database, although `SQLCODE` returns are the same. This is also noted in TimesTen Error Messages and SQL Codes.
Supplied packages	These are PL/SQL packages supplied with the database.	TimesTen provides a subset of the Oracle Database PL/SQL supplied packages. See TimesTen Supplied PL/SQL Packages.
System tables and views	These are tables and views provided with the database for administrative purposes.	TimesTen supports a subset of the Oracle Database system tables and views. See System Tables and Views in *Oracle TimesTen In-Memory Database System Tables and Views Reference*.
`ttPLSQLMemoryStats` built-in procedure	Returns statistics about library cache performance and activity.	See ttPLSQLMemoryStats in *Oracle TimesTen In-Memory Database Reference*. **Note**: In Oracle Database, the `V$LIBRARYCACHE` system view provides the same statistical information.
`%TYPE` attribute	Lets you use the data type of a field, record, nested table, database column, or variable in your own declarations, rather than hardcoding the data type. Particularly useful when declaring variables, fields, and parameters that refer to database columns.	See PL/SQL Variables and Constants.
`UPDATE` statement	Updates the values of one or more columns in all rows of a table or in rows that satisfy a search condition.	See UPDATE in *Oracle TimesTen In-Memory Database SQL Reference*.

Language Elements and Features Not Supported by TimesTen

These language elements are features are *not* supported in TimesTen.

- Features: autonomous transactions, database links (dblinks), result cache, savepoints, triggers, user-defined objects or collections

  While TimesTen does not support triggers, you can achieve similar functionality using XLA. See XLA and TimesTen Event Management in *Oracle TimesTen In-Memory Database C Developer's Guide*.

- Statements: `CREATE LIBRARY`, `CREATE TYPE`, `LOCK TABLE`, `SAVEPOINT`, `SET TRANSACTION`
- Pragmas: `AUTONOMOUS_TRANSACTIONS`, `RESTRICT_REFERENCES`, `SERIALLY_REUSABLE`

- `SYSTIMESTAMP`: TimesTen cannot support this because the return type, `TIMESTAMP WITH TIME ZONE`, is not supported. As an alternative, you can use `SELECT tt_sysdate FROM dual` using dynamic SQL:

```
declare
  ts timestamp;
begin
  execute immediate
    'select tt_sysdate from dual'
     into ts;
-- ts has millisecond resolution
end;
```