Oracle® Migration Workbench

Reference Guide for SQL Server and Sybase Adaptive Server Migrations

Release 9.2.0 for Microsoft Windows 98/2000/NT and Microsoft Windows XP

September 2002
Part Number: B10254-01

This reference guide describes how to migrate from Microsoft SQL Server 6.5, Microsoft SQL Server 7.0, Microsoft SQL Server 2000, Sybase Adaptive Server 11, and Sybase Adaptive Server 12 to Oracle9i or Oracle8i.
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Send Us Your Comments

Part Number: B10254-01

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- Did you find any errors?
- Is the information clearly presented?
- Do you need more information? If so, where?
- Are the examples correct? Do you need more examples?
- What features did you like most about this manual?

If you find any errors or have any other suggestions for improvement, please indicate the chapter, section, and page number (if available). You can send comments to us in the following ways:

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The Oracle Migration Workbench Reference Guide for SQL Server and Sybase Adaptive Server Migrations provides detailed information about migrating a database from Microsoft SQL Server 6.5, Microsoft SQL Server 7.0, Microsoft SQL Server 2000, Sybase Adaptive Server 11, and Sybase Adaptive Server 12 to Oracle9i or Oracle8i. It is a useful guide regardless of the conversion tool you are using to perform the migration, but the recommended tool for such migrations is Oracle Migration Workbench (Migration Workbench). This reference guide describes several differences between Microsoft SQL Server and Sybase Adaptive Server and Oracle and outlines how those differences are handled by the Migration Workbench during the conversion process.

This chapter contains the following sections:

- Audience
- What You Should Already Know
- How this Reference Guide is Organized
- Using This Reference Guide
- Documentation Accessibility
- Accessibility of Code Examples in Documentation
- Related Documentation
- Conventions
Audience

This guide is intended for anyone who is involved in converting a Microsoft SQL Server and Sybase Adaptive Server database to Oracle using the Migration Workbench.

What You Should Already Know

You should be familiar with relational database concepts and with the operating system environments under which you are running Oracle and Microsoft SQL Server and Sybase Adaptive Server.

How this Reference Guide is Organized

This reference guide is organized as follows:

Chapter 1, "Overview"
Introduces the Migration Workbench and outlines features of this tool.

Chapter 2, "Microsoft SQL Server, Sybase Adaptive Server, and Oracle Compared"
Contains detailed information about the differences between data types, data storage concepts, schema objects, and the data manipulation language in Microsoft SQL Server and Sybase Adaptive Server and Oracle.

Chapter 3, "Triggers and Stored Procedures"
Introduces triggers and stored procedures, and compares T-SQL and PL/SQL language elements and constructs in Microsoft SQL Server and Sybase Adaptive Server and Oracle.

Chapter 4, "Distributed Environments"
Describes when and why distributed environments are used, and discusses application development tools.

Chapter 5, "Migrating Temporary Tables to Oracle"
Describes how to emulate temporary tables in Oracle9i and Oracle8i.

Chapter 6, "Disconnected Source Model Loading"
Describes how to perform a disconnected source model load, using delimited flat files containing schema metadata.
Using This Reference Guide

Every reader of this reference guide should read Chapter 1, "Overview" as that chapter provides an introduction to the concept and terminology of the Migration Workbench.

Documentation Accessibility

Our goal is to make Oracle products, services, and supporting documentation accessible, with good usability, to the disabled community. To that end, our documentation includes features that make information available to users of assistive technology. This documentation is available in HTML format, and contains markup to facilitate access by the disabled community. Standards will continue to evolve over time, and Oracle Corporation is actively engaged with other market-leading technology vendors to address technical obstacles so that our documentation can be accessible to all of our customers. For additional information, visit the Oracle Accessibility Program Web site at http://www.oracle.com/accessibility/

Accessibility of Code Examples in Documentation

JAWS, a Windows screen reader, may not always correctly read the code examples in this document. The conventions for writing code require that closing braces should appear on an otherwise empty line; however, JAWS may not always read a line of text that consists solely of a bracket or brace.

Related Documentation

For more information, see these Oracle Migration Workbench resources:

- Oracle Migration Workbench Frequently Asked Questions (FAQ)
- Oracle Migration Workbench Release Notes
- Oracle Migration Workbench Online Help

To download free release notes, installation documentation, white papers, or other collateral, please visit the Oracle Technology Network (OTN). You must register online before using OTN; registration is free and you can do it at: http://otn.oracle.com/membership/index.htm
If you already have a user name and password for OTN, then you can go directly to the Migration Workbench documentation section of the OTN Web site at:

http://otn.oracle.com/tech/migration/workbench

Conventions

This section describes the conventions used in the text and code examples of this documentation. It describes:

■ Conventions in Text
■ Conventions in Code Examples

Conventions in Text

We use various conventions in text to help you more quickly identify special terms. The following table describes those conventions and provides examples of their use.

<table>
<thead>
<tr>
<th>Convention</th>
<th>Meaning</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bold</strong></td>
<td>Bold type indicates GUI options. It also indicates terms that are defined in the text or terms that appear in a glossary, or both.</td>
<td>The C datatypes such as <strong>ub4</strong>, <strong>sword</strong>, or <strong>OCINumber</strong> are valid.</td>
</tr>
<tr>
<td><strong>Italics</strong></td>
<td>Italic typeface indicates book titles, emphasis, syntax clauses, or placeholders.</td>
<td>When you specify this clause, you create an index-organized table.</td>
</tr>
<tr>
<td><strong>UPPERCASE monospace</strong> (fixed-width font)</td>
<td>Uppercase monospace typeface indicates elements supplied by the system. Such elements include parameters, privileges, datatypes, RMAN keywords, SQL keywords, SQL*Plus or utility commands, packages and methods, as well as system-supplied column names, database objects and structures, user names, and roles.</td>
<td>Run <strong>old_release.SQL</strong> where <strong>old_release</strong> refers to the release you installed prior to upgrading.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>You can specify this clause only for a <strong>NUMBER</strong> column.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>You can back up the database using the <strong>BACKUP</strong> command.</td>
</tr>
</tbody>
</table>
Conventions in Code Examples

Code examples illustrate SQL, PL/SQL, SQL*Plus, or other command-line statements. They are displayed in a monospace (fixed-width) font and separated from normal text as shown in this example:

```
SELECT username FROM dba_users WHERE username = 'MIGRATE';
```

The following table describes typographic conventions used in code examples and provides examples of their use.

<table>
<thead>
<tr>
<th>Convention</th>
<th>Meaning</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowercase monospace</td>
<td>Lowercase monospace typeface indicates executables and sample user-supplied elements. Such elements include computer and database names, net service names, and connect identifiers, as well as user-supplied database objects and structures, column names, packages and classes, user names and roles, program units, and parameter values.</td>
<td>Enter sqlplus to open SQL*Plus. The department_id, department_name, and location_id columns are in the hr.departments table.</td>
</tr>
<tr>
<td>Square Brackets [ ]</td>
<td>Indicates that the enclosed arguments are optional. Do not enter the brackets.</td>
<td>DECIMAL (digits [ , precision ])</td>
</tr>
<tr>
<td>Curly Braces { }</td>
<td>Indicates that one of the enclosed arguments is required. Do not enter the braces.</td>
<td>{ENABLE</td>
</tr>
<tr>
<td>Vertical Line</td>
<td>Separates alternative items that may be optional or required. Do not type the vertical bar.</td>
<td>{ENABLE</td>
</tr>
<tr>
<td>Ellipses ...</td>
<td>Indicates that the preceding item can be repeated. You can enter an arbitrary number of similar items. In code fragments, an ellipsis means that code not relevant to the discussion has been omitted. Do not type the ellipsis</td>
<td>CREATE TABLE ... AS subquery; SELECT col1, col2, ... , coln FROM employees;</td>
</tr>
<tr>
<td>Italics</td>
<td>Indicates variables that you must supply particular values.</td>
<td>CONNECT SYSTEM/system_password</td>
</tr>
<tr>
<td>Convention</td>
<td>Meaning</td>
<td>Example</td>
</tr>
<tr>
<td>------------</td>
<td>---------</td>
<td>---------</td>
</tr>
</tbody>
</table>
| UPPERCASE  | Uppercase text indicates case-insensitive filenames or directory names, commands, command keywords, initializing parameters, data types, table names, or object names. Enter text exactly as spelled; it need not be in uppercase | ```sql
SELECT last_name, employee_id FROM employees;
SELECT * FROM USER_TABLES;
DROP TABLE hr.employees;
``` |
| lowercase  | Lowercase words in example statements indicate words supplied only for the context of the example. For example, lowercase words may indicate the name of a table, column, or file. | ```sql
SELECT last_name, employee_id FROM employees;
sqlplus hr/hr
``` |
This chapter introduces the Oracle Migration Workbench (Migration Workbench) under the following headings:

- Introduction
- Product Description
- Features
- Glossary

Introduction

The Migration Workbench is a tool that simplifies the process of migrating data and applications from an Microsoft SQL Server and Sybase Adaptive Server environment to an Oracle9i or Oracle8i destination database. The Migration Workbench allows you to quickly and easily migrate an entire application system, that is the database schema including triggers and stored procedures, in an integrated, visual environment.

Note: Microsoft SQL Server is used in this document to refer to both Microsoft SQL Server 6.5, Microsoft SQL Server 7.0, and Microsoft SQL Server 2000 unless otherwise stated.

Product Description

The Migration Workbench allows you to migrate a Microsoft SQL Server and Sybase Adaptive Server database to an Oracle9i or Oracle8i database. The Migration Workbench employs an intuitive and informative User Interface and a series of
wizards to simplify the migration process. To ensure portability, all components of the Migration Workbench are written in Java.

The Migration Workbench uses a repository to store migration information. This allows you to query the initial state of the application before migration. By initially loading the migratable components of the application system into a repository, you can work independently of the production application.

Furthermore, the Migration Workbench saves useful dependency information about the components you are converting. For example, the Migration Workbench keeps a record of all the tables accessed by a stored procedure. You can then use this information to understand the impact of modifying a given table.

Features

The Migration Workbench release 9.2.0 is a wizard-driven tool. It is composed of core features and Microsoft SQL Server and Sybase Adaptive Server migration specific features. The Migration Workbench allows you to:

- Migrate a complete Microsoft SQL Server and Sybase Adaptive Server database to an Oracle9i or Oracle8i database.
- Migrate groups, users, tables, primary keys, foreign keys, unique constraints, indexes, rules, check constraints, views, triggers, stored procedures, user-defined types, and privileges to Oracle.
- Migrate multiple Microsoft SQL Server and Sybase Adaptive Server source databases to a single Oracle database.
- Customize the parser for stored procedures, triggers, or views.
- Generate the Oracle SQL*Loader and SQL Server BCP scripts for offline data loading.
- Display a representation of the source database and its Oracle equivalent.
- Generate and view a summary report of the migration.
- Customize users, tables, indexes, and tablespaces.
- Customize the default data type mapping rules.
- Create ANSI-compliant names.
- Automatically resolve conflicts such as Oracle reserved words.
- Remove and rename objects in the Oracle Model.
Glossary

The following terms are used to describe the Migration Workbench:

*Application System* is the database schema and application files that have been developed for a database environment other than Oracle, for example, Microsoft SQL Server and Sybase Adaptive Server.

*Capture Wizard* is an intuitive wizard that takes a snapshot of the data dictionary of the source database, loads it into the Source Model, and creates the Oracle Model.

*Dependency* is used to define a relationship between two migration entities. For example, a database view is dependent upon the table it references.

*Destination Database* is the Oracle database to which the Migration Workbench migrates the data dictionary of the source database.

*Migration Component* is part of an application system that can be migrated to an Oracle database. Examples of migration components are tables and stored procedures.

*Migration Entity* is an instance of a migration component. The table EMP would be a migration entity belonging to the table MIGRATION COMPONENT.

*Migration Wizard* is an intuitive wizard that helps you migrate the source database to Oracle.

*Migration Workbench* is the graphical tool that allows migration of an application system to an Oracle database environment.

*Navigator Pane* is the part of the Migration Workbench User Interface that contains the tree views representing the Source Model and the Oracle Model.

*Oracle Model* is a series of Oracle tables that is created from the information in the Source Model. It is a visual representation of how the source database looks when generated in an Oracle environment.

*Properties Pane* is the part of the Migration Workbench User Interface that displays the properties of a migration entity that has been selected in one of the tree views in the Navigator Pane.

*Progress Window* is the part of the Migration Workbench User Interface that contains informational, error, or warning messages describing the progress of the migration process.

*Software Development Kit (SDK)* is a set of well-defined application programming interfaces (APIs) that provide services that a software developer can use.
**Source Database** is the database containing the data dictionary of the application system being migrated by the Migration Workbench. The source database is a database other than Oracle, for example, Microsoft SQL Server and Sybase Adaptive Server.

**Source Model** is a replica of the data dictionary of the source database. It is stored in the Oracle Migration Workbench Repository and is loaded by the Migration Workbench with the contents of the data dictionary of the source database.

**Workbench Repository** is the area in an Oracle database used to store the persistent information necessary for the Migration Workbench to migrate an application system.
This chapter contains information comparing the Microsoft SQL Server and Sybase Adaptive Server database and the Oracle database. It includes the following sections:

- Schema Migration
- Data Types
- Data Storage Concepts
- Data Manipulation Language

## Schema Migration

The schema contains the definitions of the tables, views, indexes, users, constraints, stored procedures, triggers, and other database-specific objects. Most relational databases work with similar objects.

The schema migration topics discussed here include the following:

- Schema Object Similarities
- Schema Object Names
- Table Design Considerations

## Schema Object Similarities

There are many similarities between schema objects in Oracle and schema objects in Microsoft SQL Server and Sybase Adaptive Server. However, some schema objects differ between these databases, as shown in the following table:
### Table 2–1  Schema Objects in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Oracle</th>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database</td>
<td>Database</td>
</tr>
<tr>
<td>Schema</td>
<td>Database and database owner (DBO)</td>
</tr>
<tr>
<td>Tablespace</td>
<td>Database</td>
</tr>
<tr>
<td>User</td>
<td>User</td>
</tr>
<tr>
<td>Role</td>
<td>Group/Role</td>
</tr>
<tr>
<td>Table</td>
<td>Table</td>
</tr>
<tr>
<td>Temporary tables</td>
<td>Temporary tables</td>
</tr>
<tr>
<td>Cluster</td>
<td>N/A</td>
</tr>
<tr>
<td>Column-level check</td>
<td>Column-level check constraint</td>
</tr>
<tr>
<td>Column default</td>
<td>Column default</td>
</tr>
<tr>
<td>Unique key</td>
<td>Unique key or identity property for a column</td>
</tr>
<tr>
<td>Primary key</td>
<td>Primary key</td>
</tr>
<tr>
<td>Foreign key</td>
<td>Foreign key</td>
</tr>
<tr>
<td>Index</td>
<td>Non-unique index</td>
</tr>
<tr>
<td>PL/SQL Procedure</td>
<td>Transact-SQL (T-SQL) stored procedure</td>
</tr>
<tr>
<td>PL/SQL Function</td>
<td>T-SQL stored procedure</td>
</tr>
<tr>
<td>Packages</td>
<td>N/A</td>
</tr>
<tr>
<td>AFTER triggers</td>
<td>Triggers</td>
</tr>
<tr>
<td>BEFORE triggers</td>
<td>Complex rules</td>
</tr>
<tr>
<td>Triggers for each row</td>
<td>N/A</td>
</tr>
<tr>
<td>Synonyms</td>
<td>N/A</td>
</tr>
<tr>
<td>Sequences</td>
<td>Identity property for a column</td>
</tr>
<tr>
<td>Snapshot</td>
<td>N/A</td>
</tr>
<tr>
<td>View</td>
<td>View</td>
</tr>
</tbody>
</table>
Schema Object Names

Reserved words differ between Oracle and Microsoft SQL Server and Sybase Adaptive Server. Many Oracle reserved words are valid object or column names in Microsoft SQL Server and Sybase Adaptive Server. For example, DATE is a reserved word in Oracle, but it is not a reserved word in Microsoft SQL Server and Sybase Adaptive Server. Therefore, no column is allowed to have the name DATE in Oracle, but a column can be named DATE in Microsoft SQL Server and Sybase Adaptive Server. Use of reserved words as schema object names makes it impossible to use the same names across databases.

You should choose a schema object name that is unique by case and by at least one other characteristic, and ensure that the object name is not a reserved word from either database.

For a list of reserved words in Oracle, see the Oracle9i SQL Reference, Release 1 (9.0.1).

Table Design Considerations

This section discusses the many table design issues that you need to consider when converting Microsoft SQL Server and Sybase Adaptive Server databases to Oracle. These issues are discussed under the following headings:

- Data Types
- Entity Integrity Constraints
- Referential Integrity Constraints
- Unique Key Constraints
- Check Constraints

Data Types

This section outlines conversion considerations for the following data types:

- DATETIME Data Types
- IMAGE and TEXT Data Types (Binary Large Objects)
- Microsoft SQL Server and Sybase Adaptive Server User-Defined Data Types

DATETIME Data Types

The date/time precision in Microsoft SQL Server and Sybase Adaptive Server is 1/300th of a second. Oracle9i has a new data type TIMESTAMP which has a
precision of $1/100000000th$ of a second. Oracle also has a DATE data type that stores date and time values accurate to one second. The Migration Workbench has a default mapping to the DATE data type.

For applications that require finer date/time precision than seconds, the TIMESTAMP data type should be selected for the datatype mapping of date data types in Microsoft SQL Server and Sybase Adaptive Server. The databases store point-in-time values for DATE and TIME data types.

As an alternative, if an Microsoft SQL Server and Sybase Adaptive Server application uses the DATETIME column to provide unique IDs instead of point-in-time values, replace the DATETIME column with a SEQUENCE in the Oracle schema definition.

In the following examples, the original design does not allow the DATETIME precision to exceed seconds in the Oracle table. This example assumes that the DATETIME column is used to provide unique IDs. If millisecond precision is not required, the table design outlined in the following example is sufficient:

**Original Table Design**

**Microsoft SQL Server and Sybase Adaptive Server:**

```sql
CREATE TABLE example_table
    (datetime_column    datetime        not null,
     text_column         text            null,
     varchar_column      varchar(10)     null)
```

**Oracle:**

```sql
CREATE TABLE example_table
    (datetime_column    date            not null,
     text_column         long            null,
     varchar_column      varchar2(10)    null)
```

The following design allows the value of the sequence to be inserted into the integer_column. This allows you to order the rows in the table beyond the allowed precision of one second for DATE data type fields in Oracle. If you include this column in the Microsoft SQL Server and Sybase Adaptive Server table, you can keep the same table design for the Oracle database.

**Revised Table Design**

**Microsoft SQL Server and Sybase Adaptive Server:**

```sql
CREATE TABLE example_table
```
(datetime_column      datetime    not null,
 integer_column      int          null,
 text_column         text         null,
 varchar_column      varchar(10) null)

**Oracle:**

```
CREATE TABLE example_table
(datetime_column      date          not null,
 integer_column      number       null,
 text_column         long         null,
 varchar_column      varchar2(10) null)
```

For the Microsoft SQL Server and Sybase Adaptive Server database, the value in the `integer_column` is always NULL. For Oracle, the value for the field `integer_column` is updated with the next value of the sequence.

Create the sequence by issuing the following command:

```
CREATE SEQUENCE datetime_seq
```

Values generated for this sequence start at 1 and are incremented by 1.

Many applications do not use DATETIME values as UNIQUE IDs, but still require the date/time precision to be higher than seconds. For example, the timestamp of a scientific application may have to be expressed in milliseconds, microseconds, and nanoseconds. The precision of the Microsoft SQL Server and Sybase Adaptive Server DATETIME data type is 1/300th of a second; the precision of the Oracle DATE data type is one second. The Oracle TIMESTAMP data type has a precision to 1/100000000th of a second. However, the precision recorded is dependent on the operating system.
IMAGE and TEXT Data Types (Binary Large Objects)

The physical and logical storage methods for IMAGE and TEXT data differ from Oracle to Microsoft SQL Server and Sybase Adaptive Server. In Microsoft SQL Server and Sybase Adaptive Server, a pointer to the IMAGE or TEXT data is stored with the rows in the table while the IMAGE or TEXT data is stored separately. This arrangement allows multiple columns of IMAGE or TEXT data per table. In Oracle, IMAGE data may be stored in a BLOB type field and TEXT data may be stored in a CLOB type field. Oracle allows multiple BLOB and CLOB columns per table. BLOBS and CLOBS may or may not be stored in the row depending on their size.

If the Microsoft SQL Server and Sybase Adaptive Server TEXT column is such that the data never exceeds 4000 bytes, convert the column to an Oracle VARCHAR2 data type column instead of a CLOB column. An Oracle table can define multiple VARCHAR2 columns. This size of TEXT data is suitable for most applications.

Microsoft SQL Server and Sybase Adaptive Server User-Defined Data Types

This Microsoft SQL Server and Sybase Adaptive Server T-SQL-specific enhancement to SQL allows users to define and name their own data types to supplement the system data types. A user-defined data type can be used as the data type for any column in the database. Defaults and rules (check constraints) can be bound to these user-defined data types, which are applied automatically to the individual columns of these user-defined data types.

While migrating to Oracle PL/SQL, you must determine the base data type for each user-defined data type, to find the equivalent PL/SQL data type.

Note: User-defined data types make the data definition language code and procedural SQL code less portable across different database servers.

Entity Integrity Constraints

You can define a primary key for a table in Microsoft SQL Server and Sybase Adaptive Server. Primary keys can be defined in a CREATE TABLE statement or an ALTER TABLE statement.

Oracle provides declarative referential integrity. A primary key can be defined as part of a CREATE TABLE or an ALTER TABLE statement. Oracle internally creates a unique index to enforce the integrity.
Referential Integrity Constraints
You can define a foreign key for a table in Microsoft SQL Server and Sybase Adaptive Server. Foreign keys can be defined in a CREATE TABLE statement or an ALTER TABLE statement.

Oracle provides declarative referential integrity. A CREATE TABLE or ALTER TABLE statement can add foreign keys to the table definition. For information about referential integrity constraints, see the Oracle9i Database Concepts, Release 1 (9.0.1).

Unique Key Constraints
You can define a unique key for a table in Microsoft SQL Server and Sybase Adaptive Server. Unique keys can be defined in a CREATE TABLE statement or an ALTER TABLE statement.

Oracle defines unique keys as part of CREATE TABLE or ALTER TABLE statements. Oracle internally creates unique indexes to enforce these constraints.

Unique keys map one-to-one from Microsoft SQL Server and Sybase Adaptive Server to Oracle.

Check Constraints
Check constraints can be defined in a CREATE TABLE statement or an ALTER TABLE statement in Microsoft SQL Server and Sybase Adaptive Server. Multiple check constraints can be defined on a table. A table-level check constraint can reference any column in the constrained table. A column can have only one check constraint. A column-level check constraint can reference only the constrained column. These check constraints support complex regular expressions.

Oracle defines check constraints as part of the CREATE TABLE or ALTER TABLE statements. A check constraint is defined at the TABLE level and not at the COLUMN level. Therefore, it can reference any column in the table. Oracle, however, does not support complex regular expressions.

SQL Server Rule:
```
create rule phone_rule
as
@phone_number like
"([0-9][0-9][0-9])[0-9][0-9][0-9]-[0-9][0-9][0-9][0-9]"
```

This rule passes all the phone numbers that resemble the following:
(650)506-7000
This rule fails all the phone numbers that resemble the following:
650-506-7000
650-GET-HELP

There are a few ways to implement this INTEGRITY constraint in Oracle:

- Simulate the behavior of phone-rule in a check constraint using a combination of SUBSTR, TRANSLATE, and LIKE clauses
- Write a trigger and use PL/SQL

Table-level check constraints from Microsoft SQL Server and Sybase Adaptive Server databases map one-to-one with Oracle check constraints. You can implement the column-level check constraints from the Microsoft SQL Server and Sybase Adaptive Server database to Oracle table-level check constraints. While converting the regular expressions, convert all simple regular expressions to check constraints in Oracle. Microsoft SQL Server and Sybase Adaptive Server check constraints with complex regular expressions can be either reworked as check constraints including a combination of simple regular expressions, or you can write Oracle database triggers to achieve the same functionality.

Data Types

This chapter provides detailed descriptions of the differences in data types used by Microsoft SQL Server and Sybase Adaptive Server and Oracle databases. Specifically, this chapter contains the following information:

- A table showing the base Microsoft SQL Server and Sybase Adaptive Server data types available and how they are mapped to Oracle data types
- Recommendations based on the information listed in the table
## Data Types Table

### Table 2–2 Data Types in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Description</th>
<th>Oracle</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTEGER</td>
<td>Four-byte integer, 31 bits, and a sign. May be abbreviated as &quot;INT&quot; (this abbreviation was required prior to version 5).</td>
<td>NUMBER(10)</td>
<td>It is possible to place a table constraint on columns of this type (as an option) to force values between $-2^{31}$ and $2^{31}$. Or, place appropriate constraints such as: STATE_NO between 1 and 50.</td>
</tr>
<tr>
<td>SMALLINT</td>
<td>Two-byte integer, 15 bits, and a sign.</td>
<td>NUMBER(6)</td>
<td>It is possible to place a table constraint on columns of this type (optionally) to force values between $-2^{15}$ and $2^{15}$. Or, place appropriate constraints such as: STATE_NO between 1 and 50.</td>
</tr>
<tr>
<td>TINYINT</td>
<td>One byte integer, 8 bits and no sign. Holds whole numbers between 0 and 255.</td>
<td>NUMBER(3)</td>
<td>You may add a check constraint of (x between 0 and 255) where x is column name.</td>
</tr>
</tbody>
</table>
REAL Floating point number. Storage is four bytes and has a binary precision of 24 bits, a 7-digit precision.
Data can range from \(-3.40\times10^{38}\) to \(3.40\times10^{38}\).
In Sybase the range of values and the actual representation is platform dependent. This can result in incorrect interpretation if data is moved between platforms. REAL numbers are stored in 4 bytes and can represent about 6 decimal digits with reasonable accuracy. Sybase REALs are mapped to the ANSI equivalent in Oracle.

Table 2–2 Data Types in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Description</th>
<th>Oracle</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>REAL</td>
<td>Floating point number. Storage is four bytes and has a binary precision of 24 bits, a 7-digit precision. Data can range from (-3.40\times10^{38}) to (3.40\times10^{38}). In Sybase the range of values and the actual representation is platform dependent. This can result in incorrect interpretation if data is moved between platforms. REAL numbers are stored in 4 bytes and can represent about 6 decimal digits with reasonable accuracy. Sybase REALs are mapped to the ANSI equivalent in Oracle.</td>
<td>FLOAT</td>
<td>The ANSI data type conversion to Oracle for REAL is FLOAT(63). By default, the Oracle Migration Workbench maps REAL to FLOAT(24) that stores up to 8 significant decimal digits in Oracle. The Oracle NUMBER data type is used to store both fixed and floating-point numbers in a format that is compatible with decimal arithmetic. You may want to add a check constraint to constrain range of values. Also, you get different answers when performing operations on this data type as the Oracle NUMBER type is more precise and portable than REAL. Floating-point numbers can be specified in Oracle in the following format: FLOAT([b]). Where ([b]) is the binary precision and can range from 1 to 126. ([b]) defaults to 126. To check what a particular binary precision is in terms of decimal precision, multiply ([b]) by 0.30103 and round up to the next whole number.</td>
</tr>
</tbody>
</table>
### Table 2–2  Data Types in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Description</th>
<th>Oracle</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLOAT</td>
<td>A floating point number. This column has 15-digit precision.</td>
<td>FLOAT</td>
<td>The ANSI data type conversion to Oracle for FLOAT(p) is FLOAT(p). The ANSI data type conversion to Oracle for DOUBLE PRECISION is FLOAT(126). By default, the Oracle Migration Workbench maps FLOAT to FLOAT(53), that stores up to 16 significant decimal digits in Oracle. The Oracle NUMBER data type is used to store both fixed and floating-point numbers in a format compatible with decimal arithmetic. You get different answers when performing operations on this type due to the fact that the Oracle NUMBER type is much more precise and portable than FLOAT, but it does not have the same range. The NUMBER data type data can range from -9.999999E+125 to 9.999999E+125 (38 nines followed by 88 zeros).</td>
</tr>
</tbody>
</table>

NOTE: If you try to migrate floating point data greater than or equal to 1.0E+126 then Migration Workbench will fail to insert this data in the Oracle database and will return an error. This also applies to negative values less than or equal to -1.0E+126.
Floating-point numbers can be specified in Oracle using `FLOAT[(b)]`, where 
(b) is the binary precision and can range from 1 to 126. 
(b) defaults to 126. To check what a particular binary 
precision is in terms of decimal precision multiply 
(b) by 0.30103 and round up to the next whole 
number.

If they are outside of the range, large floating-point 
numbers will overflow, and small floating-point 
numbers will underflow.

| BIT | A Boolean 0 or 1 stored as one bit of a byte. Up to 8-bit columns from a table may be stored in a single byte, even if not contiguous. Bit data cannot be NULL, except for Microsoft SQL Server 7.0, where NULL is allowed by the BIT data type. | NUMBER(1) | In Oracle, a bit is stored in a number(1) (or char). In Oracle, it is possible to store bits in a char or varchar field (packed) and supply PL/SQL functions to set / unset / retrieve / query on them. |
### Data Types in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Description</th>
<th>Oracle</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHAR(n)</td>
<td>Fixed-length string of exactly n 8-bit characters, blank padded. Synonym for CHARACTER. 0 &lt; n &lt; 256 for Microsoft SQL Server and Sybase Adaptive Server. 0 &lt; n &lt; 8000 for Microsoft SQL Server 7.0.</td>
<td>CHAR(n)</td>
<td>Pro*C client programs must use mode=ansi to have characters interpreted correctly for string comparison, mode=oracle otherwise. A CHAR datatype with a range of 2001 to 4000 is invalid. The Migration Workbench automatically converts a CHAR datatype with this range to VARCHAR2.</td>
</tr>
<tr>
<td>VARCHAR(n)</td>
<td>Varying-length character string. 0 &lt; n &lt; 256 for Microsoft SQL Server and Sybase Adaptive Server. 0 &lt; n &lt; 8000 for Microsoft SQL Server 7.0.</td>
<td>VARCHAR2(n)</td>
<td></td>
</tr>
<tr>
<td>TEXT</td>
<td>Character string of 8-bit bytes allocated in increments of 2k pages. &quot;TEXT&quot; is stored as a linked-list of 2024-byte pages, blank padded. TEXT columns can hold up to (231-1) characters.</td>
<td>CLOB</td>
<td>The CLOB field can hold up to 4GB.</td>
</tr>
<tr>
<td>IMAGE</td>
<td>Binary string of 8-bit bytes. Holds up to (231-1) bytes of binary data.</td>
<td>BLOB</td>
<td>The BLOB field can hold up to 4GB.</td>
</tr>
</tbody>
</table>
### Data Types

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Description</th>
<th>Oracle</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>BINARY(n)</td>
<td>Fixed length binary string of exactly n 8-bit bytes. 0 &lt; n &lt; 256 for Microsoft SQL Server and Sybase Adaptive Server. 0 &lt; n &lt; 8000 for Microsoft SQL Server 7.0.</td>
<td>RAW(n)/BLOB</td>
<td></td>
</tr>
<tr>
<td>VARBINARY(n)</td>
<td>Varying length binary string of up to n 8-bit bytes. 0 &lt; n &lt; 256 for Microsoft SQL Server and Sybase Adaptive Server. 0 &lt; n &lt; 8000 for Microsoft SQL Server 7.0.</td>
<td>RAW(n)/BLOB</td>
<td></td>
</tr>
</tbody>
</table>
Microsoft SQL Server, Sybase Adaptive Server, and Oracle Compared

---

Table 2–2  Data Types in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Description</th>
<th>Oracle</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATETIME</td>
<td>Date and time are stored as two 4-byte integers. The date portion is represented as a count of the number of days offset from a baseline date (1/1/1900) and is stored in the first integer. Permitted values are legal dates between 1st January, 1753 AD and 31st December, 9999 AD. Permitted values in the time portion are legal times in the range 0 to 25920000. Accuracy is to the nearest 3.33 milliseconds with rounding downward. Columns of type DATETIME have a default value of 1/1/1900.</td>
<td>DATE</td>
<td>The precision of DATE in Oracle and DATETIME in Microsoft SQL Server and Sybase Adaptive Server is different. The DATETIME data type has higher precision than the DATE data type. This may have some implications if the DATETIME column is supposed to be UNIQUE. In Microsoft SQL Server and Sybase Adaptive Server, the column of type DATETIME can contain UNIQUE values because the DATETIME precision in Microsoft SQL Server and Sybase Adaptive Server is to the hundredth of a second. In Oracle, however, these values may not be UNIQUE as the date precision is to the second. You can replace a DATETIME column with two columns, one with data type DATE and another with a sequence, in order to get the UNIQUE combination. It is preferable to store hundredths of seconds in the second column. The Oracle TIMESTAMP data type can also be used. It has a precision of 1/10000000th of a second.</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Description</th>
<th>Oracle</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMALL-DATETIME</td>
<td>Date and time stored as two 2-byte integers. Date ranges from 1/1/1900 to 6/6/2079. Time is the count of the number of minutes since midnight.</td>
<td>DATE</td>
<td>With optional check constraint to validate the smaller range.</td>
</tr>
<tr>
<td>MONEY</td>
<td>A monetary value represented as an integer portion and a decimal fraction, and stored as two 4-byte integers. Accuracy is to the nearest 1/10,000. When inputting Data of this type it should be preceded by a dollar sign ($). In the absence of the &quot;$&quot; sign, Microsoft SQL Server and Sybase Adaptive Server create the value as a float. Monetary data values can range from -922,337,203,685,477.5808 to 922,337,203,685,477.5807, with accuracy to a ten-thousandth of a monetary unit. Storage size is 8 bytes.</td>
<td>NUMBER(19,4)</td>
<td>Microsoft SQL Server and Sybase Adaptive Server input MONEY data types as a numeric data type with a preceding dollar sign ($) as in the following example, select * from table_x where y &gt; $5.00 You must remove the &quot;$&quot; sign from queries. Oracle is more general and works in international environments where the use of the &quot;$&quot; sign cannot be assumed. Support for other currency symbols and ISO standards through NLS is available in Oracle.</td>
</tr>
<tr>
<td>Microsoft SQL Server and Sybase Adaptive Server</td>
<td>Description</td>
<td>Oracle</td>
<td>Comments</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>NCHAR(n)</td>
<td>Fixed-length character data type which uses the UNICODE UCS-2 character set. n must be a value in the range 1 to 4000. SQL Server storage size is two times n. Note: Microsoft SQL Server storage size is two times n. The Oracle Migration Workbench maps columns sizes using byte semantics, and the size of Microsoft SQL Server NCHAR data types appear in the Oracle Migration Workbench Source Model with &quot;Size&quot; specifying the number of bytes, as opposed to the number of Unicode characters. Thus, a SQL Server column NCHAR(1000) will appear in the Source Model as NCHAR(2000).</td>
<td>CHAR(n*2)</td>
<td></td>
</tr>
<tr>
<td>Microsoft SQL Server and Sybase Adaptive Server</td>
<td>Description</td>
<td>Oracle</td>
<td>Comments</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>-------------</td>
<td>--------</td>
<td>----------</td>
</tr>
<tr>
<td>NVARCHAR(n)</td>
<td>Fixed-length character data type which uses the UNICODE UCS-2 character set. n must be a value in the range 1 to 4000. SQL Server storage size is two times n. Note: Microsoft SQL Server storage size is two times n. The Oracle Migration Workbench maps columns sizes using byte semantics, and the size of Microsoft SQL Server NCHAR data types appear in the Oracle Migration Workbench Source Model with “Size” specifying the number of bytes, as opposed to the number of Unicode characters. Thus, a SQL Server column NCHAR(1000) will appear in the Source Model as NCHAR(2000).</td>
<td>VARCHAR(n*2)</td>
<td></td>
</tr>
<tr>
<td>SMALLMONEY</td>
<td>Same as MONEY above except monetary data values from -214,748.3648 to +214,748.3647, with accuracy to one ten-thousandth of a monetary unit. Storage size is 4 bytes.</td>
<td>NUMBER(10,4)</td>
<td>Since the range is -214,748.3648 to 214,748.364, NUMBER(10,4) suffices for this field.</td>
</tr>
</tbody>
</table>
Table 2–2 Data Types in Oracle and Microsoft SQL Server and Sybase Adaptive Server(Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Description</th>
<th>Oracle</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIMESTAMP</td>
<td>TIMESTAMP is defined as VARBINARY(8) with NULL allowed. Every time a row containing a TIMESTAMP column is updated or inserted, the TIMESTAMP column is automatically incremented by the system. A TIMESTAMP column may not be updated by users.</td>
<td>NUMBER</td>
<td>You must place triggers on columns of this type to maintain them. In Oracle you can have multiple triggers of the same type without having to integrate them all into one big trigger. You may want to supply triggers to prevent updates of this column to enforce full compatibility.</td>
</tr>
<tr>
<td>SYSNAME</td>
<td>VARCHAR(30) in Microsoft SQL Server and Sybase Adaptive Server. NVARCHAR(128) in Microsoft SQL Server 7.0.</td>
<td>VARCHAR2(30) and VARCHAR2(128) respectively.</td>
<td></td>
</tr>
</tbody>
</table>

TEXT and IMAGE data types in Microsoft SQL Server and Sybase Adaptive Server follow the rules listed below:

- The column of these data types cannot be indexed.
- The column cannot be a primary key.
- The column cannot be used in the GROUP BY, ORDER BY, HAVING, and DISTINCT clauses.
- IMAGE and TEXT data types can be referred to in the WHERE clause with the LIKE construct.
- IMAGE and TEXT data types can also be used with the SUBSTR and LENGTH functions.

In Microsoft SQL Server and Sybase Adaptive Server only columns with variable-length data types can store NULL values. When you create a column that allows NULLs with a fixed-length data type, the column is automatically converted...
to a system variable-length data type, as illustrated in Table 2–3. These variable-length data types are reserved system data types, and users cannot use them to create columns.

**Table 2–3 Data Type Conversion for NULL Values**

<table>
<thead>
<tr>
<th>Fixed-Length Data Type</th>
<th>Variable-Length Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHAR</td>
<td>VARCHAR</td>
</tr>
<tr>
<td>NCHAR</td>
<td>NVARCHAR</td>
</tr>
<tr>
<td>BINARY</td>
<td>VARBINARY</td>
</tr>
<tr>
<td>DATETIME, SMALLDATETIME</td>
<td>DATETIMN</td>
</tr>
<tr>
<td>FLOA'T</td>
<td>FLOATN</td>
</tr>
<tr>
<td>INT, SMALLINT, TINYINT</td>
<td>INTN</td>
</tr>
<tr>
<td>DECIMAL</td>
<td>DECIMALN</td>
</tr>
<tr>
<td>NUMERIC</td>
<td>NUMERICN</td>
</tr>
<tr>
<td>MONEY, SMALLMONEY</td>
<td>MONEYN</td>
</tr>
</tbody>
</table>

**Note:** The Oracle Migration Workbench Source Model will display table system data types for each column.

**Recommendations**

In addition to the data types listed in Table 2-2, users can define their own data types in Microsoft SQL Server and Sybase Adaptive Server databases. These user-defined data types translate to the base data types that are provided by the server. They do not allow users to store additional types of data, but can be useful in implementing standard data types for an entire application.

You can map data types from Microsoft SQL Server and Sybase Adaptive Server to Oracle with the equivalent data types listed in the above table. The Migration Workbench converts user-defined data types to their base type. You can defined how the base type is mapped to an Oracle type in the Data Type Mappings page in the Options dialog.
Data Storage Concepts

This section provides a detailed description of the conceptual differences in data storage for the Microsoft SQL Server and Sybase Adaptive Server and Oracle databases.

Specifically, it contains the following information:

- A table comparing the data storage concepts of Microsoft SQL Server and Sybase Adaptive Server, and Oracle databases
- Recommendations based on the information listed in the table

Data Storage Concepts Table

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Database Devices:</strong> A database device is mapped to the specified physical disk files.</td>
<td><strong>Datafiles:</strong> One or more datafiles are created for each tablespace to physically store the data of all logical structures in a tablespace. The combined size of the datafiles in a tablespace is the total storage capacity of the tablespace. The combined storage capacity of all the tablespaces in a database is the total storage capacity of the database. Once created, a datafile cannot change in size. This limitation does not exist in Oracle.</td>
</tr>
<tr>
<td><strong>Page:</strong> Many pages constitute a database device. Each page contains a certain number of bytes.</td>
<td><strong>Data Block:</strong> One data block corresponds to a specific number of bytes, of physical database space, on the disk. The size of the data block can be specified when creating the database. A database uses and allocates free database space in Oracle data blocks.</td>
</tr>
<tr>
<td><strong>Extent:</strong> Eight pages make one extent. Space is allocated to all the databases in increments of one extent at a time.</td>
<td><strong>Extent:</strong> An extent is a specific number of contiguous data blocks, obtained in a single allocation.</td>
</tr>
</tbody>
</table>
Segments (corresponds to Oracle Tablespace):

A segment is the name given to one or more database devices. Segment names are used in CREATE TABLE and CREATE INDEX constructs to place these objects on specific database devices. Segments can be extended to include additional devices as and when needed by using the SP_EXTENDSEGMENT system procedure.

The following segments are created along with the database:

- **System segment**
  Stores the system tables.

- **Log segment**
  Stores the transaction log.

- **Default segment**
  All other database objects are stored on this segment unless specified otherwise.

Segments are subsets of database devices.

### Table 2–4  Data Storage Concepts in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

| Segments:                                     |
| A segment is a set of extents allocated for a certain logical structure. The extents of a segment may or may not be contiguous on disk, and may or may not span the datafiles. |

| Tablespace (corresponds to Microsoft SQL Server and Sybase Adaptive Server Segments): |
| A database is divided into logical storage units called tablespaces. A tablespace is used to group related logical structures together. A database typically has one system tablespace and one or more user tablespaces. |

| Tablespace Extent:                           |
| An extent is a specific number of contiguous data blocks within the same tablespace. |

| Tablespace Segments:                         |
| A segment is a set of extents allocated for a certain logical database object. All the segments assigned to one object must be in the same tablespace. The segments get the extents allocated to them as and when needed. |

There are four different types of segments as follows:

- **Data segment**
  Each table has a data segment. All of the table's data is stored in the extents of its data segments. The tables in Oracle can be stored as clusters as well. A cluster is a group of two or more tables that are stored together. Each cluster has a data segment. The data of every table in the cluster is stored in the cluster’s data segment.
Table 2–4  Data Storage Concepts in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tablespace Segments (Cont):</td>
<td></td>
</tr>
<tr>
<td>■ Index segment</td>
<td></td>
</tr>
<tr>
<td>Each index has an index segment that</td>
<td></td>
</tr>
<tr>
<td>stores all of its data.</td>
<td></td>
</tr>
<tr>
<td>■ Rollback segment</td>
<td></td>
</tr>
<tr>
<td>One or more rollback segments are</td>
<td></td>
</tr>
<tr>
<td>created by the DBA for a database to</td>
<td></td>
</tr>
<tr>
<td>temporarily store “undo” information.</td>
<td></td>
</tr>
<tr>
<td>This is the information about all the</td>
<td></td>
</tr>
<tr>
<td>transactions that are not yet</td>
<td></td>
</tr>
<tr>
<td>committed. This information is used to</td>
<td></td>
</tr>
<tr>
<td>generate read-consistent database</td>
<td></td>
</tr>
<tr>
<td>information during database recovery</td>
<td></td>
</tr>
<tr>
<td>to rollback uncommitted transactions</td>
<td></td>
</tr>
<tr>
<td>for users.</td>
<td></td>
</tr>
<tr>
<td>■ Temporary segment</td>
<td></td>
</tr>
<tr>
<td>Temporary segments are created by</td>
<td></td>
</tr>
<tr>
<td>Oracle when a SQL statement needs a</td>
<td></td>
</tr>
<tr>
<td>temporary work area to complete</td>
<td></td>
</tr>
<tr>
<td>execution. When the statement finishes</td>
<td></td>
</tr>
<tr>
<td>execution, the extents in the temporary</td>
<td></td>
</tr>
<tr>
<td>segment are returned to the system for</td>
<td></td>
</tr>
<tr>
<td>future use.</td>
<td></td>
</tr>
<tr>
<td>Log Devices:</td>
<td></td>
</tr>
<tr>
<td>These are logical devices assigned to store</td>
<td></td>
</tr>
<tr>
<td>the log. The database device to store the</td>
<td></td>
</tr>
<tr>
<td>logs can be specified while creating the</td>
<td></td>
</tr>
<tr>
<td>database.</td>
<td></td>
</tr>
<tr>
<td>Redo Log Files:</td>
<td></td>
</tr>
<tr>
<td>Each database has a set of two or more redo</td>
<td></td>
</tr>
<tr>
<td>log files. All changes made to the database</td>
<td></td>
</tr>
<tr>
<td>are recorded in the redo log. Redo log files</td>
<td></td>
</tr>
<tr>
<td>are critical in protecting a database against</td>
<td></td>
</tr>
<tr>
<td>failures. Oracle allows mirrored redo log</td>
<td></td>
</tr>
<tr>
<td>files so that two or more copies of these</td>
<td></td>
</tr>
<tr>
<td>files can be maintained. This protects the</td>
<td></td>
</tr>
<tr>
<td>redo log files against failure of the</td>
<td></td>
</tr>
<tr>
<td>hardware the log file reside on.</td>
<td></td>
</tr>
</tbody>
</table>
## Database Devices

A database device contains the database objects. A logical device does not necessarily refer to any particular physical disk or file in the file system.

The database and logs are stored on database devices. Each database device must be initialized before being used for database storage. Initialization of the database device initializes the device for storage and registers the device with the server. After initialization, the device can be:

- Allocated to the free space available to a database
- Allocated to store specific user objects
- Used to store the transaction log of a database
- Labeled as default device to create and alter database objects

The `SP_HELPDEVICES` system procedure displays all the devices that are registered with the server. Use the `DROP DEVICE DEVICE_NAME` command to drop the device. The system administrator (SA) should restart the server after dropping the device.

A device can be labeled as a default device so that the new databases need not specify the device at the time of creation. Use the `SP_DISKDEFAULT` system procedure to label the device as a default device.

### Dump Devices

These are logical devices. A database dump is stored on these devices. The `DUMP DATABASE` command uses the dump device to dump the database.

---

### Table 2–4 Data Storage Concepts in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database Devices:</td>
<td>N/A</td>
</tr>
<tr>
<td>A database device contains the database objects. A logical device does not necessarily refer to any particular physical disk or file in the file system. The database and logs are stored on database devices. Each database device must be initialized before being used for database storage. Initialization of the database device initializes the device for storage and registers the device with the server. After initialization, the device can be:</td>
<td></td>
</tr>
<tr>
<td>- Allocated to the free space available to a database</td>
<td></td>
</tr>
<tr>
<td>- Allocated to store specific user objects</td>
<td></td>
</tr>
<tr>
<td>- Used to store the transaction log of a database</td>
<td></td>
</tr>
<tr>
<td>- Labeled as default device to create and alter database objects</td>
<td></td>
</tr>
<tr>
<td>The <code>SP_HELPDEVICES</code> system procedure displays all the devices that are registered with the server. Use the <code>DROP DEVICE DEVICE_NAME</code> command to drop the device. The system administrator (SA) should restart the server after dropping the device. A device can be labeled as a default device so that the new databases need not specify the device at the time of creation. Use the <code>SP_DISKDEFAULT</code> system procedure to label the device as a default device.</td>
<td></td>
</tr>
<tr>
<td>Dump Devices</td>
<td>N/A</td>
</tr>
<tr>
<td>These are logical devices. A database dump is stored on these devices. The <code>DUMP DATABASE</code> command uses the dump device to dump the database.</td>
<td></td>
</tr>
</tbody>
</table>
Recommendations:

The conceptual differences in the storage structures do not affect the conversion process directly. However, the physical storage structures need to be in place before conversion of the database begins.

Oracle, Microsoft SQL Server and Sybase Adaptive Server all have a way to control the physical placement of a database object. In Microsoft SQL Server and Sybase Adaptive Server, you use the ON SEGMENT clause and in Oracle you use the TABLESPACE clause.

An attempt should be made to preserve as much of the storage information as possible when converting from Microsoft SQL Server and Sybase Adaptive Server to Oracle. The decisions that were made when defining the storage of the database objects for Microsoft SQL Server and Sybase Adaptive Server should also apply for Oracle. Especially important are initial object sizes and physical object placement.

---

**Table 2–4 Data Storage Concepts in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)**

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>Control Files:</td>
</tr>
<tr>
<td></td>
<td>Each database has a control file. This file records the physical structure of the database. It contains the following information:</td>
</tr>
<tr>
<td></td>
<td>■ database name</td>
</tr>
<tr>
<td></td>
<td>■ names and locations of a database’s datafiles and redo log files</td>
</tr>
<tr>
<td></td>
<td>■ time stamp of database creation</td>
</tr>
<tr>
<td></td>
<td>It is possible to have mirrored control files. Each time an instance of an Oracle database is started, its control file is used to identify the database, the physical structure of the data, and the redo log files that must be opened for the database operation to proceed. The control file is also used for recovery if necessary. The control files hold information similar to the master database in Microsoft SQL Server and Sybase Adaptive Server.</td>
</tr>
</tbody>
</table>
Data Manipulation Language

This section uses tables to compare the syntax and description of Data Manipulation Language (DML) elements in the Microsoft SQL Server and Sybase Adaptive Server, and Oracle databases. Each table is followed by a recommendations section based on the information in the tables. The following topics are presented in this section:

- Connecting to the Database
- SELECT Statement
- SELECT with GROUP BY Statement
- INSERT Statement
- UPDATE Statement
- DELETE Statement
- Operators
  - Comparison Operators
  - Arithmetic Operators
  - String Operators
  - Set Operators
  - Bit Operators
- Built-In Functions
  - Character Functions
  - Date Functions
  - Mathematical Functions
- Locking Concepts and Data Concurrency Issues
  - Locking
  - Row-Level Versus Page-Level Locking
  - Read Consistency
- Logical Transaction Handling
Connecting to the Database

The statement illustrated in the following table connects a user to a database.

Table 2-5  Connecting to the Database in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syntax:</td>
<td>Syntax:</td>
</tr>
<tr>
<td>USE database_name</td>
<td>CONNECT user_name/password</td>
</tr>
<tr>
<td>Description: A default database is assigned</td>
<td>SET role</td>
</tr>
<tr>
<td>to each user. This database is made current</td>
<td></td>
</tr>
<tr>
<td>when the user logs on to the server. A user</td>
<td></td>
</tr>
<tr>
<td>executes the USE DATABASE_NAME command to</td>
<td></td>
</tr>
<tr>
<td>switch to another database.</td>
<td></td>
</tr>
</tbody>
</table>

Recommendations:

This concept of connecting to a database is conceptually different in the Microsoft SQL Server and Sybase Adaptive Server, and Oracle databases. An Microsoft SQL Server and Sybase Adaptive Server user can log on to the server and switch to another database residing on the server, provided the user has privileges to access that database. An Oracle Server controls only one database, so here the concept of a user switching databases on a server does not exist. Instead, in Oracle a user executes the SET ROLE command to change roles or re-issues a CONNECT command using a different user_name.
SELECT Statement

The statement in the following table retrieves rows from one or more tables or views.
Table 2–6  SELECT Statements in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Syntax:</th>
<th>Syntax:</th>
</tr>
</thead>
<tbody>
<tr>
<td>SELECT [ALL</td>
<td>DISTINCT]</td>
</tr>
<tr>
<td>{select_list}</td>
<td>FROM [user.][table</td>
</tr>
<tr>
<td>[INTO [owner.][table</td>
<td>view][alias] [HOLDLOCK]</td>
</tr>
<tr>
<td>[WHERE condition]</td>
<td>[WHERE condition]</td>
</tr>
<tr>
<td>[GROUP BY [ALL] aggregate_free_expression [, aggregate_free_expression]...]</td>
<td>[GROUP BY aggregate_free_expression [,...] ]</td>
</tr>
<tr>
<td>[HAVING search_condition]</td>
<td>[HAVING search_condition]</td>
</tr>
<tr>
<td>[UNION [ALL] SELECT...]</td>
<td>[UNION [ALL]</td>
</tr>
<tr>
<td>[ORDER BY {[[owner.][table</td>
<td>view].]column</td>
</tr>
<tr>
<td>[=</td>
<td>DESC]</td>
</tr>
<tr>
<td>[, [owner.][table</td>
<td>view].]column</td>
</tr>
<tr>
<td>[ASC</td>
<td>DESC]</td>
</tr>
<tr>
<td>[COMPUTE row_aggregate(column) [row_aggregate(column) ...]</td>
<td>The individual element in the select list is as follows:</td>
</tr>
<tr>
<td>[BY column[, column...]]</td>
<td>[*, [owner.][table</td>
</tr>
<tr>
<td>[FOR BROWSE]</td>
<td>{owner.][table.column</td>
</tr>
<tr>
<td>The individual element in the select list is as follows:</td>
<td>alias = ]</td>
</tr>
<tr>
<td>[alias = ]</td>
<td>(*</td>
</tr>
<tr>
<td>{*, [owner.][table</td>
<td>view].*</td>
</tr>
<tr>
<td>([owner.][table.column</td>
<td>constant_literal</td>
</tr>
</tbody>
</table>

Microsoft SQL Server, Sybase Adaptive Server, and Oracle Compared  2-29
### Table 2–6  SELECT Statements in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.) (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td><strong>Description:</strong></td>
</tr>
<tr>
<td>DISTINCT eliminates the duplicate rows.</td>
<td>DISTINCT eliminates the duplicate rows.</td>
</tr>
<tr>
<td>The INTO clause and the items that follow it in the command syntax are optional, because Microsoft SQL Server and Sybase Adaptive Server allow SELECT statements without FROM clauses as can be seen in the following example:</td>
<td>The INSERT INTO &lt;table&gt; SELECT FROM.... construct allows you to insert the results of the SELECT statement into a table.</td>
</tr>
<tr>
<td>SELECT getdate()</td>
<td>COLUMN ALIAS is defined by putting the alias directly after the selected COLUMN.</td>
</tr>
<tr>
<td>SELECT...INTO allows you to insert the results of the SELECT statement into a table.</td>
<td>If you use TABLE ALIAS, the TABLE must always be referenced using the ALIAS.</td>
</tr>
<tr>
<td>SELECT_LIST can contain a SELECT statement in the place of a column specification as follows:</td>
<td>You can also retrieve data from SYNONYMS.</td>
</tr>
<tr>
<td></td>
<td>EXPRESSION could be a column name, a literal, a mathematical computation, a function, several functions combined, or one of several PSEUDO-COLUMNS.</td>
</tr>
<tr>
<td>SELECT d.empno, d.deptname,</td>
<td>Outer joins are implemented as follows:</td>
</tr>
<tr>
<td>empname = (SELECT ename FROM emp</td>
<td>WHERE tab1.col1 = tab2.col1 (+);</td>
</tr>
<tr>
<td>WHERE enum = d.empno)</td>
<td>Where all values from TAB1 are returned even if TAB2 does not have a match or</td>
</tr>
<tr>
<td>FROM dept d</td>
<td>WHERE tab1.col1 (+) = tab2.col1;</td>
</tr>
<tr>
<td>WHERE deptid = 10</td>
<td>where all values from TAB2 are returned even if TAB1 does not have a match.</td>
</tr>
<tr>
<td>The above example also shows the format for the column alias.</td>
<td>If a GROUP BY clause is used, all non-aggregate select columns must be in a GROUP BY clause.</td>
</tr>
<tr>
<td>ALIAS = selected_column</td>
<td>The FOR UPDATE clause locks the rows selected by the query. Other users cannot lock these row until you end the transaction. This clause is not a direct equivalent of the FOR BROWSE mode in Microsoft SQL Server and Sybase Adaptive Server.</td>
</tr>
<tr>
<td>COMPUTE attaches computed values at the end of the query. These are called row_aggregates.</td>
<td></td>
</tr>
</tbody>
</table>
SELECT Statements without FROM Clauses:

Microsoft SQL Server and Sybase Adaptive Server support SELECT statements that do not have a FROM clause. This can be seen in the following example

SELECT getdate()

Oracle does not support SELECTs without FROM clauses. However, Oracle provides the DUAL table which always contains one row. Use the DUAL table to convert constructs such as the one above.

Translate the above query to:

SELECT sysdate FROM dual;
**SELECT INTO Statement:**

The Microsoft SQL Server and Sybase Adaptive Server SELECT INTO statement can insert rows into a table. This construct, which is part SELECT and part INSERT, is not supported by ANSI. Replace these statements with INSERT...SELECT statements in Oracle.

If the Microsoft SQL Server and Sybase Adaptive Server construct is similar to the following:

```
SELECT col1, col2, col3
INTO target_table
FROM source_table
WHERE where_clause
```

you should convert it to the following for Oracle:

```
INSERT into target_table
SELECT col1, col2, col3
FROM source_table
WHERE where_clause
```

**Subqueries in Place of Columns:**

In Microsoft SQL Server and Sybase Adaptive Server, a SELECT statement may appear anywhere that a column specification appears. Oracle does not support this non-ANSI extension to ANSI SQL. Change the subquery in the SELECT list either by using a DECODE statement or by dividing the query into two different queries.

Use the following sales table as a basis for the examples below:

<table>
<thead>
<tr>
<th>Year</th>
<th>Quantity</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>1</td>
<td>1.3</td>
</tr>
<tr>
<td>1993</td>
<td>2</td>
<td>1.4</td>
</tr>
<tr>
<td>1993</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>1993</td>
<td>4</td>
<td>2.3</td>
</tr>
</tbody>
</table>
Microsoft SQL Server and Sybase Adaptive Server:

If you want to select the year, q1 amount, q2 amount, q3 amount, and q4 as a row, Microsoft SQL Server and Sybase Adaptive Server accept the following query:

```sql
SELECT distinct year,
    q1 = (SELECT amt FROM sales 
        WHERE qtr=1 AND year = s.year),
    q2 = (SELECT amt FROM sales 
        WHERE qtr=2 AND year = s.year),
    q3 = (SELECT amt FROM sales 
        WHERE qtr=3 AND year = s.year),
    q4 = (SELECT amt FROM sales 
        WHERE qtr=4 AND year = s.year)
FROM sales s
```

Oracle:

In this example, replace the SELECT statements with DECODE so that the query functions as normal. The DECODE function is much faster than Microsoft SQL Server and Sybase Adaptive Server subqueries. Translate the above query to the following for Oracle:

```sql
SELECT year,
    DECODE( qtr, 1, amt, 0 ) q1,
    DECODE( qtr, 2, amt, 0 ) q2,
    DECODE( qtr, 3, amt, 0 ) q3,
    DECODE( qtr, 4, amt, 0 ) q4
FROM sales s;
```

If you cannot convert the query using the above method, create views and base the query on the views rather than on the original tables.

For example, consider the following query in Microsoft SQL Server and Sybase Adaptive Server:

```sql
SELECT name,
    sumlength = (SELECT sum(length) FROM syscolumns WHERE id = t.id),
    count_indexes = (SELECT count(*) FROM sysindexes WHERE id = t.id)
FROM sysobjects t
```

This query returns the sum of the lengths of the columns of a table and the number of indexes on that table. This is best handled in Oracle by using some views.

Convert this to the following in Oracle:

```sql
CREATE view V1 ( sumlength, oid ) as

SELECT sum(length), id FROM syscolumns
```

---

Microsoft SQL Server, Sybase Adaptive Server, and Oracle Compared  2-33
GROUP BY id

CREATE view V2 (count_indexes, oid) AS
SELECT count(*), id FROM sysindexes
GROUP BY id

SELECT name, sumlength, count_indexes
FROM sysobjects t, v1, v2
WHERE t.id = v1.oid
AND t.id = v2.oid

Comparing Subqueries to Subqueries:

Microsoft SQL Server and Sybase Adaptive Server also allow a SELECT statement in the WHERE clause. For example, consider the following statement from Microsoft SQL Server and Sybase Adaptive Server:

SELECT empname, deptname
FROM emp, dept
WHERE emp.empno = 100
AND (SELECT security_code
    FROM employee_security
    WHERE empno = emp.empno) =
    (SELECT security_code
    FROM security_master
    WHERE sec_level = dept.sec_level)

Convert this to the ANSI-standard statement below for Oracle:

SELECT empname, deptname
FROM emp, dept
WHERE emp.empno = 100
AND EXISTS (SELECT security_code
            FROM employee_security es
            WHERE es.empno = emp.empno
            AND es.security_code =
            (SELECT security_code
             FROM security_master
             WHERE sec_level =
               dept.sec_level));
Column Aliases:
Convert column aliases from the following Microsoft SQL Server and Sybase Adaptive Server syntax:

```
SELECT employees=col1 FROM table
```

to the following Oracle syntax:

```
SELECT col1 employees FROM table
```

**Note:** Microsoft SQL Server and Sybase Adaptive Server also support Oracle-style column aliases.

Table Aliases:
Remove table aliases (also known as correlation names) unless they are used everywhere.

Compute:
Replace the `COMPUTE` clause with another `SELECT`. Attach the two sets of results using the `UNION` clause.

Outer JOIN Syntax:
Convert the outer `JOIN` syntax from the Microsoft SQL Server and Sybase Adaptive Server syntax to the Oracle syntax.

In addition to these, there are many implications due to the differences in the implementation of the special clauses such as GROUP BY, functions, joins. These are discussed later in this chapter.

**SELECT with GROUP BY Statement**

Table 2–7 compares the `SELECT with GROUP BY` statement in Oracle to the same statement in Microsoft SQL Server and Sybase Adaptive Server.
Data Manipulation Language

### INSERT Statement

The statements illustrated in the following table add one or more rows to the table or view.

<table>
<thead>
<tr>
<th>Table 2–8</th>
<th>INSERT Statement in Oracle and Microsoft SQL Server and Sybase Adaptive Server</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft SQL Server and Sybase Adaptive Server</td>
<td>Oracle</td>
</tr>
<tr>
<td>Syntax:</td>
<td>Syntax:</td>
</tr>
<tr>
<td>INSERT [INTO] [[database.]owner.] [table</td>
<td>INSERT INTO [user.]{table</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description:</th>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTO is optional.</td>
<td>INTO is required.</td>
</tr>
<tr>
<td>Inserts are allowed in a view provided only one of the base tables is undergoing change.</td>
<td>Inserts can only be done on single table views.</td>
</tr>
</tbody>
</table>

### Recommendations:

INSERT statements in Microsoft SQL Server and Sybase Adaptive Server must be changed to include an INTO clause if it is not specified in the original statement.

The values supplied in the VALUES clause in either database may contain functions. The Microsoft SQL Server-specific functions must be replaced with the equivalent Oracle constructs.
Convert inserts that are inserting into multi-table views in Microsoft SQL Server and Sybase Adaptive Server to insert directly into the underlying tables in Oracle.

**UPDATE Statement**

The statement illustrated in the following table updates the data in a table or the data in a table referenced by a view.

<table>
<thead>
<tr>
<th>Table 2–9 UPDATE Statement in Oracle and Microsoft SQL Server and Sybase Adaptive Server</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Microsoft SQL Server</strong></td>
</tr>
<tr>
<td><strong>Syntax:</strong></td>
</tr>
<tr>
<td>UPDATE [{database.}{owner.} {table</td>
</tr>
<tr>
<td>SET [{database.}{owner.} {table</td>
</tr>
<tr>
<td>column = expression</td>
</tr>
</tbody>
</table>
| [, column = expression | NULL | (select_statement)...
| (select_statement)]... | |
| [FROM [{database.}{owner.} {table | view}] | [WHERE {condition | CURRENT OF cursor}]
| [, [{database.}{owner.} {table | view}]... | |
| [WHERE {condition}] | |

**Description:**

The FROM clause is used to get the data from one or more tables into the table that is being updated or to qualify the rows that are being updated.

Updates through multi-table views can modify only columns in one of the underlying tables.

A single subquery may be used to update a set of columns. This subquery must select the same number of columns (with compatible data types) as are used in the list of columns in the SET clause.

The CURRENT OF cursor clause causes the UPDATE statement to effect only the single row currently in the cursor as a result of the last FETCH. The cursor SELECT statement must have included in the FOR UPDATE clause.

Updates can only be done on single table views.
Recommendations:

There are two ways to convert UPDATE statements with FROM clauses as indicated below.

Method 1 - Convert UPDATE statements with FROM clauses:

Use the subquery in the SET clause if columns are being updated to values coming from a different table.

Convert the following in Microsoft SQL Server and Sybase Adaptive Server:

```sql
update titles
SET pub_id = publishers.pub_id
FROM titles, publishers
WHERE titles.title LIKE 'C%'
AND publishers.pub_name = 'new age'
```

to the following in Oracle:

```sql
UPDATE titles
SET pub_id =
(SELECT a.pub_id
FROM publishers a
WHERE publishers.pub_name = 'new age')
WHERE titles.title like 'C%'
```

Method 2 - Convert UPDATE statements with FROM clauses:

Use the subquery in the WHERE clause for all other UPDATE...FROM statements.

Convert the following in Microsoft SQL Server and Sybase Adaptive Server:

```sql
UPDATE shipping_parts
SET qty = 0
FROM shipping_parts sp, suppliers s
WHERE sp.supplier_num = s.supplier_num
AND s.location = "USA"
```

to the following in Oracle:

```sql
UPDATE shipping_parts
SET qty = 0
WHERE supplier_num IN (SELECT supplier_num
FROM suppliers WHERE location = 'USA')
```
DELETE Statement

The statement illustrated in the following table removes rows from tables and rows from tables referenced in views.

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Syntax:</strong></td>
<td></td>
</tr>
<tr>
<td>DELETE [FROM]</td>
<td>DELETE [FROM] [user.][table</td>
</tr>
<tr>
<td>[([database.]owner.][table</td>
<td>view]</td>
</tr>
<tr>
<td>FROM [([database.]owner.][table</td>
<td>view]</td>
</tr>
<tr>
<td>[, [([database.]owner.][table</td>
<td>view])...]</td>
</tr>
<tr>
<td>[WHERE where_clause]</td>
<td></td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td></td>
</tr>
<tr>
<td>The first FROM in DELETE FROM is optional.</td>
<td>FROM is optional.</td>
</tr>
<tr>
<td>The second FROM clause is an SQL Server and Sybase Adaptive Server extension that allows the user to make deletions based on the data in other tables. A subquery in the WHERE clause serves the same purpose.</td>
<td>ALIAS can be specified for the table name as a correlation name, which can be used in the condition. Deletes can only be performed through single table views.</td>
</tr>
</tbody>
</table>

Remove Second FROM Clause:

Remove the second FROM clause from the DELETE statements.

Convert the following Microsoft SQL Server and Sybase Adaptive Server query:

```sql
DELETE
FROM sales
FROM sales, titles
WHERE sales.title_id = titles.title_id
AND titles.type = 'business'
```
to the following in Oracle:

```sql
DELETE
FROM sales
WHERE title_id in
( SELECT title_id
  FROM titles
  WHERE type = 'business'
)
```

Remove the second `FROM` even if the WHERE contains a multi-column JOIN.

Convert the following Microsoft SQL Server and Sybase Adaptive Server query:

```sql
DELETE
FROM sales
FROM sales, table_x
WHERE sales.a = table_x.a
  AND sales.b = table_x.b
  AND table_x.c = 'd'
```

to the following in Oracle:

```sql
DELETE
FROM sales
WHERE ( a, b ) in
( SELECT a, b
  FROM table_x
  WHERE c = 'd'
)
```

### Operators

#### Comparison Operators

The following table compares the operators used in the Microsoft SQL Server and Sybase Adaptive Server, and Oracle databases. Comparison operators are used in WHERE clauses and COLUMN check constraints/rules to compare values.
Table 2–11 Comparison Operators in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Operator</th>
<th>Same in All Three Databases</th>
<th>Microsoft SQL Server and Sybase Adaptive Server Only</th>
<th>Oracle Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equal to</td>
<td>=</td>
<td></td>
<td>^=</td>
</tr>
<tr>
<td>Not equal to</td>
<td>!=</td>
<td></td>
<td>^=</td>
</tr>
<tr>
<td>Less than</td>
<td>&lt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greater than</td>
<td>&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than or equal to</td>
<td>&lt;=</td>
<td></td>
<td>!&gt;</td>
</tr>
<tr>
<td>Greater than or equal to</td>
<td>&gt;=</td>
<td></td>
<td>!&lt;</td>
</tr>
<tr>
<td>Greater than or equal to x and less than or equal to y</td>
<td>BETWEEN x AND y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than x or greater than y</td>
<td>NOT BETWEEN x AND y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pattern Matches</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a followed by 0 or more characters</td>
<td>LIKE 'a%'</td>
<td>LIKE'a[x-z]'</td>
<td>LIKE 'a%'</td>
</tr>
<tr>
<td></td>
<td>LIKE 'a_'</td>
<td>LIKE'a[^x-z]'</td>
<td>ESCAPE ''</td>
</tr>
<tr>
<td>Does not match pattern</td>
<td>NOT LIKE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No value exists</td>
<td>IS NULL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A value exists</td>
<td>IS NOT NULL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At least one row returned by query</td>
<td>EXISTS (query)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No rows returned by query</td>
<td>NOT EXISTS (query)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equal to a member of set</td>
<td>IN</td>
<td></td>
<td>= SOME</td>
</tr>
<tr>
<td></td>
<td>=ANY</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2–11 Comparison Operators in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Operator</th>
<th>Same in All Three Databases</th>
<th>Microsoft SQL Server and Sybase Adaptive Server Only</th>
<th>Oracle Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not equal to a member of set</td>
<td>NOT IN</td>
<td>!= SOME</td>
<td>&lt;&gt;</td>
</tr>
<tr>
<td></td>
<td>!= ANY</td>
<td></td>
<td>SOME</td>
</tr>
<tr>
<td></td>
<td>&lt;&gt; ANY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than a member of set</td>
<td>&lt; ANY</td>
<td>&lt; SOME</td>
<td></td>
</tr>
<tr>
<td>Greater than a member of set</td>
<td>&gt; ANY</td>
<td>&gt; SOME</td>
<td></td>
</tr>
<tr>
<td>Less than or equal to a member of set</td>
<td>&lt;= ANY</td>
<td>&lt;= SOME</td>
<td></td>
</tr>
<tr>
<td>Greater than or equal to a member of set</td>
<td>&gt;= ANY</td>
<td>&gt;= SOME</td>
<td></td>
</tr>
<tr>
<td>Equal to every member of set</td>
<td>= ALL</td>
<td>= ALL</td>
<td></td>
</tr>
<tr>
<td>Not equal to every member of set</td>
<td>!= ALL</td>
<td>!= ALL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;&gt; ALL</td>
<td>&lt;&gt; ALL</td>
<td></td>
</tr>
<tr>
<td>Less than every member of set</td>
<td>&lt; ALL</td>
<td>&lt; ALL</td>
<td></td>
</tr>
<tr>
<td>Greater than every member of set</td>
<td>&gt; ALL</td>
<td>&gt; ALL</td>
<td></td>
</tr>
<tr>
<td>Less than or equal to every member of set</td>
<td>&lt;= ALL</td>
<td>&lt;= ALL</td>
<td></td>
</tr>
<tr>
<td>Greater than or equal to every member of set</td>
<td>&gt;= ALL</td>
<td>&gt;= ALL</td>
<td></td>
</tr>
</tbody>
</table>

Recommendations:

1. Convert all !< and !> to >= and <=
   
   Convert the following in Microsoft SQL Server and Sybase Adaptive Server:
   
   WHERE coll !< 100
   
   to this for Oracle:
   
   WHERE coll >= 100

2. Convert like comparisons which use [ ] and [^]
   
   SELECT title
   FROM titles
   WHERE title like "^[A-F]$"
Method 1 - Eliminating use of [ ]:
Use this method with the SUBSTR () function if possible.

```sql
SELECT title
from titles
where substr (titles,1,1) in
    ('A', 'B', 'C', 'D', 'E', 'F')
```

Method 2 - Eliminating use of [ ]:
The second method uses the % construct.

```sql
SELECT title
FROM titles
WHERE (title like 'A%
    OR  title like 'B%
    OR  title like 'C%
    OR  title like 'D%
    OR  title like 'E%
    OR  title like 'F%')
```

3. Change NULL constructs:
The following table shows that in Oracle, NULL is never equal to NULL. Change the all = NULL constructs to IS NULL to retain the same functionality.

<table>
<thead>
<tr>
<th>NULL Construct</th>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>where col1 = NULL</td>
<td>depends on the data</td>
<td>FALSE</td>
</tr>
<tr>
<td>where col1 != NULL</td>
<td>depends on the data</td>
<td>TRUE</td>
</tr>
<tr>
<td>where col1 IS NULL</td>
<td>depends on the data</td>
<td>depends on the data</td>
</tr>
<tr>
<td>where col1 IS NOT NULL</td>
<td>depends on the data</td>
<td>depends on the data</td>
</tr>
<tr>
<td>where NULL = NULL</td>
<td>TRUE</td>
<td>FALSE</td>
</tr>
</tbody>
</table>

If you have the following in Microsoft SQL Server and Sybase Adaptive Server:
```
WHERE col1 = NULL
```

Convert it as follows for Oracle:

```
WHERE col1 IS NULL
```
WHERE col1 IS NULL

Arithmetic Operators

Table 2–13  Arithmetic Operators in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Operator</th>
<th>Same in All Three Databases</th>
<th>Microsoft SQL Server and Sybase Adaptive Server Only</th>
<th>Oracle Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtract</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiply</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Divide</td>
<td>/</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modulo</td>
<td>%</td>
<td>mod(x, y)</td>
<td></td>
</tr>
</tbody>
</table>

Recommendations:
Replace any Modulo functions in Microsoft SQL Server and Sybase Adaptive Server with the mod() function in Oracle.

String Operators

Table 2–14  String Operators in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Operator</th>
<th>Same in All Three Databases</th>
<th>Microsoft SQL Server and Sybase Adaptive Server Only</th>
<th>Oracle Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concatenate</td>
<td>s</td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Identify Literal</td>
<td>'this is a string'</td>
<td></td>
<td>“this is also a string”</td>
</tr>
</tbody>
</table>

Recommendations:
Replace all addition of strings with the || construct.
Replace all double quotes string identifiers with single quote identifiers.
In Microsoft SQL Server and Sybase Adaptive Server, an empty string ("") is interpreted as a single space in INSERT or assignment statements on VARCHAR data. In concatenating VARCHAR, CHAR, or TEXT data, the empty string is interpreted as a single space. The empty string is never evaluated as NULL. You must bear this in mind when converting the application.

**Set Operators**

<table>
<thead>
<tr>
<th>Operator</th>
<th>Same in All Three Databases</th>
<th>Microsoft SQL Server and Sybase Adaptive Server Only</th>
<th>Oracle Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distinct row from either query</td>
<td>UNION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All rows from both queries</td>
<td>UNION ALL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All distinct rows in both queries</td>
<td>d</td>
<td></td>
<td>INTERSECT</td>
</tr>
<tr>
<td>All distinct rows in the first query but not in the second query</td>
<td>d</td>
<td></td>
<td>MINUS</td>
</tr>
</tbody>
</table>

**Bit Operators**

<table>
<thead>
<tr>
<th>Operator</th>
<th>Same in All Three Databases</th>
<th>Microsoft SQL Server and Sybase Adaptive Server Only</th>
<th>Oracle Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>bit and</td>
<td>&amp;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bit or</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bit exclusive or</td>
<td>^</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bit not</td>
<td>~</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Recommendations:**

Oracle enables you to write the procedures to perform bitwise operations.
If you have the following Microsoft SQL Server and Sybase Adaptive Server construct:

\[ X \mid Y : (\text{Bitwise OR}) \]

You could write a procedure called `dbms_bits.or (x,y)` and convert the above construct to the following in Oracle:

`dbms_bits.or(x,y)`

### Built-In Functions

#### Character Functions

<table>
<thead>
<tr>
<th><code>Microsoft SQL Server and Sybase Adaptive Server</code></th>
<th><code>Oracle</code></th>
<th><code>Description</code></th>
</tr>
</thead>
<tbody>
<tr>
<td><code>ascii(char)</code></td>
<td><code>ascii(char)</code></td>
<td>Returns the ASCII equivalent of the character.</td>
</tr>
<tr>
<td><code>char(integer_expression)</code></td>
<td><code>chr(integer_expression)</code></td>
<td>Converts the decimal code for an ASCII character to the corresponding character.</td>
</tr>
<tr>
<td><code>charindex(specified_exp, char_string)</code></td>
<td><code>instr(specified_exp, char_string, 1, 1)</code></td>
<td>Returns the position where the specified_exp first occurs in the char_string.</td>
</tr>
<tr>
<td><code>convert(data type, expression, [format])</code></td>
<td><code>to_char, to_number, to_date, to_label, chartorowid, rowtochar, hextochar, chartohex</code></td>
<td>Converts one data type to another using the optional format. The majority of the functionality can be matched. Refer to Oracle9i SQL Reference, Release 1 (9.0.1) for more information.</td>
</tr>
<tr>
<td><code>datalength(expression)</code></td>
<td><code>g</code></td>
<td>Computes the length allocated to an expression, giving the result in bytes.</td>
</tr>
<tr>
<td><code>difference(character_exp, character_exp)</code></td>
<td><code>d</code></td>
<td>Returns the numeric difference of the SOUNDEX values of the two strings.</td>
</tr>
<tr>
<td><code>isnull(variable, new_value)</code></td>
<td><code>nvl(variable, new_value)</code></td>
<td>If the value of the variable is NULL, the new_value is returned.</td>
</tr>
<tr>
<td><strong>Microsoft SQL Server and Sybase Adaptive Server</strong></td>
<td><strong>Oracle</strong></td>
<td><strong>Description</strong></td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>------------</td>
<td>-----------------</td>
</tr>
<tr>
<td><code>lower(char_exp)</code></td>
<td><code>lower(char_exp)</code></td>
<td>Converts uppercase characters to lowercase characters.</td>
</tr>
<tr>
<td><code>ltrim(char_exp)</code></td>
<td><code>ltrim(char_exp)</code></td>
<td>Truncates trailing spaces from the left end of <code>char_exp</code>.</td>
</tr>
<tr>
<td><code>patindex(pattern, column_name)</code></td>
<td><code>column_name</code></td>
<td>Returns the position of the pattern in the column value. The pattern can have wild characters. This function also works on TEXT and BINARY data types.</td>
</tr>
<tr>
<td><code>replicate(char_exp, n)</code></td>
<td><code>rpad(char_exp, length(char_exp)*n, '')</code></td>
<td>Produces a string with <code>char_exp</code> repeated <code>n</code> times.</td>
</tr>
<tr>
<td><code>reverse(char_string)</code></td>
<td></td>
<td>Reverses the given <code>char_string</code>.</td>
</tr>
<tr>
<td><code>right(char_exp, n)</code></td>
<td><code>substr(char_exp, (length(char_exp)-n), length(char_exp))</code></td>
<td>Returns the part of the string starting at the position given by <code>n</code> from the right and extending up to the end of the string.</td>
</tr>
<tr>
<td><code>rtrim(char_exp)</code></td>
<td><code>rtrim(char_exp)</code></td>
<td>Truncates the trailing spaces from the right end of <code>char_exp</code>.</td>
</tr>
<tr>
<td><code>soundex(exp)</code></td>
<td><code>soundex(exp)</code></td>
<td>Returns phonetically similar expressions to the specified exp.</td>
</tr>
<tr>
<td><code>space(int_exp)</code></td>
<td><code>rpad(' ', int_exp-1, '')</code></td>
<td>Generates a string with <code>int_exp</code> spaces.</td>
</tr>
<tr>
<td><code>str(float_exp, length)</code></td>
<td>`to_char(float_exp)stuff(char_exp, start, length, replace_str)substr(char_exp, 1, start)</td>
<td></td>
</tr>
</tbody>
</table>
### Table 2–17  Character Functions in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>substring(char_exp, start, length)</td>
<td>substr(char_exp, start, length)</td>
<td>Replaces a substring within char_exp with replace_str.</td>
</tr>
<tr>
<td>Works on IMAGE and TEXT data types</td>
<td>Does not work with LONG and LONG_RAW data types</td>
<td></td>
</tr>
<tr>
<td>textptr(column_name)</td>
<td>d</td>
<td>Returns a pointer as a varbinary(16) data type for a named IMAGE or TEXT column.</td>
</tr>
<tr>
<td>textvalid(&quot;column_name&quot;, text_pointer)</td>
<td>h</td>
<td>Returns 1 if the specified text_pointer is valid for the specified column_name. The column must be of type TEXT or IMAGE.</td>
</tr>
<tr>
<td>upper(char_exp)</td>
<td>upper(char_exp)</td>
<td>Converts lowercase characters to uppercase characters.</td>
</tr>
</tbody>
</table>

### Miscellaneous Functions

### Table 2–18  Comparison Operators in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>datalength(expression)</td>
<td>lengthb</td>
<td>Computes the length allocated to an expression, giving the result in bytes.</td>
</tr>
<tr>
<td>isnull(variable, new_value)</td>
<td>nvl(variable, new_value)</td>
<td>If the value of the variable is NULL, the new_value is returned.</td>
</tr>
</tbody>
</table>

**Note:** The above functions tables list all the Microsoft SQL Server and Sybase Adaptive Server character manipulation functions. They do not list all the Oracle functions. There are many more Oracle character manipulation functions that you can use.
Defining Functions in Oracle:

Oracle adds the ability to define functions. With this feature you can create Oracle functions that match the name and function of Microsoft SQL Server and Sybase Adaptive Server functions.

Date Functions

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>dateadd/dd, int_exp,datetime_var</td>
<td>date+int_exp</td>
<td>Adds the int_exp number of days to the date contained in datetime_var.</td>
</tr>
<tr>
<td></td>
<td>requires conversion of int_exp to a number of days</td>
<td></td>
</tr>
<tr>
<td>dateadd/mm, int_exp,datetime_var</td>
<td>add_months(date, int_exp) or date+int_exp requires conversion of int_exp to a number of days</td>
<td>Adds the int_exp number of months to the date contained in datetime_var.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>dateadd/yy, int_exp,datetime_var</td>
<td>date+int_exp</td>
<td>Adds the int_exp number of years to the date contained in datetime_var.</td>
</tr>
<tr>
<td></td>
<td>requires conversion of int_exp to a number of days</td>
<td></td>
</tr>
<tr>
<td>datediff/dd, datetime1,datetime2</td>
<td>date2-date1</td>
<td>Returns the difference between the dates specified by the datetime1 and datetime2 variables. This difference is calculated in the number of days.</td>
</tr>
<tr>
<td>datediff/mm, datetime1,datetime2</td>
<td>months_between (date2, date1)</td>
<td>Returns the difference between the dates specified by the datetime1 and datetime2 variables. This difference is calculated in the number of months.</td>
</tr>
<tr>
<td>datediff/yy, datetime1,datetime2</td>
<td>(date2-date1) /365.254</td>
<td>Returns the difference between the dates specified by the datetime1 and datetime2 variables. This difference is calculated in the number of years.</td>
</tr>
</tbody>
</table>
Data Manipulation Language

Table 2–19  Date Functions in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>datename (datepart, date)</td>
<td>to_char(date, format)</td>
<td>Returns the specified part of the date as an integer. The Microsoft SQL Server and Sybase Adaptive Server DATETIME has a higher precision than Oracle DATE. For this reason, it is not always possible to find an equivalent format string in Oracle to match the datepart in Microsoft SQL Server and Sybase Adaptive Server. See the Data Types section of this chapter for more information about conversion of the DATETIME data type.</td>
</tr>
<tr>
<td>datepart(datepart, date)</td>
<td>to_char(date, format)</td>
<td>Returns the specified part of the date as a character string (name). The Microsoft SQL Server and Sybase Adaptive Server DATETIME has a higher precision than Oracle DATE. For this reason, it is not always possible to find an equivalent format string in Oracle to match the datepart in Microsoft SQL Server and Sybase Adaptive Server.</td>
</tr>
<tr>
<td>getdate()</td>
<td>sysdate</td>
<td>Returns the system date.</td>
</tr>
</tbody>
</table>

Recommendations:

The above table lists all the Microsoft SQL Server and Sybase Adaptive Server date manipulation functions. It does not list all the Oracle date functions. There are many more Oracle date manipulation functions that you can use.

It is recommended that you convert most date manipulation functions to "+" or "-" in Oracle.

Oracle adds the ability to define functions. With this feature you can create Oracle functions that match the name and functionality of all Microsoft SQL Server and Sybase Adaptive Server functions. This is a useful feature, where users can call a PL/SQL function from a SQL statement’s SELECT LIST, WHERE clause, ORDER BY clause, and HAVING clause. With the parallel query option, Oracle executes the PL/SQL function in parallel with the SQL statement. Hence, users create parallel logic.
# Mathematical Functions

## Table 2–20  Mathematical Functions in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Mathematical Functions</th>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>abs(n)</td>
<td>abs(n)</td>
<td></td>
</tr>
<tr>
<td>acos(n)</td>
<td>acos(n)</td>
<td></td>
</tr>
<tr>
<td>asin(n)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>atan(n)</td>
<td>atan(n)</td>
<td></td>
</tr>
<tr>
<td>atn2(n,m)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ceiling(n)</td>
<td>ceil(n)</td>
<td></td>
</tr>
<tr>
<td>cos(n)</td>
<td>cos(n)</td>
<td></td>
</tr>
<tr>
<td>cot(n)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>degrees(n)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>exp(n)</td>
<td>exp(n)</td>
<td></td>
</tr>
<tr>
<td>floor(n)</td>
<td>floor(n)</td>
<td></td>
</tr>
<tr>
<td>log(n)</td>
<td>ln(n)</td>
<td></td>
</tr>
<tr>
<td>log10(n)</td>
<td>log(base,number)</td>
<td></td>
</tr>
<tr>
<td>pi()</td>
<td></td>
<td></td>
</tr>
<tr>
<td>power(m,n)</td>
<td>power(m,n)</td>
<td></td>
</tr>
<tr>
<td>radians(n)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rand(n)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>round(n[,m])</td>
<td>round(n[,m])</td>
<td></td>
</tr>
<tr>
<td>sign(n)</td>
<td>sign(n)</td>
<td></td>
</tr>
<tr>
<td>sin(n)</td>
<td>sin(n)</td>
<td></td>
</tr>
<tr>
<td>sqrt(n)</td>
<td>sqrt(n)</td>
<td></td>
</tr>
<tr>
<td>tan(n)</td>
<td>tan(n)</td>
<td></td>
</tr>
</tbody>
</table>

**Recommendations:**
The above table lists all the Microsoft SQL Server and Sybase Adaptive Server number manipulation functions. It does not list all the Oracle mathematical functions. There are many more Oracle number manipulation functions that you can use.

Oracle adds the ability to define functions. With this feature you can create Oracle functions that match the name and functionality of all Microsoft SQL Server and Sybase Adaptive Server functions. This is the most flexible approach. Users can write their own functions and execute them seamlessly from a SQL statement.

Oracle functions listed in the table work in SQL as well as PL/SQL.

**Locking Concepts and Data Concurrency Issues**

**Locking**

Locking serves as a control mechanism for concurrency. Locking is a necessity in a multi-user environment because more than one user at a time may be working with the same data.
Table 2–21 Locking in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th><strong>Microsoft SQL Server and Sybase Adaptive Server</strong></th>
<th><strong>Oracle</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft SQL Server and Sybase Adaptive Server locking is fully automatic and does not require intervention by users.</td>
<td>Oracle locking is fully automatic and does not require intervention by users. Oracle features the following categories of locks:</td>
</tr>
<tr>
<td>Microsoft SQL Server and Sybase Adaptive Server apply exclusive locks for INSERT, UPDATE, and DELETE operations. When an exclusive lock is set, no other transaction can obtain any type of lock on those objects until the original lock is in place. For non-update or read operations, a shared lock is applied. If a shared lock is applied to a table or a page, other transactions can also obtain a shared lock on that table or page. However, no transaction can obtain an exclusive lock. Therefore, Microsoft SQL Server and Sybase Adaptive Server reads block the modifications to the data.</td>
<td>Data locks (DML locks) to protect data. The &quot;table locks&quot; lock the entire table and &quot;row locks&quot; lock individual rows.</td>
</tr>
<tr>
<td>Update locks: Update locks are held at the page level. They are placed during the initial stages of an update operation when the pages are being read. Update locks can co-exist with shared locks. If the pages are changed later, the update locks are escalated to exclusive locks.</td>
<td>Dictionary locks (DDL locks) to protect the structure of objects.</td>
</tr>
<tr>
<td></td>
<td>Internal locks to protect internal structures, such as files.</td>
</tr>
<tr>
<td></td>
<td>DML operations can acquire data locks at two different levels; one for specific rows and one for entire tables.</td>
</tr>
<tr>
<td></td>
<td>Row-level locks: An exclusive lock is acquired for an individual row on behalf of a transaction when the row is modified by a DML statement. If a transaction obtains a row level lock, it also acquires a table (dictionary) lock for the corresponding table. This prevents conflicting DDL (DROP TABLE, ALTER TABLE) operations that would override data modifications in an on-going transaction.</td>
</tr>
</tbody>
</table>
Table 2–21  Locking in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Intent locks:</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intent locks:</td>
<td>Table-level data locks can be held in any of the following modes:</td>
</tr>
<tr>
<td>Microsoft SQL Server and Sybase Adaptive Server locking is fully automatic and does not require intervention by users. Microsoft SQL Server and Sybase Adaptive Server apply exclusive locks for INSERT, UPDATE, and DELETE operations. When an exclusive lock is set, no other transaction can obtain any type of lock on those objects until the original lock is in place. For non-update or read operations, a shared lock is applied. If a shared lock is applied to a table or a page, other transactions can also obtain a shared lock on that table or page. However, no transaction can obtain an exclusive lock. Therefore, Microsoft SQL Server and Sybase Adaptive Server reads block the modifications to the data.</td>
<td>Row share table lock (RW):</td>
</tr>
<tr>
<td>Extent locks:</td>
<td>This indicates that the transaction holding the lock on the table has locked rows in the table and intends to update them. This prevents other transactions from obtaining exclusive write access to the same table by using the LOCK TABLE table IN EXCLUSIVE MODE statement. Apart from that, all the queries, inserts, deletes, and updates are allowed in that table.</td>
</tr>
<tr>
<td>Extent locks lock a group of eight database pages while they are being allocated or freed. These locks are held during a CREATE or DROP statement, or during an INSERT that requires new data or index pages.</td>
<td>Row exclusive table lock (RX):</td>
</tr>
<tr>
<td>A list of active locks for the current server can be seen with the SP_LOCK system procedure.</td>
<td>This generally indicates that the transaction holding the lock has made one or more updates to the rows in the table. Queries, inserts, deletes, updates are allowed in that table.</td>
</tr>
<tr>
<td>Table 2–21  Locking in Oracle and Microsoft SQL Server and Sybase Adaptive Server</td>
<td>Share lock (SL):</td>
</tr>
<tr>
<td>Microsoft SQL Server and Sybase Adaptive Server locking is fully automatic and does not require intervention by users. Microsoft SQL Server and Sybase Adaptive Server apply exclusive locks for INSERT, UPDATE, and DELETE operations. When an exclusive lock is set, no other transaction can obtain any type of lock on those objects until the original lock is in place. For non-update or read operations, a shared lock is applied. If a shared lock is applied to a table or a page, other transactions can also obtain a shared lock on that table or page. However, no transaction can obtain an exclusive lock. Therefore, Microsoft SQL Server and Sybase Adaptive Server reads block the modifications to the data.</td>
<td>Share row exclusive lock(SRX)</td>
</tr>
<tr>
<td>Extent locks:</td>
<td>Exclusive lock (X):</td>
</tr>
<tr>
<td>Extent locks lock a group of eight database pages while they are being allocated or freed. These locks are held during a CREATE or DROP statement, or during an INSERT that requires new data or index pages.</td>
<td>The dynamic performance table V$LOCK keeps the information about locks.</td>
</tr>
<tr>
<td>A list of active locks for the current server can be seen with the SP_LOCK system procedure.</td>
<td></td>
</tr>
</tbody>
</table>

Recommendations:

In Microsoft SQL Server and Sybase Adaptive Server, SELECT statements obtain shared locks on pages/rows. This prevents other statements from obtaining an exclusive lock on those pages/rows. All statements that update the data need an exclusive lock. This means that the SELECT statement in Microsoft SQL Server and Sybase Adaptive Server blocks the UPDATE statements as long as the transaction that includes the SELECT statement does not commit or rollback. This also means that two transactions are physically serialized whenever one transaction selects the data and the other transaction wants to change the data first and then select the data again. In Oracle, however, SELECT statements do not block UPDATE statements,
since the rollback segments are used to store the changed data before it is updated in the actual tables. Also, the reader of the data is never blocked in Oracle. This allows Oracle transactions to be executed simultaneously.

If Microsoft SQL Server and Sybase Adaptive Server logical transactions are automatically translated to Oracle logical transactions, the transactions explained above that execute properly in Microsoft SQL Server and Sybase Adaptive Server as they are serialized causes a deadlock in Oracle. These transactions should be identified and serialized to avoid the deadlock. These transactions are serialized in Microsoft SQL Server and Sybase Adaptive Server as INSERT, UPDATE, and DELETE statements block other statements.

**Row-Level Versus Page-Level Locking**

**Table 2–22  Row-Level Versus Page-Level Locking in Oracle and Microsoft SQL Server and Sybase Adaptive Server**

<table>
<thead>
<tr>
<th><strong>Microsoft SQL Server and Sybase Adaptive Server</strong></th>
<th><strong>Oracle</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft SQL Server and Sybase Adaptive Server do not have a row-level locking feature.</td>
<td>Oracle has a row-locking feature. Only one row is locked when a DML statement is changing the row.</td>
</tr>
<tr>
<td>Microsoft SQL Server and Sybase Adaptive Server apply a page-level lock, which effectively locks all rows on the page, whenever any row in the page is being updated. This is an exclusive lock whenever the data is being changed by DML statements.</td>
<td></td>
</tr>
<tr>
<td>Microsoft SQL Server 7.0 implements a form of row-level locking.</td>
<td></td>
</tr>
<tr>
<td>Microsoft SQL Server 7.0 escalates locks at row level to page level automatically.</td>
<td></td>
</tr>
<tr>
<td>SELECT statements are blocked by exclusive locks that lock an entire page.</td>
<td></td>
</tr>
</tbody>
</table>
Recommendations:

No changes are required to take advantage of the row-level locking feature of Oracle.

Read Consistency

Table 2–23 Read Consistency in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft SQL Server and Sybase Adaptive Server provide the HOLDLOCK function for transaction-level read consistency. Specifying a SELECT with HOLDLOCK puts a shared lock on the data. More than one user can execute a SELECT with HOLDLOCK at the same time without blocking each other. When one of the users tries to update the selected data, HOLDLOCK blocks the update until the other users commit, rollback, or attempt an update and a deadlock occurs. This means that HOLDLOCK prevents other transactions from updating the same data until the current transaction is in effect.</td>
<td>Read consistency as supported by Oracle does the following:</td>
</tr>
<tr>
<td>■ Ensures that the set of data seen by a statement is consistent at a single point-in-time and does not change during statement execution</td>
<td></td>
</tr>
<tr>
<td>■ Ensures that reads of database data do not wait for other reads or writes of the same data</td>
<td></td>
</tr>
<tr>
<td>■ Ensures that writes of database data do not wait for reads of the same data</td>
<td></td>
</tr>
<tr>
<td>■ Ensures that writes wait for other writes only if they attempt to update identical rows in concurrent transactions</td>
<td></td>
</tr>
<tr>
<td>To provide read consistency, Oracle creates a read-consistent set of data when a table is being read and simultaneously updated. Read consistency functions as follows:</td>
<td></td>
</tr>
<tr>
<td>1. When an update occurs, the original data values changed by the update are recorded in rollback segments.</td>
<td></td>
</tr>
<tr>
<td>2. While the update remains part of an uncommitted transaction, any user that reads the modified data views the original data values. Only statements that start after another user’s transaction is committed reflect the changes made by the transaction.</td>
<td></td>
</tr>
<tr>
<td>You can specify that a transaction be read only using the following command:</td>
<td></td>
</tr>
<tr>
<td>SET TRANSACTION READ ONLY</td>
<td></td>
</tr>
</tbody>
</table>
Logical Transaction Handling

Table 2–24  Logical Transaction Handling in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>After completion, any statement not within a transaction is automatically committed. A statement can be a batch containing multiple T-SQL statements that are sent to the server as one stream. The changes to the database are automatically committed after the batch executes. A ROLLBACK TRAN statement subsequently executed has no effect. In Microsoft SQL Server and Sybase Adaptive Server, transactions are not implicit. Start logical transaction with a BEGIN TRANSACTION clause. Logical transactions can be committed or rolled back as follows.</td>
<td></td>
</tr>
<tr>
<td>BEGIN TRANSACTION [transaction_name] Use COMMIT TRAN to commit the transaction to the database. You have the option to specify the transaction name. Use ROLLBACK TRAN to roll back the transaction. You can set savepoints to roll back to a certain point in the logical transaction using the following command: SAVE TRANSACTION savepoint_name Roll back to the specified SAVEPOINT with the following command: ROLLBACK TRAN &lt;savepoint_name&gt;</td>
<td></td>
</tr>
<tr>
<td>Statements are not automatically committed to the database. The COMMIT WORK statement is required to commit the pending changes to the database. Oracle transactions are implicit. This means that the logical transaction starts as soon as data changes in the database. COMMIT WORK commits the pending changes to the database. ROLLBACK undoes all the transactions after the last COMMIT WORK statement. Savepoints can be set in transactions with the following command: SET SAVEPOINT savepoint_name The following command rolls back to the specified SAVEPOINT: ROLLBACK &lt;savepoint_name&gt; Two-phase commit is automatic and transparent in Oracle. Two-phase commit operations are needed only for transactions which modify data on two or more databases.</td>
<td></td>
</tr>
</tbody>
</table>
Table 2–24 Logical Transaction Handling in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft SQL Server and Sybase Adaptive Server allow you to nest BEGIN TRAN/COMMIT TRAN statements. When nested, the outermost pair of transactions creates and commits the transaction. The inner pairs keep track of the nesting levels. A ROLLBACK command in the nested transactions rolls back to the outermost BEGIN TRAN level, if it does not include the name of the SAVEPOINT. Most Microsoft SQL Server and Sybase Adaptive Server applications require two-phase commit, even on a single server. To see if the server is prepared to commit the transaction, use PREPARE TRAN in two-phase commit applications. Completed transactions are written to the database device at CHECKPOINT. A CHECKPOINT writes all dirty pages to the disk devices since the last checkpoint. Calls to remote procedures are executed independently of any transaction in which they are included.</td>
<td>When a CHECKPOINT occurs, the completed transactions are written to the database device. A CHECKPOINT writes all dirty pages to the disk devices that have been modified since last checkpoint.</td>
</tr>
</tbody>
</table>

Recommendations:

Transactions are not implicit in Microsoft SQL Server and Sybase Adaptive Server. Therefore, applications expect that every statement they issue is automatically committed it is executed.

Oracle transactions are always implicit, which means that individual statements are not committed automatically. When converting an Microsoft SQL Server and Sybase Adaptive Server application to an Oracle application, care needs to be taken to determine what constitutes a transaction in that application. In general, a COMMIT work statement needs to be issued after every "batch" of statements, single statement, or stored procedure call to replicate the behavior of Microsoft SQL Server and Sybase Adaptive Server for the application.
In Microsoft SQL Server and Sybase Adaptive Server, transactions may also be explicitly begun by a client application by issuing a BEGIN TRAN statement during the conversion process.
This chapter includes the following sections:

- **Introduction**
- **Data Types**
- **Schema Objects**
- **T/SQL Versus PL/SQL Constructs**
- **T/SQL and PL/SQL Language Elements**

### Introduction

Microsoft SQL Server and Sybase Adaptive Server store triggers and stored procedures with the server. Oracle stores triggers and stored subprograms with the server. Oracle has three different kinds of stored subprograms, namely functions, stored procedures, and packages. For detailed discussion on all these objects, see the *PL/SQL User’s Guide and Reference, Release 1 (9.0.1).*

The following topics are discussed in this section:

- **Triggers**
- **Stored Procedures**

### Triggers

Microsoft SQL Server and Sybase Adaptive Server database triggers are AFTER triggers. This means that triggers are fired after the specific operation is performed. For example, the INSERT trigger fires after the rows are inserted into the database. If the trigger fails, the operation is rolled back.
Microsoft SQL Server and Sybase Adaptive Server allow INSERT, UPDATE, and DELETE triggers. Triggers typically need access to the before image and after image of the data that is being changed. Microsoft SQL Server and Sybase Adaptive Server achieve this with two temporary tables called INSERTED and DELETED. These two tables exist during the execution of the trigger. These tables and the table for which the trigger is written have the exact same structure. The DELETED table holds the before image of the rows that are undergoing change because of the INSERT/UPDATE/DELETE operation, and the INSERTED table holds the after image of these rows. If there is an error, the triggers can issue a rollback statement.

Most of the Microsoft SQL Server and Sybase Adaptive Server trigger code is written to enforce referential integrity. Microsoft SQL Server and Sybase Adaptive Server triggers are executed once per triggering SQL statement (such as INSERT, UPDATE, or DELETE). If you want some actions to be performed for each row that the SQL statement affects, you must code the actions using the INSERTED and DELETED tables.

Oracle has a rich set of triggers. Oracle also provides triggers that fire for events such as INSERT, UPDATE, and DELETE. You can also specify the number of times that the trigger action is to be executed. For example, once for every row affected by the triggering event (such as might be fired by an UPDATE statement that updates many rows), or once for the triggering statement (regardless of how many rows it affects).

A ROW trigger is fired each time that the table is affected by the triggering event. For example, if an UPDATE statement updates multiple rows of a table, a row trigger is fired once for each row affected by the UPDATE statement. A STATEMENT trigger is fired once on behalf of the triggering statement, regardless of the number of rows in the table that the triggering statement affects.

Oracle triggers can be defined as either BEFORE triggers or AFTER triggers. BEFORE triggers are used when the trigger action should determine whether the triggering statement should be allowed to complete. By using a BEFORE trigger, you can avoid unnecessary processing of the triggering statement and its eventual rollback in cases where an exception is raised.

As combinations, there are four different types of triggers in Oracle:

- BEFORE STATEMENT trigger
- BEFORE ROW trigger
- AFTER STATEMENT trigger
- AFTER ROW trigger
It is sometimes necessary to create a ROW trigger or a STATEMENT trigger to achieve the same functionality as the Microsoft SQL Server and Sybase Adaptive Server trigger. This occurs in the following cases:

- The triggering code reads from its own table (mutating).
- The triggering code contains group functions.

In the following example, the group function AVG is used to calculate the average salary:

```sql
SELECT AVG(inserted.salary)
FROM inserted a, deleted b
WHERE a.id = b.id;
```

This would be converted to Oracle by creating an AFTER ROW trigger to insert all the updated values into a package, and an AFTER STATEMENT trigger to read from the package and calculate the average.

For examples of Oracle triggers, see the Oracle9i Application Developer’s Guide - Fundamentals, Release 1 (9.0.1).

**Stored Procedures**

Stored procedures provide a powerful way to code the application logic that can be stored with the server. Microsoft SQL Server and Sybase Adaptive Server and Oracle all provide stored procedures.

The language used to code these objects is a database-specific procedural extension to SQL. In Oracle it is PL/SQL and in Microsoft SQL Server and Sybase Adaptive Server it is Transact SQL (T/SQL). These languages differ to a considerable extent. The individual SQL statements and the procedural constructs, such as if-then-else, are similar in both versions of the procedural SQL. Considerable differences can be found in the following areas discussed in this section:

- Methods Used to Send Data to Clients
- Individual SQL Statements
- Logical Transaction Handling
- Error Handling within the Stored Procedure

This section also considers various components of typical Microsoft SQL Server and Sybase Adaptive Server stored procedures and suggests ways to design them in order to avoid conversion problems. By applying the standards described below to
the coding, you can convert your stored procedures from Microsoft SQL Server and Sybase Adaptive Server to Oracle.

**Methods Used to Send Data to Clients**

Different relational database management systems (RDBMSs) use different methods to send data to clients. For example, in Microsoft SQL Server and Sybase Adaptive Server the server sends data to the client in the form of a byte-stream. The client is responsible for retrieving all the data from the communication channel before sending another request to the server. In Oracle, the client can issue one or more SQL statements on the same network connection, and the system global area (SGA) stores all the data retrieved from the database. The server sends the data to the client as requested and the client sends a FETCH request on the connection whenever it is ready for the next set of results. This section discusses the different methods used to send data to clients under the following headings:

- **Output Variables**
- **Results Sets: Microsoft SQL Server and Sybase Adaptive Server Method of Sending Data to the Client**
- **Oracle: Cursor Variables for Returning Query Results**
- **Microsoft SQL Server and Sybase Adaptive Server: Multiple Results Sets**
- **Microsoft SQL Server and Sybase Adaptive Server: Cursors**

**Output Variables**

Microsoft SQL Server and Sybase Adaptive Server and Oracle can all send data to clients by means of output variables.

**Results Sets: Microsoft SQL Server and Sybase Adaptive Server Method of Sending Data to the Client**

Many Microsoft SQL Server and Sybase Adaptive Server applications rely on the SQL Server-specific stream-based data return method called "result sets". Oracle is optimized to return data more efficiently when the data is requested using an ANSI-standard SQL SELECT statement, as compared to any proprietary stored procedure method. Therefore, the best design decision is to use stored procedures for data processing and SELECT statements for queries.

In Oracle, the use of cursor variables allows client programs to retrieve well-structured result sets.
To send even a single row back to the client from the stored procedure, Microsoft SQL Server and Sybase Adaptive Server can use result sets instead of an ANSI-standard method.

For example:

```sql
CREATE PROCEDURE get_emp_rec @empid INT
AS
    SELECT fname, lname, loginid, addr, title, dept, mgrid
    FROM employee
    WHERE empid = @empid

The above procedure can be converted to an Oracle PL/SQL procedure as follows:

```sql
CREATE OR REPLACE PROCEDURE get_emp_rec
    (empid IN NUMBER,
     fname OUT VARCHAR2,
     lname OUT VARCHAR2,
     loginid OUT VARCHAR2,
     addr OUT VARCHAR2,
     title OUT VARCHAR2,
     dept OUT NUMBER,
     mgrid OUT NUMBER)
AS
    BEGIN
        SELECT fname, lname, loginid, addr, title, dept, mgrid
        INTO fname, lname, loginid, addr, title, dept, mgrid
        FROM employee
        WHERE empid = empid;
END;
```

Output variables are a structured way of sending data from server to client. Output variables allow the caller to see the results in a predictable manner, as the structure of the output variable is predefined. This method also allows encapsulation of behavior of the called routine.

Output variables offer the following benefits:

- Facilitate better structuring of code
- Allow the caller to see the results in a structured and predictable way, as the structure of the output variables is well defined
- Allow encapsulation of behavior of the called routine

If a third-party user interface product uses the result set capability of Microsoft SQL Server and Sybase Adaptive Server, make sure that the same functionality can be
made available to the Oracle database. For example, PowerBuilder can use result sets to populate the data windows.

Although many client programs, such as Oracle Call Interface (OCI), precompilers, SQL*Module, and SQL*Plus, recognize cursor variables, most Open Database Connectivity (ODBC) drivers cannot recognize cursor variables. One solution when using ODBC drivers is to identify the code that produces the result set, and move this code online in the client program. The Oracle9i and Oracle8i ODBC Driver release 8.1.5.4.0 and later releases support result sets.

In the following example, an Microsoft SQL Server and Sybase Adaptive Server stored procedure returns a result set with multiple rows:

```
CREATE PROCEDURE make_loginid
BEGIN
  update employee
  set loginid = substring(fname,1,1) + convert(varchar(7),empid)
  select fname, lname, loginid from employee
END
```

This procedure sends all the qualifying rows to the client as a continuous data stream. To further process the rows, the client program must retrieve the rows one after another from the communication channel.

The following piece of the DB-Library/C code executes the above procedure and prints each row to the screen.

```
main()
{
  /* Data structure dbproc is conceptually very similar
to CDA data structure used in Oracle's OCI/C programs */
dbcmd(dbproc, "exec make_loginid");
/* This command sets the command buffer with the
transact-sql command that needs to be executed. */
dbsqlexec(dbproc);
/* This command causes the parsing and execution of the
SQL command on the server side. */
dbresults(dbproc);
/* This command puts the result rows onto the
communications channel. */
/*The following while loop retrieves the result rows one after the other
by calling the function dbnextrow repeatedly. This */
```
implementation is cursor implementation through DB-Library functions.

```c
while (dbnextrow(dbproc) != NO_MORE_ROWS)
{
    dbprrow(dbproc);
    /* This function prints the retrieved row to the standard output.
    */
}
```

You can migrate Microsoft SQL Server and Sybase Adaptive Server stored procedures to the Oracle PL/SQL stored procedures or packages in different ways, as follows:

1. Place the final SELECT statement, which should return the result rows, in the client program. The Oracle client can fetch the result rows from the server as a multi-row array, and the entire process is very efficient.

2. Make use of PL/SQL tables. The SELECT statement in this case is part of the stored procedure code and the columns in the result rows are stored in PL/SQL tables. These tables are available to the client program as output variables from the stored procedures.

3. This method is the default method used by the Migration Workbench. This method is applicable only when it is extremely necessary to simulate the looping mechanism of the Microsoft SQL Server and Sybase Adaptive Server client to retrieve the result rows. This process is not recommended in Oracle because for each row that has to be retrieved, a FETCH request must be sent to the server from the client, thus creating more network traffic. In this case, an Microsoft SQL Server and Sybase Adaptive Server stored procedure is converted to a package and a member procedure. A cursor is defined with the package body; this cursor is equivalent to the SELECT statement associated with the result set. The first call to the procedure opens the cursor. Subsequent calls fetch and send the next row back to the client in the form of output parameters. Once the last row has been fetched, the cursor is closed.

Examples of these different Oracle solutions to the result set problem are presented below:

1. If the SELECT statement is made part of the client code, the PL/SQL code for the `make_loginid` procedure is as follows:

   ```sql
   CREATE OR REPLACE PROCEDURE make_loginid
   AS
   BEGIN
   ```
update employee
set loginid = substr(lname,1,1)
  ||
  substr(to_char(empid),1,7);
END;

The following SELECT statement becomes part of the client code:

select fname, lname, loginid from employee

The following PL/SQL code shows how to migrate the make_loginid
procedure to Oracle by using PL/SQL tables as output parameters:

CREATE OR REPLACE PACKAGE make_loginid_pkg
IS
BEGIN

  DECLARE EmpFnameTabType IS TABLE OF
    employee.fname %TYPE
    INDEX BY BINARY_INTEGER;
  DECLARE EmpLnameTabType IS TABLE OF
    employee.lname %TYPE
    INDEX BY BINARY_INTEGER;
  DECLARE EmpLoginidTabType IS TABLE OF
    employee.loginid %TYPE
    INDEX BY BINARY_INTEGER;

  emp_fname_tab   EmpFnameTabType;
  emp_lname_tab   EmpLnameTabType;
  emp_loginid_tab EmpLoginidTabType;

  PROCEDURE make_loginid
    (emp_fname_tab  OUT     EmpFnameTabType,
     emp_lname_tab  OUT     EmpLnameTabType,
     emp_loginid_tab        OUT     EmpLoginidTabType);

END make_loginid_pkg;

The package body definition is as follows:

CREATE OR REPLACE PACKAGE BODY make_loginid_pkg
IS
BEGIN

  PROCEDURE make_loginid
    (emp_fname_tab  OUT     EmpFnameTabType,
     emp_lname_tab  OUT     EmpLnameTabType,
     emp_loginid_tab        OUT     EmpLoginidTabType)
  AS
    DECLARE i BINARY_INTEGER := 0;

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BEGIN
    update employee
    set loginid = substr(fname,1,1)
        ||
        substr(to_char(empid),1,7);
    FOR emprec IN (select fname,lname,loginid
        from employee) LOOP
        i := i + 1;
        emp_fname_tab[i] = emprec.fname;
        emp_lname_tab[i] = emprec.lname;
        emp_loginid_tab[i] = emprec.loginid;
    END LOOP;
    END make_loginid;
END make_loginid_pkg;

This procedure updates the PL/SQL tables with the data. This data is then available to the client after the execution of this packaged procedure.

2. The following packaged procedure sends the rows one after the other to the client upon each call to the packaged procedure. The make_loginid_pkg.update_loginid procedure must be executed once and the make_loginid_pkg.fetch_emprec procedure must be executed in a loop to fetch the rows one after another from the client program.

The package definition is as follows:
CREATE OR REPLACE PACKAGE make_loginid_pkg
IS
BEGIN
PROCEDURE update_loginid;
PROCEDURE fetch_emprec
        done_flag       IN OUT  INTEGER,
        nrows   IN OUT  INTEGER,
        fname   OUT             VARCHAR2,
        lname   OUT             VARCHAR2,
        loginid OUT             VARCHAR2);
END make_loginid_pkg;

The package body definition is as follows:
CREATE OR REPLACE PACKAGE BODY make_loginid_pkg
IS
BEGIN
CURSOR emprec IS
    select fname, lname, loginid
    from employee;

BEGIN
    update employee
    set loginid = substr(fname,1,1)
        ||
        substr(to_char(empid),1,7);
    FOR emprec IN (select fname,lname,loginid
        from employee) LOOP
        i := i + 1;
        emp_fname_tab[i] = emprec.fname;
        emp_lname_tab[i] = emprec.lname;
        emp_loginid_tab[i] = emprec.loginid;
    END LOOP;
    END make_loginid;
END make_loginid_pkg;
PROCEDURE update_loginid
IS
BEGIN
    update employee
    set loginid = substr(fname,1,1) ||
                substr(to_char(loginid),1,7);
END update_loginid;

PROCEDURE fetch_emprec
done_flag   IN OUT  INTEGER,
nrows   IN OUT  INTEGER,
fname   OUT             VARCHAR2,
lname   OUT             VARCHAR2,
loginid OUT             VARCHAR2)
IS
BEGIN
    IF NOT emprec%ISOPEN THEN
        OPEN emprec;
        nrows := 0;
    END IF;
    done_flag := 0;
    FETCH emprec INTO fname, lname, loginid;
    IF emprec%NOTFOUND THEN
        CLOSE emprec;
        done_flag := 1;
    ELSE
        nrows := nrows + 1;
    ENDIF;
    END fetch_emprec;
END make_loginid_pkg;

**Oracle: Cursor Variables for Returning Query Results**

Oracle allows you to define a cursor variable to return query results. This cursor variable is similar to the user-defined record type and array type. The cursor stored in the cursor variable is like any other cursor. It is a reference to a work area associated with a multi-row query. It denotes both the set of rows and a current row in that set. The cursor referred to in the cursor variable can be opened, fetched from, and closed just like any other cursor.

There is a difference; since it is a PL/SQL variable, it can be passed into and out of procedures like any other PL/SQL variable. As a result, procedures that use cursor variables are reusable. You can see what the output of the procedure is by looking at the procedure definition. You can use the same procedure to return the results of a
SELECT statement to a calling client program. Cursor variables can even be the return value of a function. The cursor variables preserve well-structured programming concepts while allowing the client routine to retrieve result sets.

Typically, the cursor would be declared in a client program (for example, OCI, precompilers, SQL*Module, or SQL*Plus) and then passed as an IN OUT parameter to the PL/SQL procedure. The procedure then opens the cursor based on a SELECT statement. The calling program performs the FETCHs from the cursor, including the possibility of using ARRAY FETCH to retrieve multiple rows in one network message, and closes the cursor when it is done.

**Pro*C Client**:  

```c
...  
struct emp_record {  
    char ename[11];  
    float sal;  
}emp_record;  
SQL_CURSOR c;  
EXEC SQL EXECUTE  
BEGIN  
    emp_package.open_emp(:c,1);  
END;  
END-EXEC;  
...  
/* fetch loop until done */  
EXEC SQL FETCH :c INTO :emp_record;  
...  
CLOSE :c;  
...  
```

**Oracle Server**:  

```sql
CREATE OR REPLACE PACKAGE emp_package IS  
    TYPE emp_part_rec IS RECORD  
        (ename emp.ename%type, sal emp.sal%type);  
    TYPE emp_cursor IS REF CURSOR  
        RETURN emp_part_rec;  
    PROCEDURE open_emp (c_emp IN OUT emp_cursor,  
        select_type IN NUMBER);  
END emp_package;  

CREATE OR REPLACE PACKAGE BODY emp_package IS  
PROCEDURE open_emp (c_emp IN OUT emp_cursor,
```sql
select_type IN NUMBER) IS
    BEGIN
        IF select_type=1 THEN
            OPEN c_emp FOR SELECT ename, sal FROM EMP
                 WHERE COMM IS NOT NULL;
        ELSE
            OPEN c_emp FOR SELECT ename, sal FROM EMP;
        END IF;
    END open_emp;
END emp_package;
```

**Microsoft SQL Server and Sybase Adaptive Server: Multiple Results Sets**

Microsoft SQL Server and Sybase Adaptive Server stored procedures can return multiple different result sets to the calling routine.

For example, consider the following procedure:

```sql
CREATE PROCEDURE example_proc
AS
BEGIN
    SELECT empno, empname, empaddr FROM emp
    WHERE empno BETWEEN 1000 and 2000

    SELECT empno, deptno, deptname FROM emp, dept
    WHERE emp.empno = dept.empno
    AND emp.empno BETWEEN 1000 and 2000
END
```

This procedure returns two different result sets. The client is responsible for processing the results. To convert Microsoft SQL Server and Sybase Adaptive Server multiple result sets to Oracle, pass one more cursor variable to the stored procedure to open a second cursor; the client program then looks at both cursor variables for data. However, it can be difficult to track all the result sets in a single procedure. It is recommended that you just use one result set, that is, one cursor variable per procedure, if possible.

**Microsoft SQL Server and Sybase Adaptive Server: Cursors**

Cursors allow row-by-row operations on a given result set. Microsoft SQL Server and Sybase Adaptive Server provide ANSI-standard SQL syntax to handle cursors. The additional DECLARE CURSOR, OPEN, FETCH, CLOSE, and DEALLOCATE CURSOR clauses are included in T/SQL. Using these statements you can achieve
cursor manipulation in a stored procedure. After FETCHing the individual row of a result set, this current row can be modified with extensions provided with UPDATE and DELETE statements.

The UPDATE statement syntax is as follows:

```
update <table_name>
set <column_name> = <expression>
from <table1>, <table_name>
where current of <cursor name>
```

The DELETE statement syntax is as follows:

```
delete from <table_name>
where current of <cursor name>
```

Microsoft SQL Server and Sybase Adaptive Server cursors map one-to-one with Oracle cursors.

**Individual SQL Statements**

In individual SQL statements, you should try to follow ANSI-standard SQL whenever possible. However, there are cases where you need to use database-specific SQL constructs, mostly for ease of use, simplicity of coding, and performance enhancement. For example, Microsoft SQL Server and Sybase Adaptive Server constructs such as the following are SQL Server-specific, and cannot be converted to Oracle without manual intervention:

```
update <table_name>
set ...
from <table1>, <table_name>
where...
```

The manual intervention required to convert statements such as this can be seen in the following examples:

**Microsoft SQL Server and Sybase Adaptive Server:**

```sql
DELETE sales
FROM sales, titles
WHERE sales.title_id = titles.title_id
AND titles.type = 'business'
```

**Oracle:**

```sql
DELETE
FROM sales
WHERE title_id IN
(SELECT title_id
```
FROM titles
WHERE type = 'business'
)

Microsoft SQL Server and Sybase Adaptive Server:

UPDATE titles
SET price = price + author_royalty
FROM titles, title_author
WHERE titles.title.id = title_author.title_id

Oracle:

UPDATE titles O
SET price = (SELECT (O.price + I.author_royalty)
            FROM title_author I
            WHERE I.title_id = O.title_id)
WHERE EXISTS (SELECT 1
              FROM title_author
              WHERE title_author.title_id = O.title_id) ;

All the ANSI-standard SQL statements can be converted from one database to another using automatic conversion utilities.

Logical Transaction Handling

In Microsoft SQL Server and Sybase Adaptive Server, transactions are explicit by definition. This implies that an individual SQL statement is not part of a logical transaction by default. A SQL statement belongs to a logical transaction if the transaction explicitly initiated by the user with a BEGIN TRANSACTION (or BEGIN TRAN) statement is still in effect. The logical transaction ends with a corresponding COMMIT TRANSACTION (or COMMIT TRAN) or ROLLBACK TRANSACTION (or ROLLBACK TRAN) statement. Each SQL statement that is not part of a logical transaction is committed on completion.

In Oracle, transactions are implicit as set by the ANSI standard. The implicit transaction model requires that each SQL statement is part of a logical transaction. A new logical transaction is automatically initiated when a COMMIT or ROLLBACK command is executed. This also implies that data changes from an individual SQL statement are not committed to the database after execution. The changes are committed to the database only when a COMMIT statement is run. The differences in the transaction models impact the coding of application procedures.

Transaction-Handling Statements
For client/server applications, it is recommended that you make the transaction-handling constructs part of the client procedures. The logical transaction is always defined by client users, and they should control it. This strategy is also more suitable for distributed transactions, where the two-phase commit operations are necessary. Making the transaction-handling statements a part of the client code serves a two-fold purpose; the server code is more portable, and the distributed transactions can be independent of the server code. Try to avoid using the BEGIN TRAN, ROLLBACK TRAN, and COMMIT TRAN statements in the stored procedures. In Microsoft SQL Server and Sybase Adaptive Server, transactions are explicit. In Oracle, transactions are implicit. If the transactions are handled by the client, the application code residing on the server can be independent of the transaction model.

**Error Handling within the Stored Procedure**

Oracle PL/SQL checks each SQL statement for errors before proceeding with the next statement. If an error occurs, control immediately jumps to an exception handler. This avoids you having to check the status of every SQL statement. For example, if a SELECT statement does not find any rows in the database, an exception is raised, and the code to deal with this error is executed.

In Microsoft SQL Server and Sybase Adaptive Server, you need not check for errors after each SQL statement. Control is passed to the next statement, irrespective of the error conditions generated by the previous statement. It is your responsibility to check for errors after the execution of each SQL statement. Failure to do so may result in erroneous results.

In Oracle, to simulate the behavior of Microsoft SQL Server and Sybase Adaptive Server and to pass the control to the next statement regardless of the status of execution of the previous SQL statement, you must enclose each SQL statement in an equivalent PL/SQL block. This block must deal with all possible exceptions for that SQL statement. This coding style is required only to simulate Microsoft SQL Server and Sybase Adaptive Server behavior. An Oracle PL/SQL procedure ideally has only one exception block, and all error conditions are handled in that block.

Consider the following code in an Microsoft SQL Server and Sybase Adaptive Server stored procedure:

```sql
begin
    select @x = col1 from table1 where col2 = @y
    select @z = col3 from table2 where col4 = @x
end
```
In this code example, if the first SELECT statement does not return any rows, the value of @x could be UNDEFINED. If the control is passed on to the next statement without raising an exception, the second statement returns incorrect results because it requires the value of @x to be set by an earlier statement. In a similar situation, Oracle PL/SQL raises a NO_DATA_FOUND exception if the first statement fails.

RAISERROR Statement

The Microsoft SQL Server and Sybase Adaptive Server RAISERROR statement does not return to the calling routine. The error code and message is passed to the client, and the execution of the stored procedure continues further. The Oracle RAISE_APPLICATION_ERROR statement returns to the calling routine. As a standard, a RETURN statement must appear after the RAISERROR statement in Microsoft SQL Server and Sybase Adaptive Server, so that it can be converted to the Oracle RAISE_APPLICATION_ERROR statement.

Customized Error Messages

Microsoft SQL Server and Sybase Adaptive Server allow you to customize the error messages using a system table. The system procedures allow the user to add error messages to the system. Adding error messages to the Microsoft SQL Server and Sybase Adaptive Server system table is not desirable because there is no equivalent on the Oracle system. This can be avoided by maintaining a user-defined error messages table, located in the centralized database. Standard routines can be written to add the error message to the table and retrieve it whenever necessary. This method serves a two-fold purpose: it ensures that the system is more portable across different types of database servers, and it gives the administrator centralized control over the error messages.

Data Types

This section provides information about data types under the following headings:

- Local Variable
- Server Data Types
- Composite Data Types
Local Variable
T/SQL local variables can be any server data type except TEXT and IMAGE.
PL/SQL local variables can be any server data type including the following:

- BINARY_INTEGER
- BOOLEAN

PL/SQL local variables can also be either of the following composite data types allowed by PL/SQL:
- RECORD
- TABLE

Server Data Types
See the Data Types section in Chapter 2 for a list of Microsoft SQL Server and Sybase Adaptive Server data types and their equivalent Oracle data types.

Composite Data Types
Microsoft SQL Server and Sybase Adaptive Server do not have composite data types

<table>
<thead>
<tr>
<th>Oracle</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>RECORD</td>
<td>You can declare a variable to be of type RECORD. Records have uniquely named fields. Logically related data that is dissimilar in type can be held together in a record as a logical unit.</td>
</tr>
<tr>
<td>TABLE</td>
<td>PL/SQL tables can have one column and a primary key, neither of which can be named. The column can belong to any scalar data type. The primary key must belong to type BINARY_INTEGER.</td>
</tr>
</tbody>
</table>

Schema Objects
This section compares the following Microsoft SQL Server and Sybase Adaptive Server and Oracle schema objects:
- Procedure
- Function
Schema Objects

- Package
- Package Body

Each schema object is compared in separate tables based on create, drop, execute and alter, where applicable. The tables are divided into the following four sections:
- Syntax
- Description
- Permissions
- Examples

Some tables are followed by a recommendations section that contains important information about conversion implications.

Procedure

This section provides the following tables for the schema object Procedure:
- Create
- Drop
- Execute
- Alter

Create

Table 3–2  Comparison of Creating the Procedure Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syntax:</td>
<td>Syntax:</td>
</tr>
<tr>
<td>CREATE PROCEDURE procedure [@$formal_parameter formal_parameter_data type [OUTPUT] [= default_value],@$formal_parameter formal_parameter_data type [OUTPUT] [= default_value] ... AS [BEGIN] procedural_statements [END]</td>
<td>CREATE [OR REPLACE] PROCEDURE [schema.]procedure [{} [formal_parameter [IN</td>
</tr>
</tbody>
</table>
Schema Objects

Description:
The CREATE PROCEDURE statement creates the named stored procedure in the database.

You can optionally specify the parameters passed to the procedure as OUTPUT. Values of OUTPUT variables are available to the calling routine after the procedure is executed. The parameters specified without the OUTPUT keyword are considered as input parameters.

The keyword AS indicates the start of the body of the procedure.

The BEGIN and END keywords that enclose the stored procedure body are optional; all the procedural statements contained in the file after AS are considered part of the stored procedure if BEGIN and END are not used to mark blocks.

See the T/SQL and PL/SQL Language Elements section of this chapter for more information about the constructs allowed in T/SQL procedures.

Permissions:
You must have the CREATE PROCEDURE system privilege to create the stored procedures.

Oracle

Description:
The OR REPLACE keywords replace the procedure by the new definition if it already exists.

The parameters passed to the PL/SQL procedure can be specified as IN (input), OUT (output only), or IN OUT (input and output). In the absence of these keywords, the parameter is assumed to be the "IN" parameter.

The keyword IS or AS indicates the start of the procedure. The local variables are declared after the keyword IS or AS and before the keyword BEGIN.

The BEGIN and END keywords enclose the body of the procedure.

Permissions:
To create a procedure in your own schema, you must have the CREATE PROCEDURE system privilege. To create a procedure in another user’s schema, you must have the CREATE ANY PROCEDURE system privilege.

---

Table 3–2  Comparison of Creating the Procedure Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
</table>
| **Description:**                             | **Description:**
The CREATE PROCEDURE statement creates the named stored procedure in the database.
The OR REPLACE keywords replace the procedure by the new definition if it already exists.

You can optionally specify the parameters passed to the procedure as OUTPUT. Values of OUTPUT variables are available to the calling routine after the procedure is executed. The parameters specified without the OUTPUT keyword are considered as input parameters.

The keyword AS indicates the start of the body of the procedure.

The BEGIN and END keywords that enclose the stored procedure body are optional; all the procedural statements contained in the file after AS are considered part of the stored procedure if BEGIN and END are not used to mark blocks.

See the T/SQL and PL/SQL Language Elements section of this chapter for more information about the constructs allowed in T/SQL procedures.

| **Permissions:**                              | **Permissions:**
You must have the CREATE PROCEDURE system privilege to create the stored procedures.

To create a procedure in your own schema, you must have the CREATE PROCEDURE system privilege. To create a procedure in another user’s schema, you must have the CREATE ANY PROCEDURE system privilege.
Recommendations:

Functionally identical parts can be identified in the T/SQL procedure and PL/SQL procedure structure. Therefore, you can automate the conversion of most of the constructs from Microsoft SQL Server and Sybase Adaptive Server to Oracle.

OR REPLACE keywords in an Oracle CREATE PROCEDURE statement provide an elegant way of recreating the procedure. In Microsoft SQL Server and Sybase Adaptive Server, the procedure must be dropped explicitly before replacing it.

Drop

<table>
<thead>
<tr>
<th>Table 3–3 Comparison of Dropping the Procedure Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Microsoft SQL Server and Sybase Adaptive Server</strong></td>
</tr>
<tr>
<td><strong>Syntax:</strong></td>
</tr>
<tr>
<td>DROP PROCEDURE procedure</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
</tr>
<tr>
<td>The procedure definition is deleted from the data dictionary. All the objects that reference this procedure must have references to this procedure removed</td>
</tr>
</tbody>
</table>
Table 3–3  Comparison of Dropping the Procedure Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissions: Procedure owners can drop their own procedures. A DBO can drop any procedure.</td>
<td>Permissions: The procedure must be in the schema of the user or the user must have the DROP ANY PROCEDURE system privilege to execute this command.</td>
</tr>
<tr>
<td>Example: DROP PROCEDURE myproc</td>
<td>Example: DROP PROCEDURE sam.credit;</td>
</tr>
</tbody>
</table>

Recommendations:
The above statement does not have any effect on the conversion process. This information is provided for reference only.

Execute

Table 3–4  Comparison of Executing the Procedure Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syntax: EXEC [@return_value = ] procedure [[[@formal_parameter = ] [@actual_parameter</td>
<td>constant_literal] [OUT]]],[[[@formal_parameter = ] [@actual_parameter</td>
</tr>
</tbody>
</table>

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### Table 3–4  Comparison of Executing the Procedure Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th><strong>Microsoft SQL Server and Sybase Adaptive Server</strong></th>
<th><strong>Oracle</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong> Microsoft SQL Server and Sybase Adaptive Server stored procedures can only return integer values to the calling routine using the RETURN statement. In the absence of a RETURN statement, the stored procedure still returns a return status to the calling routine. This value can be captured in the &quot;return_value&quot; variable. The formal_parameter is the parameter in the procedure definition. The actual_parameter is defined in the local block which calls the procedure supplying the value of the actual parameter for the respective formal parameter. The association between an actual parameter and formal parameter can be indicated using either positional or named notation.</td>
<td><strong>Description:</strong> Oracle PL/SQL procedures send data back to the calling routine by means of OUT parameters. Oracle offers FUNCTIONS that are a different type of schema objects. Functions can return an atomic value to the calling routine using the RETURN statement. The RETURN statement can return value of any data type. The formal_parameter is the parameter in the procedure definition. The actual_parameter is defined in the local block which calls the procedure supplying the value of the actual parameter for the respective formal parameter. The association between an actual parameter and formal parameter can be indicated using either positional or named notation.</td>
</tr>
</tbody>
</table>

**Positional notation:** The actual parameters are supplied to the procedure in the same order as the formal parameters in the procedure definition.

**Named notation:** The actual parameters are supplied to the procedure in an order different than that of the formal parameters in the procedure definition by using the name of the formal parameter as:

```plaintext
@formal_parameter = @actual_parameter
```

A constant literal can be specified in the place of the following:

```plaintext
'@actual_parameter' as:
@formal_parameter = 10
```

The keyword OUT should be specified if the procedure has to return the value of that parameter to the calling routine as OUTPUT.

**Positional notation:** The actual parameters are supplied to the procedure in the same order as the formal parameters in the procedure definition.

**Named notation:** The actual parameters are supplied to the procedure in an order different than that of the formal parameters in the procedure definition by using the name of the formal parameter as:

```plaintext
formal_parameter => actual_parameter
```

A constant literal can be specified in the place of the following:

```plaintext
'actual_parameter' as:
formal_parameter => 10
```

If the formal_parameter is specified as OUT or IN OUT in the procedure definition, the value is made available to the calling routine after the execution of the procedure.
Permissions:
The user should have the EXECUTE permission on the stored procedure. The user need not have explicit privileges to access the underlying objects referred to within the stored procedure.

Example:

Positional notation:
EXEC GetEmpName @EmpID
EXEC @status = GetAllDeptCodes
EXEC @status = UpdateEmpSalary
@EmpID,
@EmpName
EXEC UpdateEmpSalary 13000,'Joe Richards'

Named notation:
EXEC UpdateEmpSalary
@Employee = @EmpName,
@Employee_Id = @EmpID

Mixed notation:
EXEC UpdateEmpSalary
@EmpName, @Employee_Id = @EmpID
EXEC UpdateEmpSalary
@Employee = @EmpName, @EmpID
Alter

Table 3–5  Comparison of Altering the Procedure Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
</table>
| Syntax:  
The system procedure SP_RECOMPILE recompiles the named stored procedure. For example:  
ALTER PROCEDURE <procedure name> | ALTER PROCEDURE [schema.]procedure COMPILE |
| Description:  
This command causes the recompilation of the procedure. Procedures that become invalid for some reason should be recompiled explicitly using this command. | Description:  
This command causes the recompilation of the procedure. Procedures that become invalid for some reason should be recompiled explicitly using this command. Explicit recompilation eliminates the need for implicit recompilation and prevents associated runtime compilation errors and performance overhead |
| Permissions:  
The owner of the procedure can issue this command | Permissions:  
The procedure must be in the user’s schema or the user must have the ALTER ANY PROCEDURE privilege to use this command |
| Example:  
sp_recompile my_proc | Example:  
ALTER PROCEDURE sam.credit COMPILE; |

Function

This section provides the following tables for the schema object Function:

- Create
- Drop
- Execute
- Alter
Create Table 3-6  Comparison of Creating the Function Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
</table>
| Syntax:  
In Microsoft SQL Server and Sybase Adaptive Server, you can convert a stored procedure to a function in Oracle because the stored procedure in Microsoft SQL Server and Sybase Adaptive Server can RETURN an integer value to the calling routine using a RETURN statement. A stored procedure returns a status value to the calling routine even in the absence of a RETURN statement. The returned status is equal to ZERO if the procedure execution is successful or NON-ZERO if the procedure fails for some reason. The RETURN statement can return only integer values. |  
Syntax:  
CREATE [OR REPLACE] FUNCTION [user.]function [(parameter [OUT] data type[,parameter [IN OUT] data type]...)] RETURN data type { IS | AS } block  
Description:  
The OR REPLACE keywords replace the function with the new definition if it already exists. Parameters passed to the PL/SQL function can be specified as "IN" (input), "OUT" (output), or "IN OUT" (input and output). In the absence of these keywords the parameter is assumed to be IN. RETURN data type specifies the data type of the function's return value. The data type can be any data type supported by PL/SQL. See the Data Types section in Chapter 2, Database for more information about data types. |
| N/A | N/A  
Permissions:  
To create a function in your own schema, you must have the CREATE PROCEDURE system privilege. To create a function in another user's schema, you must have the CREATE ANY PROCEDURE system privilege. |
### Table 3–6  Comparison of Creating the Function Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>CREATE FUNCTION get_bal</td>
</tr>
<tr>
<td></td>
<td>(acc_no IN NUMBER)</td>
</tr>
<tr>
<td></td>
<td>RETURN NUMBER</td>
</tr>
<tr>
<td></td>
<td>IS</td>
</tr>
<tr>
<td></td>
<td>acc_bal NUMBER(11,12);</td>
</tr>
<tr>
<td></td>
<td>BEGIN</td>
</tr>
<tr>
<td></td>
<td>SELECT balance</td>
</tr>
<tr>
<td></td>
<td>INTO acc_bal</td>
</tr>
<tr>
<td></td>
<td>FROM accounts</td>
</tr>
<tr>
<td></td>
<td>WHERE account_id = acc_no;</td>
</tr>
<tr>
<td></td>
<td>RETURN(acc_bal);</td>
</tr>
<tr>
<td></td>
<td>END;</td>
</tr>
</tbody>
</table>

### Drop

### Table 3–7  Comparison of Dropping the Function Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>Syntax:</td>
</tr>
<tr>
<td></td>
<td>DROP FUNCTION [schema.]function</td>
</tr>
<tr>
<td>N/A</td>
<td>Description:</td>
</tr>
<tr>
<td></td>
<td>When a function is dropped, Oracle invalidates all the local objects that reference the dropped function.</td>
</tr>
<tr>
<td>N/A</td>
<td>Permissions:</td>
</tr>
<tr>
<td></td>
<td>The function must be in the schema of the user or the user must have the DROP ANY PROCEDURE system privilege to execute this command</td>
</tr>
<tr>
<td>N/A</td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>DROP FUNCTION sam.credit;</td>
</tr>
</tbody>
</table>
### Table 3–8  Comparison of Executing the Function Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>Syntax:</td>
</tr>
<tr>
<td></td>
<td>function ((</td>
</tr>
<tr>
<td>N/A</td>
<td>Description:</td>
</tr>
<tr>
<td></td>
<td>Functions can return an atomic value to the calling routine using the RETURN statement.</td>
</tr>
<tr>
<td></td>
<td>A function can be called as part of an expression. This is a very powerful concept. All the Microsoft SQL Server and Sybase Adaptive Server built-in functions can be coded using PL/SQL, and these functions can be called like any other built-in functions in an expression, starting with Oracle.</td>
</tr>
<tr>
<td>N/A</td>
<td>Permissions:</td>
</tr>
<tr>
<td></td>
<td>You should have the EXECUTE privilege on the function to execute the named function. You need not have explicit privileges to access the underlying objects that are referred to within the PL/SQL function.</td>
</tr>
<tr>
<td>N/A</td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>1) IF sal_ok (new_sal, new_title) THEN .... END IF;</td>
</tr>
<tr>
<td></td>
<td>2) promotable:=sal_ok(new_sal, new_title) AND (rating&gt;3);</td>
</tr>
<tr>
<td></td>
<td>where sal_ok is a function that returns a BOOLEAN value.</td>
</tr>
</tbody>
</table>
Alter

Table 3–9  Comparison of Altering the Function Schema Object in Oracle and Microsoft SQL Server 7.0

<table>
<thead>
<tr>
<th>Microsoft SQL Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>Syntax:</td>
</tr>
<tr>
<td></td>
<td>ALTER FUNCTION [schema.]function COMPILE</td>
</tr>
<tr>
<td>N/A</td>
<td>Description:</td>
</tr>
<tr>
<td></td>
<td>This command causes the recompilation of a function. Functions become invalid if the objects that are referenced from within the function are dropped or altered. Functions that become invalid for some reason should be recompiled explicitly using this command. Explicit recompilation eliminates the need for implicit recompilation and prevents associated runtime compilation errors and performance overhead.</td>
</tr>
<tr>
<td>N/A</td>
<td>Permissions:</td>
</tr>
<tr>
<td></td>
<td>The function must be in the user's schema or the user must have the ALTER ANY PROCEDURE privilege to use this command</td>
</tr>
<tr>
<td>N/A</td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>ALTER FUNCTION sam.credit COMPILE</td>
</tr>
</tbody>
</table>

Package

This section provides the following tables for the schema object Package:

- Create
- Drop
- Alter
### Create

**Table 3-10 Comparison of Creating the Package Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server**

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Syntax:</strong></td>
<td><strong>Syntax:</strong></td>
</tr>
<tr>
<td>Microsoft SQL Server and Sybase Adaptive Server do not support this concept.</td>
<td>CREATE [OR REPLACE] PACKAGE [user.]package {IS</td>
</tr>
<tr>
<td>N/A</td>
<td><strong>Description:</strong></td>
</tr>
<tr>
<td></td>
<td>This is the external or public part of the package.</td>
</tr>
<tr>
<td></td>
<td>CREATE PACKAGE sets up the specification for a PL/SQL package which can be a group of procedures, functions, exception, variables, constants, and cursors.</td>
</tr>
<tr>
<td></td>
<td>Functions and procedures of the package can share data through variables, constants, and cursors.</td>
</tr>
<tr>
<td></td>
<td>The OR REPLACE keywords replace the package by the new definition if it already exists. This requires recompilation of the package and any objects that depend on its specification.</td>
</tr>
<tr>
<td>N/A</td>
<td><strong>Permissions:</strong></td>
</tr>
<tr>
<td></td>
<td>To create a package in the user’s own schema, the user must have the CREATE PROCEDURE system privilege. To create a package in another user’s schema, the user must have the CREATE ANY PROCEDURE system privilege.</td>
</tr>
</tbody>
</table>
Table 3–10  Comparison of Creating the Package Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>Example:</td>
</tr>
<tr>
<td>CREATE PACKAGE emp_actions AS</td>
<td></td>
</tr>
<tr>
<td>-- specification</td>
<td></td>
</tr>
<tr>
<td>TYPE EmpRecTyp IS RECORD (emp_id INTEGER, salary</td>
<td></td>
</tr>
<tr>
<td>REAL);</td>
<td></td>
</tr>
<tr>
<td>CURSOR desc_salary {emp_id NUMBER} RETURN EmpRecTyp;</td>
<td></td>
</tr>
<tr>
<td>PROCEDURE hire_employee</td>
<td></td>
</tr>
<tr>
<td>(ename CHAR,</td>
<td></td>
</tr>
<tr>
<td>job CHAR,</td>
<td></td>
</tr>
<tr>
<td>mgr NUMBER,</td>
<td></td>
</tr>
<tr>
<td>sal NUMBER,</td>
<td></td>
</tr>
<tr>
<td>comm NUMBER,</td>
<td></td>
</tr>
<tr>
<td>deptno NUMBER);</td>
<td></td>
</tr>
<tr>
<td>PROCEDURE fire-employee (emp_id NUMBER);</td>
<td></td>
</tr>
<tr>
<td>END emp_actions;</td>
<td></td>
</tr>
</tbody>
</table>

Drop

Table 3–11  Comparison of Dropping the Package Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syntax:</td>
<td>Syntax:</td>
</tr>
<tr>
<td>Microsoft SQL Server and Sybase Adaptive Server do not support this concept.</td>
<td>DROP PACKAGE [BODY] [schema.]package</td>
</tr>
</tbody>
</table>
### Alter

**Table 3–11 Comparison of Dropping the Package Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)**

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>Description: The BODY option drops only the body of the package. If you omit BODY, Oracle drops both the body and specification of the package. If you drop the body and specification of the package, Oracle invalidates any local objects that depend on the package specification. schema is the schema containing the package. If you omit schema, Oracle assumes the package is in your own schema. When a package is dropped, Oracle invalidates all the local objects that reference the dropped package.</td>
</tr>
<tr>
<td>N/A</td>
<td>Permissions: The package must be in the schema of the user or the user must have the DROP ANY PROCEDURE system privilege to execute this command.</td>
</tr>
<tr>
<td>N/A</td>
<td>Example: DROP PACKAGE emp_actions;</td>
</tr>
</tbody>
</table>

**Table 3–12 Comparison of Altering the Package Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server**

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syntax: Microsoft SQL Server and Sybase Adaptive Server do not support this concept.</td>
<td>Syntax: ALTER PACKAGE [user.]package COMPILE [PACKAGE</td>
</tr>
</tbody>
</table>
This section provides the following tables for the schema object Package Body:

- Create
- Drop
- Alter

### Table 3–12  Comparison of Altering the Package Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>Description: Packages that become invalid for some reason should be recompiled explicitly using this command.</td>
</tr>
<tr>
<td></td>
<td>This command causes the recompilation of all package objects together. You cannot use the ALTER PROCEDURE or ALTER FUNCTION commands to individually recompile a procedure or function that is part of a package.</td>
</tr>
<tr>
<td></td>
<td>PACKAGE, the default option, recompiles the package body and specification.</td>
</tr>
<tr>
<td></td>
<td>BODY recompiles only the package body.</td>
</tr>
<tr>
<td></td>
<td>Explicit recompilation eliminates the need for implicit recompilation and prevents associated runtime compilation errors and performance overhead.</td>
</tr>
<tr>
<td>N/A</td>
<td>Permissions: The package must be in the user's schema or the user must have the ALTER ANY PROCEDURE privilege to use this command.</td>
</tr>
<tr>
<td>N/A</td>
<td>Example: ALTER PACKAGE emp_actions COMPARE PACKAGE</td>
</tr>
</tbody>
</table>
### Table 3–13 Comparison of Creating the Package Body Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syntax: Microsoft SQL Server and Sybase Adaptive Server do not support this concept.</td>
<td>Syntax: CREATE [OR REPLACE] PACKAGE BODY (schema.</td>
</tr>
<tr>
<td></td>
<td>{IS</td>
</tr>
<tr>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**Description:**

This is the internal or private part of the package.

CREATE PACKAGE creates the body of a stored package.

OR REPLACE recreates the package body if it already exists. If you change a package body, Oracle recompiles it.

schema is the schema to contain the package. If omitted, the package is created in your current schema.

package is the name of the package to be created.

pl/sql_package_body is the package body which can declare and define program objects. For more information on writing package bodies, see the PL/SQL User’s Guide and Reference, Release 1 (9.0.1).

**Permissions:**

To create a package in your own schema, you must have the CREATE PROCEDURE privilege.

To create a package in another user’s schema, you must have the CREATE ANY PROCEDURE privilege.
Example:

```sql
CREATE PACKAGE BODY emp_actions AS
    CURSOR desc_salary (emp_id NUMBER) RETURN EmpRecTyp IS
        SELECT empno, sal FROM emp
        ORDER BY sal DESC;
    PROCEDURE hire_employee
        (ename    CHAR,
         job      CHAR,
         mgr      NUMBER,
         sal      NUMBER,
         comm     NUMBER,
         deptno   NUMBER) IS
        BEGIN
            INSERT INTO emp VALUES
                (empno_seq.NEXTVAL, ename, job, mgr, SYSDATE, sal, comm, deptno);
        END hire_employee;
    PROCEDURE fire_employee
        (emp_id   NUMBER) IS
        BEGIN
            DELETE FROM emp
                WHERE empno = emp_id;
        END fire_employee;
END emp_actions;
```
### Drop

**Table 3–14**  Comparison of Dropping the Package Body Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Syntax:</strong></td>
<td><strong>Syntax:</strong> DROP PACKAGE [BODY] [schema.]package</td>
</tr>
<tr>
<td>Microsoft SQL Server and Sybase Adaptive Server do not support this concept.</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>The BODY option drops only the body of the package. If you omit BODY, Oracle drops both the body and specification of the package. If you drop the body and specification of the package, Oracle invalidates any local objects that depend on the package specification.</td>
</tr>
<tr>
<td></td>
<td>schema. is the schema containing the package. If you omit schema., Oracle assumes the package is in your own schema. When a package is dropped, Oracle invalidates all the local objects that reference the dropped package.</td>
</tr>
<tr>
<td><strong>Permissions:</strong></td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>The package must be in the your own schema or you must have the DROP ANY PROCEDURE system privilege to execute this command.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>DROP PACKAGE BODY emp_actions;</td>
</tr>
</tbody>
</table>

### Alter

**Table 3–15**  Comparison of Altering the Package Body Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Syntax:</strong></td>
<td><strong>Syntax:</strong> ALTER PACKAGE [user.]package COMPILER [PACKAGE</td>
</tr>
<tr>
<td>Microsoft SQL Server and Sybase Adaptive Server do not support this concept.</td>
<td>N/A</td>
</tr>
</tbody>
</table>

---

Triggers and Stored Procedures  3-35
This section provides information about the Microsoft SQL Server and Sybase Adaptive Server constructs and equivalent Oracle constructs generated by the Migration Workbench. The conversions of the following constructs are discussed in detail:

- CREATE PROCEDURE Statement
- Parameter Passing
- DECLARE Statement
- IF Statement

Table 3–15  Comparison of Altering the Package Body Schema Object in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>Description: Packages that become invalid for some reason should be recompiled explicitly using this command.</td>
</tr>
</tbody>
</table>

This command causes the recompilation of all package objects together. You cannot use the ALTER PROCEDURE or ALTER FUNCTION commands to individually recompile a procedure or function that is part of a package. PACKAGE, the default option, recompiles the package body and specification. BODY recompiles only the package body. Explicit recompilation eliminates the need for implicit recompilation and prevents associated runtime compilation errors and performance overhead.

| N/A | Permissions: The package must be your own schema or you must have the ALTER ANY PROCEDURE privilege to use this command. |

| N/A | Example: ALTER PACKAGE emp_actions COMPILE BODY |

T/SQL Versus PL/SQL Constructs
■ RETURN Statement
■ RAISERROR Statement
■ EXECUTE Statement
■ WHILE Statement
■ GOTO Statement
■ @@Rowcount and @@Error Variables
■ ASSIGNMENT Statement
■ SELECT Statement
■ SELECT Statement as Part of the SELECT List
■ SELECT Statement with GROUP BY Clause
■ Column Aliases
■ UPDATE with FROM Statement
■ DELETE with FROM Statement
■ Temporary Tables
■ Result Set (Converted Using a Cursor Variable)
■ Cursor Handling
■ Transaction Handling Statements

Listed is the syntax for the Microsoft SQL Server and Sybase Adaptive Server constructs and their Oracle equivalents, as well as comments about conversion considerations.

The procedures in the Oracle column are the direct output of the Migration Workbench. These PL/SQL procedures have more lines of code compared to the source Microsoft SQL Server and Sybase Adaptive Server procedures because these PL/SQL procedures are converted to emulate Microsoft SQL Server and Sybase Adaptive Server functionality. The PL/SQL procedures written from scratch for the same functionality in Oracle would be much more compact. The PL/SQL procedures generated by the Migration Workbench indicate the manual conversion required by adding appropriate commands. In general, the Migration Workbench deals with the Microsoft SQL Server and Sybase Adaptive Server T/SQL constructs in one of the following ways:

■ The ANSI-standard SQL statements are converted to PL/SQL because it supports ANSI-standard SQL.
Microsoft SQL Server-specific constructs are converted into PL/SQL constructs if the equivalent constructs are available in PL/SQL.

Some Microsoft SQL Server-specific constructs are ignored and appropriate comments are incorporated in the output file.

Constructs that require manual conversion are wrapped around with proper comments in the output file.

For Microsoft SQL Server-specific constructs that result in syntax errors, an appropriate error message is displayed including the line number.

CREATE PROCEDURE Statement

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE PROC proc1 AS RETURN 0</td>
<td>CREATE OR REPLACE FUNCTION PROC1 AS RETURN INTEGER AS StoO_selcnt INTEGER; StoO_error INTEGER; StoO_rowcnt INTEGER; StoO_errmsg VARCHAR2(255); StoO_sqlstatus INTEGER; BEGIN RETURN 0; END PROC1;</td>
</tr>
</tbody>
</table>

Comments

An Microsoft SQL Server and Sybase Adaptive Server stored procedure can be converted to a stored procedure, a function, or a package in Oracle. The output depends upon the option used when running the Migration Workbench.

The Migration Workbench automatically adds what is necessary to simulate Microsoft SQL Server and Sybase Adaptive Server functionality. In the example in Table 3-16 above, the Migration Workbench added the following three variables:

StoO_selcnt INTEGER;
StoO_error INTEGER;
StoO_rowcnt INTEGER;
These variables are needed in the EXCEPTION clause in the PL/SQL procedures that must be added for each SQL statement to emulate Microsoft SQL Server and Sybase Adaptive Server functionality. See the SELECT Statement topic in this section for clarification of the purpose of these variables.

**Note:** The REPLACE keyword is added to replace procedure, function, or package if it already exists.

### Parameter Passing

**Table 3–17  Comparison of Parameter Passing in Oracle and Microsoft SQL Server and Sybase Adaptive Server**

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE PROC proc1 @x int=-1, @y money, @z bit OUT, @a char(20) = 'TEST' AS RETURN 0</td>
<td>CREATE OR REPLACE FUNCTION proc1(x INTEGER DEFAULT -1, y NUMBER, z IN OUT NUMBER, a CHAR DEFAULT 'TEST') RETURN INTEGER AS StoO_selcnt INTEGER; StoO_error INTEGER; StoO_rowcnt INTEGER; StoO_errmsg VARCHAR2(255); StoO_sqlstatus INTEGER; BEGIN RETURN 0; END proc1; /</td>
</tr>
</tbody>
</table>

**Comments**

Parameter passing is almost the same in Microsoft SQL Server and Sybase Adaptive Server and Oracle. By default, all the parameters are INPUT parameters, if not specified otherwise.

The value of the INPUT parameter cannot be changed from within the PL/SQL procedure. Thus, an INPUT parameter cannot be assigned any values nor can it be
passed to another procedure as an OUT parameter. In Oracle, only IN parameters can be assigned a default value.

The @ sign in a parameter name declaration is removed in Oracle.

In Oracle, the parameter data type definition does not include length/size.

Microsoft SQL Server and Sybase Adaptive Server data types are converted to Oracle base data types. For example, all Microsoft SQL Server and Sybase Adaptive Server numeric data types are converted to NUMBER and all alphanumeric data types are converted to VARCHAR2 and CHAR in Oracle.

**DECLARE Statement**

Table 3–18 Comparison of DECLARE Statement in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE PROC proc1 AS DECLARE @x int, @y money, @z bit, @a char(20) RETURN 0 GO</td>
<td>CREATE OR REPLACE FUNCTION PROC1 RETURN INTEGER AS STO0_SELCNT INTEGER; STO0_ERROR INTEGER; STO0_ROWCNT INTEGER; STO0_ERRMSG VARCHAR2(255); STO0_SQLSTATUS INTEGER; X INTEGER; Y NUMBER; Z NUMBER; A CHAR(20); BEGIN RETURN 0; END PROC1; /</td>
</tr>
</tbody>
</table>

**Comments**

Microsoft SQL Server and Sybase Adaptive Server and Oracle follow similar rules for declaring local variables.

The Migration Workbench overrides the scope rule for variable declarations. As a result, all the local variables are defined at the top of the procedure body in Oracle.
IF Statement

Table 3–19  Comparison of IF Statement in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 1:</td>
<td>Example 1:</td>
</tr>
<tr>
<td>CREATE PROC proc1 @Flag int = 0 AS BEGIN</td>
<td>CREATE OR REPLACE PROCEDURE PROC1( Flag INTEGER DEFAULT 0) AS</td>
</tr>
<tr>
<td>DECLARE @x int IF ( @Flag = 0 ) SELECT @x = -1 ELSE SELECT @x = 10 END</td>
<td>StoO_selcnt INTEGER; StoO_error INTEGER; StoO_rowcnt INTEGER; StoO_errmsg VARCHAR2(255); StoO_sqlstatus INTEGER; x INTEGER; BEGIN IF (PROC1.Flag = 0) THEN PROC1.x := -1; ELSE PROC1.x := 10; END IF; END; /</td>
</tr>
</tbody>
</table>
Example 2:
CREATE PROC proc1 @Flag char(2) = ''
AS
BEGIN
DECLARE @x int
IF ( @Flag='' )
SELECT @x = -1
ELSE IF (@Flag = 'a')
SELECT @x = 10
ELSE IF (@Flag = 'b')
SELECT @x = 20
END

Example 2:
CREATE OR REPLACE PROCEDURE PROC1(
Flag CHAR DEFAULT ' ')
AS
StoO_selcnt INTEGER;
StoO_error INTEGER;
StoO_rowcnt INTEGER;
StoO_errmsg VARCHAR2(255);
StoO_sqlstatus INTEGER;
x INTEGER;
BEGIN
IF (PROC1.Flag = ' ') THEN
PROC1.x := -1;
ELSE
IF (PROC1.Flag = 'a') THEN
PROC1.x := 10;
ELSE
IF (PROC1.Flag = 'b') THEN
PROC1.x := 20;
END IF;
END IF;
END IF;
END;
/

Table 3–19  Comparison of IF Statement in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 2:</td>
<td>Example 2:</td>
</tr>
<tr>
<td>CREATE PROC proc1 @Flag</td>
<td>CREATE OR REPLACE PROCEDURE PROC1(</td>
</tr>
<tr>
<td>char(2) = ''</td>
<td>Flag CHAR DEFAULT ' ' )</td>
</tr>
<tr>
<td>AS</td>
<td>AS</td>
</tr>
<tr>
<td>BEGIN</td>
<td>BEGIN</td>
</tr>
<tr>
<td>DECLARE @x int</td>
<td>StoO_selcnt INTEGER;</td>
</tr>
<tr>
<td>IF ( @Flag='' )</td>
<td>StoO_error INTEGER;</td>
</tr>
<tr>
<td>SELECT @x = -1</td>
<td>StoO_rowcnt INTEGER;</td>
</tr>
<tr>
<td>ELSE IF (@Flag = 'a')</td>
<td>StoO_errmsg VARCHAR2(255);</td>
</tr>
<tr>
<td>SELECT @x = 10</td>
<td>StoO_sqlstatus INTEGER;</td>
</tr>
<tr>
<td>ELSE IF (@Flag = 'b')</td>
<td>x INTEGER;</td>
</tr>
<tr>
<td>SELECT @x = 20</td>
<td>BEGIN</td>
</tr>
<tr>
<td>END</td>
<td>IF (PROC1.Flag = ' ') THEN</td>
</tr>
<tr>
<td></td>
<td>PROC1.x := -1;</td>
</tr>
<tr>
<td></td>
<td>ELSE</td>
</tr>
<tr>
<td></td>
<td>IF (PROC1.Flag = 'a') THEN</td>
</tr>
<tr>
<td></td>
<td>PROC1.x := 10;</td>
</tr>
<tr>
<td></td>
<td>ELSE</td>
</tr>
<tr>
<td></td>
<td>IF (PROC1.Flag = 'b') THEN</td>
</tr>
<tr>
<td></td>
<td>PROC1.x := 20;</td>
</tr>
<tr>
<td></td>
<td>END IF;</td>
</tr>
<tr>
<td></td>
<td>END IF;</td>
</tr>
<tr>
<td></td>
<td>END;</td>
</tr>
<tr>
<td></td>
<td>/</td>
</tr>
</tbody>
</table>
Example 3:

```sql
CREATE PROC proc1
AS
BEGIN
DECLARE @x int
IF EXISTS ( SELECT * FROM table2 )
SELECT @x = -1
END
```

Example 3:

```sql
CREATE OR REPLACE PROCEDURE PROC1
AS
StoO_selcnt INTEGER;
StoO_error INTEGER;
StoO_rowcnt INTEGER;
StoO_errmsg VARCHAR2(255);
StoO_sqlstatus INTEGER;
x INTEGER;
BEGIN
BEGIN
StoO_selcnt := 0;
StoO_error := 0;
StoO_rowcnt := 0;
SELECT 1 INTO StoO_selcnt
FROM DUAL
WHERE EXISTS (
    SELECT *
    FROM TABLE2);
StoO_rowcnt := SQL%ROWCOUNT;
EXCEPTION
WHEN OTHERS THEN
    StoO_selcnt := 0;
    StoO_error := SQLCODE;
    StoO_errmsg := SQLERRM;
END;
IF StoO_selcnt != 0 THEN
    PROC1.x := -1;
END IF;
END;
/```

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 3:</td>
<td>Example 3:</td>
</tr>
<tr>
<td>CREATE PROC proc1</td>
<td>CREATE OR REPLACE PROCEDURE PROC1</td>
</tr>
<tr>
<td>AS</td>
<td>AS</td>
</tr>
<tr>
<td>BEGIN</td>
<td>BEGIN</td>
</tr>
<tr>
<td>DECLARE @x int</td>
<td>BEGIN</td>
</tr>
<tr>
<td>IF EXISTS ( SELECT * FROM table2 )</td>
<td>BEGIN</td>
</tr>
<tr>
<td>SELECT @x = -1</td>
<td>BEGIN</td>
</tr>
<tr>
<td>END</td>
<td>StoO_selcnt := 0;</td>
</tr>
<tr>
<td></td>
<td>StoO_error := 0;</td>
</tr>
<tr>
<td></td>
<td>StoO_rowcnt := 0;</td>
</tr>
<tr>
<td></td>
<td>SELECT 1 INTO StoO_selcnt</td>
</tr>
<tr>
<td></td>
<td>FROM DUAL</td>
</tr>
<tr>
<td></td>
<td>WHERE EXISTS (</td>
</tr>
<tr>
<td></td>
<td>SELECT *</td>
</tr>
<tr>
<td></td>
<td>FROM TABLE2);</td>
</tr>
<tr>
<td></td>
<td>StoO_rowcnt := SQL%ROWCOUNT;</td>
</tr>
<tr>
<td></td>
<td>EXCEPTION</td>
</tr>
<tr>
<td></td>
<td>WHEN OTHERS THEN</td>
</tr>
<tr>
<td></td>
<td>StoO_selcnt := 0;</td>
</tr>
<tr>
<td></td>
<td>StoO_error := SQLCODE;</td>
</tr>
<tr>
<td></td>
<td>StoO_errmsg := SQLERRM;</td>
</tr>
<tr>
<td></td>
<td>END;</td>
</tr>
<tr>
<td></td>
<td>IF StoO_selcnt != 0 THEN</td>
</tr>
<tr>
<td></td>
<td>PROC1.x := -1;</td>
</tr>
<tr>
<td></td>
<td>END IF;</td>
</tr>
<tr>
<td></td>
<td>END;</td>
</tr>
<tr>
<td></td>
<td>/</td>
</tr>
</tbody>
</table>
Table 3–19  Comparison of IF Statement in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 4:</td>
<td>Example 4:</td>
</tr>
<tr>
<td>CREATE PROC procl @basesal money, @empid int AS</td>
<td>CREATE OR REPLACE PROCEDURE PROC1(</td>
</tr>
<tr>
<td>BEGIN</td>
<td>basel NUMBER,</td>
</tr>
<tr>
<td>IF (select sal from emp where empid = @empid) &lt; @basesal</td>
<td></td>
</tr>
<tr>
<td>UPDATE emp</td>
<td>empid INTEGER</td>
</tr>
<tr>
<td>SET sal_flag = -1</td>
<td>AS</td>
</tr>
<tr>
<td>WHERE empid = @empid</td>
<td>StoO_selcnt INTEGER;</td>
</tr>
<tr>
<td>END</td>
<td>StoO_error INTEGER;</td>
</tr>
<tr>
<td></td>
<td>StoO_rowcnt INTEGER;</td>
</tr>
<tr>
<td></td>
<td>StoO_errmsg VARCHAR2(255);</td>
</tr>
<tr>
<td></td>
<td>StoO_sqlstatus INTEGER;</td>
</tr>
<tr>
<td></td>
<td>BEGIN</td>
</tr>
<tr>
<td></td>
<td>BBEGIN</td>
</tr>
<tr>
<td></td>
<td>StoO_selcnt := 0;</td>
</tr>
<tr>
<td></td>
<td>StoO_error := 0;</td>
</tr>
<tr>
<td></td>
<td>StoO_rowcnt := 0;</td>
</tr>
<tr>
<td></td>
<td>SELECT 1 INTO StoO_selcnt</td>
</tr>
<tr>
<td></td>
<td>FROM DUAL</td>
</tr>
<tr>
<td></td>
<td>WHERE (</td>
</tr>
<tr>
<td></td>
<td>SELECT SAL</td>
</tr>
<tr>
<td></td>
<td>FROM EMP</td>
</tr>
<tr>
<td></td>
<td>WHERE EMPID =</td>
</tr>
<tr>
<td></td>
<td>PROC1.empid) &lt; PROC1.basesal;</td>
</tr>
<tr>
<td></td>
<td>StoO_rowcnt := SQLROWCOUNT;</td>
</tr>
<tr>
<td></td>
<td>EXCEPTION</td>
</tr>
<tr>
<td></td>
<td>WHEN OTHERS THEN</td>
</tr>
<tr>
<td></td>
<td>StoO_selcnt := 0;</td>
</tr>
<tr>
<td></td>
<td>StoO_error := SQLCODE;</td>
</tr>
<tr>
<td></td>
<td>StoO_errmsg := SQLERRM;</td>
</tr>
<tr>
<td></td>
<td>END;</td>
</tr>
<tr>
<td></td>
<td>IF StoO_selcnt != 0 THEN</td>
</tr>
<tr>
<td></td>
<td>BEGIN</td>
</tr>
<tr>
<td></td>
<td>StoO_error := 0;</td>
</tr>
<tr>
<td></td>
<td>StoO_rowcnt := 0;</td>
</tr>
<tr>
<td></td>
<td>UPDATE EMP</td>
</tr>
<tr>
<td></td>
<td>SET SAL_FLAG = -1</td>
</tr>
<tr>
<td></td>
<td>WHERE EMPID = PROC1.empid;</td>
</tr>
<tr>
<td></td>
<td>StoO_rowcnt := SQLROWCOUNT;</td>
</tr>
<tr>
<td></td>
<td>EXCEPTION</td>
</tr>
<tr>
<td></td>
<td>WHEN OTHERS THEN</td>
</tr>
<tr>
<td></td>
<td>StoO_error := SQLCODE;</td>
</tr>
<tr>
<td></td>
<td>StoO_errmsg := SQLERRM;</td>
</tr>
<tr>
<td></td>
<td>END;</td>
</tr>
<tr>
<td></td>
<td>END;</td>
</tr>
<tr>
<td></td>
<td>/</td>
</tr>
</tbody>
</table>
Comments

IF statements in Microsoft SQL Server and Sybase Adaptive Server and Oracle are nearly the same except in the following two cases:

If EXISTS(...) in Microsoft SQL Server and Sybase Adaptive Server does not have an equivalent PL/SQL construct. Therefore, it is converted to a SELECT INTO WHERE EXISTS clause and an IF statement as shown in Example 3 above.

IF (SELECT...) with comparison does not have an equivalent PL/SQL construct. Therefore, it is converted to a SELECT INTO...WHERE... clause, as shown in Example 4 above.

RETURN Statement

Table 3–20  Comparison of RETURN Statement in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE PROC proc1 @x int AS IF @x = -1 RETURN 25022 ELSE RETURN 25011</td>
<td>CREATE OR REPLACE FUNCTION PROC1( x INTEGER ) AS BEGIN IF PROC1.x = -1 THEN RETURN 25022; ELSE RETURN 25011; END IF; END PROC1;</td>
</tr>
</tbody>
</table>

Comments

A RETURN statement is used to return a single value back to the calling program and works the same in both databases. Microsoft SQL Server and Sybase Adaptive Server can return only the numeric data type, while Oracle can return any of the server data types or the PL/SQL data types.
In a PL/SQL procedure, a `RETURN` statement can only return the control back to the calling program without returning any data. For this reason, the value is commented out if the Microsoft SQL Server and Sybase Adaptive Server procedure is converted to a PL/SQL procedure, but not commented out if converted to a PL/SQL function. The Migration Workbench does this automatically.

**RAISERROR Statement**

Table 3–21  Comparison of RAISERROR Statement in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE PROC proc1 AS RAISERROR 12345 &quot;No Employees found&quot;</td>
<td>CREATE OR REPLACE PROCEDURE PROC1 AS StoO_selcnt INTEGER; StoO_error INTEGER; StoO_rowcnt INTEGER; StoO_errmsg VARCHAR2(255); StoO_sqlstatus INTEGER; BEGIN raise_application_error(-20999, 12345</td>
</tr>
</tbody>
</table>

Comments

Microsoft SQL Server and Sybase Adaptive Server use RAISERROR to notify the client program of any error that occurred. This statement does not end the execution of the procedure, and the control is passed to the next statement.

PL/SQL provides similar functionality with `RAISE_APPLICATION_ERROR` statements. However, it ends the execution of the stored subprogram and returns the control to the calling program. It is equivalent to a combination of RAISERROR and a `RETURN` statement.

The Migration Workbench copies the error code and error message from a RAISERROR statement and places them in the `RAISE_APPLICATION_ERROR` statement appended to the error message.
### EXECUTE Statement

**Table 3–22 Comparison of EXECUTE Statement in Oracle and Microsoft SQL Server and Sybase Adaptive Server**

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE PROC proc1 AS</td>
<td>CREATE OR REPLACE PROCEDURE PROC1 AS</td>
</tr>
<tr>
<td>EXEC SetExistFlag</td>
<td>StoO_selcnt INTEGER;</td>
</tr>
<tr>
<td>EXEC SetExistFlag yes=@yes, @Status OUT</td>
<td>StoO_error INTEGER;</td>
</tr>
<tr>
<td>EXEC @Status = RecordExists</td>
<td>StoO_rowcnt INTEGER;</td>
</tr>
<tr>
<td>EXEC SetExistFlag @yes</td>
<td>StoO_errmsg VARCHAR2(255);</td>
</tr>
<tr>
<td></td>
<td>StoO_sqlstatus INTEGER;</td>
</tr>
<tr>
<td></td>
<td>BEGIN</td>
</tr>
<tr>
<td></td>
<td>SETEXISTFLAG;</td>
</tr>
<tr>
<td></td>
<td>EXCEPTION</td>
</tr>
<tr>
<td></td>
<td>WHEN OTHERS THEN</td>
</tr>
<tr>
<td></td>
<td>StoO_error := SQLCODE;</td>
</tr>
<tr>
<td></td>
<td>StoO_errmsg := SQLERRM;</td>
</tr>
<tr>
<td></td>
<td>END;</td>
</tr>
<tr>
<td></td>
<td>BEGIN</td>
</tr>
<tr>
<td></td>
<td>SETEXISTFLAG(=PROC1.yes, PROC1.Status);</td>
</tr>
<tr>
<td></td>
<td>EXCEPTION</td>
</tr>
<tr>
<td></td>
<td>WHEN OTHERS THEN</td>
</tr>
<tr>
<td></td>
<td>StoO_error := SQLCODE;</td>
</tr>
<tr>
<td></td>
<td>StoO_errmsg := SQLERRM;</td>
</tr>
<tr>
<td></td>
<td>END;</td>
</tr>
<tr>
<td></td>
<td>BEGIN</td>
</tr>
<tr>
<td></td>
<td>PROC1.Status:=RECORDEXISTS;</td>
</tr>
<tr>
<td></td>
<td>EXCEPTION</td>
</tr>
<tr>
<td></td>
<td>WHEN OTHERS THEN</td>
</tr>
<tr>
<td></td>
<td>StoO_error := SQLCODE;</td>
</tr>
<tr>
<td></td>
<td>StoO_errmsg := SQLERRM;</td>
</tr>
<tr>
<td></td>
<td>END;</td>
</tr>
<tr>
<td></td>
<td>BEGIN</td>
</tr>
<tr>
<td></td>
<td>SETEXISTFLAG(PROC1.yes);</td>
</tr>
<tr>
<td></td>
<td>EXCEPTION</td>
</tr>
<tr>
<td></td>
<td>WHEN OTHERS THEN</td>
</tr>
<tr>
<td></td>
<td>StoO_error := SQLCODE;</td>
</tr>
<tr>
<td></td>
<td>StoO_errmsg := SQLERRM;</td>
</tr>
<tr>
<td></td>
<td>END;</td>
</tr>
<tr>
<td></td>
<td>END PROC1;</td>
</tr>
<tr>
<td></td>
<td>/</td>
</tr>
</tbody>
</table>
Comments
The EXECUTE statement is used to execute another stored procedure from within a procedure. In PL/SQL, the procedure is called by its name within the PL/SQL block. If a procedure is converted to a PL/SQL function, make sure to assign the RETURN value to a variable when calling it (see the call to RecordExists in Table 3-22 above).

The Migration Workbench converts the parameter-calling convention to be either positional, named, or mixed. For information on parameter-calling conventions, see the Schema Objects section in this chapter.

WHILE Statement

Table 3–23    Comparison of WHILE Statement in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 1:</td>
<td>Example 1:</td>
</tr>
<tr>
<td>CREATE PROC proc1</td>
<td>CREATE OR REPLACE PROCEDURE PROC1(</td>
</tr>
<tr>
<td>@i int</td>
<td>in_i   IN INTEGER )</td>
</tr>
<tr>
<td>AS</td>
<td>AS</td>
</tr>
<tr>
<td>WHILE @i &gt; 0</td>
<td>INTEGER;</td>
</tr>
<tr>
<td>print 'Looping inside WHILE....'</td>
<td>StoO_selcnt</td>
</tr>
<tr>
<td>SELECT @i - @i + 1</td>
<td>BEGIN</td>
</tr>
<tr>
<td>END</td>
<td>PROC1.i := PROC1.in_i;</td>
</tr>
<tr>
<td></td>
<td>&lt;&lt;i_loop1&gt;&gt;</td>
</tr>
<tr>
<td></td>
<td>WHILE PROC1.i &gt; 0 LOOP</td>
</tr>
<tr>
<td></td>
<td>BEGIN</td>
</tr>
<tr>
<td></td>
<td>DBMS_OUTPUT.PUT_LINE('Looping inside while.....');</td>
</tr>
<tr>
<td></td>
<td>PROC1.i := PROC1.i + 1;</td>
</tr>
<tr>
<td></td>
<td>END;</td>
</tr>
<tr>
<td></td>
<td>END LOOP;</td>
</tr>
<tr>
<td></td>
<td>END PROC1;</td>
</tr>
<tr>
<td></td>
<td>/</td>
</tr>
</tbody>
</table>
### Example 2:

- **Microsoft SQL Server and Sybase Adaptive Server**
  ```sql
  CREATE PROC proc1
  @i int,
  @y int
  AS
  WHILE @i > 0
  BEGIN
  print 'Looping inside WHILE....'
  SELECT @i = @i + 1
  END
  END proc1;
  ```

- **Oracle**
  ```sql
  CREATE OR REPLACE PROCEDURE PROC1(
in_i IN INTEGER,
y INTEGER)
  AS
  StoO_selcnt INTEGER;
  StoO_error INTEGER;
  StoO_rowcnt INTEGER;
  StoO_errmsg VARCHAR2(255);
  StoO_sqlstatus INTEGER;
  i INTEGER;
  BEGIN
  PROC1.i := PROC1.in_i;
  WHILE PROC1.i > 0 LOOP
  BEGIN
  DBMS_OUTPUT.PUT_LINE('Looping inside while.....');
  PROC1.i := PROC1.i + 1;
  END LOOP;
  END PROC1;
  ```

### Table 3–23 Comparison of WHILE Statement in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 2: CREATE PROC proc1 @i int, @y int AS WHILE @i &gt; 0 BEGIN print 'Looping inside WHILE....' SELECT @i = @i + 1 END END proc1;</td>
<td>Example 2: CREATE OR REPLACE PROCEDURE PROC1(in_i IN INTEGER, y INTEGER) AS StoO_selcnt INTEGER; StoO_error INTEGER; StoO_rowcnt INTEGER; StoO_errmsg VARCHAR2(255); StoO_sqlstatus INTEGER; i INTEGER; BEGIN PROC1.i := PROC1.in_i; WHILE PROC1.i &gt; 0 LOOP BEGIN DBMS_OUTPUT.PUT_LINE('Looping inside while.....'); PROC1.i := PROC1.i + 1; END LOOP; END PROC1; /</td>
</tr>
</tbody>
</table>
Table 3–23  Comparison of WHILE Statement in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 3:</td>
<td>Example 3:</td>
</tr>
<tr>
<td>CREATE PROC proc1 AS</td>
<td>CREATE OR REPLACE PROCEDURE PROC1 AS</td>
</tr>
<tr>
<td>DECLARE @sal money</td>
<td>Sto0_selcnt INTEGER;</td>
</tr>
<tr>
<td>SELECT @sal = 0</td>
<td>Sto0_error INTEGER;</td>
</tr>
<tr>
<td>WHILE EXISTS(SELECT * FROM emp where sal &lt; @sal ) BEGIN</td>
<td>Sto0_rowcnt INTEGER;</td>
</tr>
<tr>
<td>SELECT @sal = @sal + 99</td>
<td>Sto0_errmsg VARCHAR2(255);</td>
</tr>
<tr>
<td>END</td>
<td>Sto0 Sqlstatus INTEGER;</td>
</tr>
<tr>
<td>DELETE emp</td>
<td>sal NUMBER;</td>
</tr>
<tr>
<td>WHERE sal &lt; @sal</td>
<td>BEGIN</td>
</tr>
<tr>
<td>END</td>
<td>PROC1.sal := 0;</td>
</tr>
<tr>
<td>GO</td>
<td>&lt;&lt;i_loop1&gt;&gt;</td>
</tr>
</tbody>
</table>

```sql
BEGIN
  PROC1.sal := 0;
  <<i_loop1>>
  WHILE 1 = 1 LOOP
  BEGIN
    BEGIN
      Sto0_selcnt := 0;
      Sto0_error := 0;
      SELECT 1 INTO Sto0_selcnt FROM DUAL WHERE (EXISTS (SELECT * FROM EMP WHERE SAL < PROC1.sal));
      EXCEPTION
        WHEN OTHERS THEN
          Sto0_selcnt := 0;
          Sto0_error := SQLCODE;
          Sto0_errmsg := SQLERRM;
    END;
    IF Sto0_selcnt != 1 THEN
      EXIT;
    END IF;
    PROC1.sal := PROC1.sal + 99;
    BEGIN
      Sto0_error := 0;
      Sto0_rowcnt := 0;
      DELETE EMP WHERE SAL < PROC1.sal;
      Sto0_rowcnt := SQLROWCOUNT;
      EXCEPTION
        WHEN OTHERS THEN
          Sto0_error := SQLCODE;
          Sto0_errmsg := SQLERRM;
    END;
  END LOOP;
END PROC1;
```

3-50  Reference Guide for Microsoft SQL Server and Sybase Adaptive Server Migrations
Example 4:

```sql
CREATE PROC proc1
AS
DECLARE @sal money
WHILE (SELECT count (*)
FROM emp ) > 0
BEGIN
SELECT @sal = max(sal)
from emp
WHERE stat = 1
DELETE emp
WHERE sal < @sal
END
GO
```

Example 4:

```sql
CREATE OR REPLACE PROCEDURE PROC1
AS
StoO_selcnt     INTEGER;
StoO_error      INTEGER;
StoO_rowcnt     INTEGER;
StoO_errmsg     VARCHAR2(255);
StoO_sqlstatus  INTEGER;
sal     NUMBER;
BEGIN
WHILE 1 = 1 LOOP
BEGIN
BEGIN
StoO_selcnt := 0;
StoO_error  := 0;
SELECT 1 INTO StoO_selcnt FROM DUAL
WHERE (SELECT  COUNT(*)
FROM EMP)>0);
EXCEPTION
WHEN OTHERS THEN
StoO_selcnt := 0;
StoO_error := SQLCODE;
StoO_errmsg := SQLERRM;
END;
IF StoO_selcnt != 1 THEN
EXIT;
END IF;
BEGIN
StoO_error   := 0;
StoO_rowcnt  := 0;
DELETE  EMP
WHERE SAL < PROC1.sal;
END
```

Table 3–23 Comparison of WHILE Statement in Oracle and Microsoft SQL Server and Sybase Adaptive Server (Cont.)

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE PROC proc1 AS</td>
<td>CREATE OR REPLACE PROCEDURE PROC1 AS</td>
</tr>
<tr>
<td>DECLARE @sal money</td>
<td>StoO_selcnt INTEGER; StoO_error INTEGER; StoO_rowcnt INTEGER; StoO_errmsg VARCHAR2(255); StoO_sqlstatus INTEGER; sal NUMBER;</td>
</tr>
<tr>
<td>WHILE (SELECT count (*) FROM emp ) &gt; 0</td>
<td>BEGIN</td>
</tr>
<tr>
<td>BEGIN</td>
<td>WHILE 1 = 1 LOOP</td>
</tr>
<tr>
<td>SELECT @sal = max(sal) FROM emp WHERE stat = 1</td>
<td>BEGIN</td>
</tr>
<tr>
<td>DELETE emp WHERE sal &lt; @sal END GO</td>
<td>BEGIN</td>
</tr>
</tbody>
</table>

```

Triggers and Stored Procedures 3-51
Comments

The Migration Workbench can convert most WHILE constructs. However, the CONTINUE within a WHILE loop in Microsoft SQL Server and Sybase Adaptive Server does not have a direct equivalent in PL/SQL. It is simulated using the GOTO statement with a label. Because the Migration Workbench is a single-pass parser, it adds a label statement at the very beginning of every WHILE loop (see Example 2 in Table 3-23 above).
GOTO Statement

Table 3–24 Comparison of GOTO Statement in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE PROC proc1 @Status int AS DECLARE @j int IF @Status = -1 GOTO Error SELECT @j = -1 Error: SELECT @j = -99</td>
<td>CREATE OR REPLACE PROCEDURE PROC1( Status INTEGER ) AS StoO_selcnt INTEGER; StoO_error INTEGER; StoO_rowcnt INTEGER; StoO_errmsg VARCHAR2(255); StoO_sqlstatus INTEGER; j INTEGER; BEGIN IF PROC1.Status = -1 THEN GOTO ERROR; END IF; PROC1.j := -1; &lt;&lt;ERROR&gt;&gt; PROC1.j := 99; END PROC1; /</td>
</tr>
</tbody>
</table>

Comments

The GOTO <label> statement is converted automatically. No manual changes are required.
@@Rowcount and @@Error Variables

Table 3–25 Comparison of @@Rowcount and @@Error Variables in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE PROC procl AS DECLARE @x int SELECT @x=count(*) FROM emp IF @rowcount = 0 print 'No rows found.' IF @@error = 0 print 'No errors.'</td>
<td>CREATE OR REPLACE PROCEDURE procl AS StoO_selcnt INTEGER; StoO_error INTEGER; StoO_rowcnt INTEGER; i_x INTEGER; BEGIN BEGIN SELECT COUNT(*) INTO i_x FROM emp; StoO_rowcnt := SQL%ROWCOUNT; EXCEPTION WHEN TOO_MANY_ROWS THEN StoO_rowcnt := 2; WHEN OTHERS THEN StoO_rowcnt := 0; StoO_selcnt := 0; StoO_error := SQLCODE; END; IF StoO_rowcnt = 0 THEN DBMS_OUTPUT.PUT_LINE ('No rows found.'); END IF; IF StoO_error = 0 THEN DBMS_OUTPUT.PUT_LINE ('No errors.'); END IF; END;</td>
</tr>
</tbody>
</table>

Comments

@@rowcount is converted to StoO_rowcnt, which takes its value from the PL/SQL cursor attribute SQL%ROWCOUNT.

@@error is converted to StoO_error, which contains the value returned by the SQLCODE function. The value returned by SQLCODE should only be assigned within an exception block; otherwise, it returns a value of zero. This requires that the Migration Workbench add a local exception block around every SQL statement.
and a few PL/SQL statements. Other global variables are converted with a warning message. These may need to be converted manually.

**ASSIGNMENT Statement**

### Table 3–26  Comparison of ASSIGNMENT Statement in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE PROC proc1 AS DECLARE @x int SELECT @x = -1 SELECT @x=sum(salary) FROM employee</td>
<td>CREATE OR REPLACE PROCEDURE PROC1 AS StoO_selcnt INTEGER; StoO_error INTEGER; StoO_rowcnt INTEGER; StoO_errmsg VARCHAR2(255); StoO_sqlstatus INTEGER; x INTEGER; BEGIN PROC1.x := -1; BEGIN StoO_rowcnt := 0; StoO_selcnt := 0; StoO_error := 0; SELECT SUM(SALARY) INTO PROC1.x FROM EMPLOYEE; StoO_rowcnt := SQL%ROWCOUNT; EXCEPTION WHEN TOO_MANY_ROWS THEN StoO_rowcnt := 2; WHEN OTHERS THEN StoO_rowcnt := 0; StoO_selcnt := 0; StoO_error := SQLCODE; StoO_errmsg := SQLERRM; END; END PROC1; /</td>
</tr>
</tbody>
</table>
Comments

Assignment in Microsoft SQL Server and Sybase Adaptive Server is done using the SELECT statement as illustrated in Table 3-26.

PL/SQL assigns values to a variable as follows:

It uses the assignment statement to assign the value of a variable or an expression to a local variable. It assigns a value from a database using the `SELECT..INTO` clause. This requires that the SQL returns only one row, or a NULL value is assigned to the variable as can be seen in the following example:

```sql
SELECT empno INTO empno
FROM employee
WHERE ename = 'JOE RICHARDS'
```

SELECT Statement

Table 3–27 Comparison of SELECT Statement in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 1: Create procedure <code>proc1</code> as</td>
<td>Example 1: Create or replace package <code>PROC1Pkg</code> as</td>
</tr>
<tr>
<td>SELECT <code>ename</code> from <code>employee</code></td>
<td>TYPE <code>RT1</code> is record {</td>
</tr>
<tr>
<td></td>
<td><code>ENAME</code> <code>EMPLOYEE.ENAME%TYPE</code></td>
</tr>
<tr>
<td></td>
<td><code>TYPE </code>RCT1<code>is ref cursor return</code>RT1`;</td>
</tr>
<tr>
<td></td>
<td><code>END;</code></td>
</tr>
<tr>
<td></td>
<td>CREATE or replace procedure <code>PROC1</code>(</td>
</tr>
<tr>
<td></td>
<td><code>RC1</code> in out <code>PROC1Pkg.RCT1</code>) as</td>
</tr>
<tr>
<td></td>
<td><code>STO_SELCNT</code> INTEGER;</td>
</tr>
<tr>
<td></td>
<td><code>STO_ERROR</code> INTEGER;</td>
</tr>
<tr>
<td></td>
<td><code>STO_ROWCNT</code> INTEGER;</td>
</tr>
<tr>
<td></td>
<td><code>STO_ERRMSG</code> VARCHAR2(255);</td>
</tr>
<tr>
<td></td>
<td><code>STO_SQLSTATUS</code> INTEGER;</td>
</tr>
<tr>
<td></td>
<td>BEGIN</td>
</tr>
<tr>
<td></td>
<td>OPEN <code>RC1</code> for</td>
</tr>
<tr>
<td></td>
<td>SELECT <code>ENAME</code> from <code>EMPLOYEE</code>;</td>
</tr>
<tr>
<td></td>
<td>END <code>PROC1</code>;</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Comments

Because of the differences in their architectures, Microsoft SQL Server and Sybase Adaptive Server stored procedures return data to the client program in a different way than Oracle.
Microsoft SQL Server and Sybase Adaptive Server and Oracle can all pass data to the client using output parameters in the stored procedures. Microsoft SQL Server and Sybase Adaptive Server use another method known as result sets to transfer the data from the server to client. The examples discussed here do not return multiple rows to the client.

In Example 1, the procedure returns a single row result set to the client which is converted to a PL/SQL procedure that returns a single row using the output parameters.

**Example 1:**

A SELECT statement is converted into a SELECT...INTO clause and the extra parameter "i_oval1" is added to the procedure definition. Since the Migration Workbench does not currently look up the data types on the Oracle server, it sets the default data type to VARCHAR2.

*Note:* In Oracle, the query should return only one row or the TOO_MANY_ROWS exception is raised and the data value is not assigned to the variables. To return more than one row, refer to the example on RESULT SETS later in this section.

In Microsoft SQL Server and Sybase Adaptive Server, if the SELECT statement that assigns value to a variable returns more than one value, the last value that is returned is assigned to the variable.

**Example 2:**

The second example illustrates fetching data into a local variable. Since this is straightforward, the Migration Workbench handles it successfully.

*Note:* Microsoft SQL Server-specific SQL statements should be converted manually. The Migration Workbench handles ANSI-standard SQL statements only.
SELECT Statement as Part of the SELECT List

Table 3–28  Comparison of SELECT Statement as Part of the SELECT List in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE PROC proc1 AS                      CREATE OR REPLACE PROCEDURE PROC1 AS</td>
<td></td>
</tr>
<tr>
<td>DECLARE @x int                             DECLARE Stoo_selcnt INTEGER;</td>
<td></td>
</tr>
<tr>
<td>DECLARE @y char(20)                        DECLARE Stoo_error INTEGER;</td>
<td></td>
</tr>
<tr>
<td>SELECT @x = col1, @y = (select name from emp)</td>
<td>Stoo_rowcnt INTEGER;</td>
</tr>
<tr>
<td>FROM table1                                Stoo_errmsg VARCHAR2(255);</td>
<td></td>
</tr>
<tr>
<td>Stoo_sqlstatus INTEGER;</td>
<td></td>
</tr>
<tr>
<td>x INTEGER;</td>
<td></td>
</tr>
<tr>
<td>y CHAR(20);</td>
<td></td>
</tr>
<tr>
<td>t_var1 VARCHAR2(255);</td>
<td></td>
</tr>
</tbody>
</table>
|                                               BEGIN
|                                               /****** Subqueries in select list is not supported in Oracle. ******/
|                                               /****** MANUAL CONVERSION MIGHT BE REQUIRED ******/
|                                               BEGIN
|                                               Stoo_error := 0;
|                                               Stoo_rowcnt := 0;
|                                               SELECT NAME INTO t_var1
|                                               FROM EMP;
|                                               Stoo_rowcnt := SQL%ROWCOUNT;
|                                               EXCEPTION
|                                               WHEN TOO_MANY_ROWS THEN
|                                               Stoo_StoO_rowcnt := 2;
|                                               WHEN OTHERS THEN
|                                               Stoo_StoO_rowcnt := 0;
|                                               Stoo_error := SQLCODE;
|                                               Stoo_errmsg := SQLERRM;
|                                               END;
|                                               BEGIN
|                                               Stoo_rowcnt := 0;
|                                               Stoo_selcnt := 0;
|                                               Stoo_error := 0;
|                                               SELECT COL1, t_var1 INTO PROC1.x, PROC1.y FROM TABLE1;
|                                               Stoo_rowcnt := SQL%ROWCOUNT;
|                                               EXCEPTION
|                                               WHEN TOO_MANY_ROWS THEN
|                                               Stoo_rowcnt := 2;
|                                               WHEN OTHERS THEN
|                                               Stoo_rowcnt := 0;
|                                               Stoo_selcnt := 0;
|                                               Stoo_error := SQLCODE;
|                                               Stoo_errmsg := SQLERRM;
|                                               END;
|                                               END PROC1;
|                                               /
T/SQl Versus PL/SQL Constructs

Comments

The Microsoft SQL Server and Sybase Adaptive Server SELECT statement with a subquery as part of the SELECT list cannot be converted to PL/SQL using the Migration Workbench. Manual changes are needed to convert this type of SELECT statement.

The Migration Workbench writes appropriate comments in the output PL/SQL procedures and the subqueries are omitted.
SELECT Statement with GROUP BY Clause

Table 3–29  Comparison of SELECT Statement with GROUP BY Clause in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE PROC proc1 AS</td>
<td>CREATE OR REPLACE PROCEDURE PROC1 AS</td>
</tr>
<tr>
<td>DECLARE @ename char(20)</td>
<td>STO0_selcnt INTEGER;</td>
</tr>
<tr>
<td>DECLARE @salary int</td>
<td>STO0_error INTEGER;</td>
</tr>
<tr>
<td>SELECT @ename=ename,</td>
<td>STO0_rowcnt INTEGER;</td>
</tr>
<tr>
<td>@salary=salary FROM emp</td>
<td>STO0_errmsg VARCHAR2(255);</td>
</tr>
<tr>
<td>WHERE salary &gt; 100000</td>
<td>STO0_sqlstatus INTEGER;</td>
</tr>
<tr>
<td>GROUP BY deptno</td>
<td>ename CHAR(20);</td>
</tr>
<tr>
<td></td>
<td>salary INTEGER;</td>
</tr>
<tr>
<td></td>
<td>BEGIN</td>
</tr>
<tr>
<td></td>
<td>STO0_rowcnt := 0;</td>
</tr>
<tr>
<td></td>
<td>STO0_selcnt := 0;</td>
</tr>
<tr>
<td></td>
<td>STO0_error := 0;</td>
</tr>
<tr>
<td></td>
<td>SELECT ENAME, SALARY INTO PROC1.ename,</td>
</tr>
<tr>
<td></td>
<td>PROC1.salary FROM EMP</td>
</tr>
<tr>
<td></td>
<td>WHERE SALARY &gt; 100000 GROUP BY DEPTNO;</td>
</tr>
<tr>
<td></td>
<td>STO0_rowcnt := SQL%ROWCOUNT;</td>
</tr>
<tr>
<td></td>
<td>EXCEPTION</td>
</tr>
<tr>
<td></td>
<td>WHEN TOO_MANY_ROWS THEN</td>
</tr>
<tr>
<td></td>
<td>STO0_rowcnt := 2;</td>
</tr>
<tr>
<td></td>
<td>WHEN OTHERS THEN</td>
</tr>
<tr>
<td></td>
<td>STO0_rowcnt := 0;</td>
</tr>
<tr>
<td></td>
<td>STO0_selcnt := 0;</td>
</tr>
<tr>
<td></td>
<td>STO0_error := SQLCODE;</td>
</tr>
<tr>
<td></td>
<td>STO0_errmsg := SQLERRM;</td>
</tr>
<tr>
<td></td>
<td>END;</td>
</tr>
<tr>
<td></td>
<td>END PROC1;</td>
</tr>
<tr>
<td></td>
<td>/</td>
</tr>
</tbody>
</table>
T/SQL Versus PL/SQL Constructs

Comments

T/SQL allows GROUP BY statements where the column used in the GROUP BY clause does not need to be part of the SELECT list. PL/SQL does not allow this type of GROUP BY clause.

The Migration Workbench converts this type of SELECT statement to PL/SQL. However, the equivalent PL/SQL statement returns an error in Oracle.

Column Aliases

Table 3–30  Comparison of Column Aliases in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE PROC proc1 @Status int=0 AS SELECT x=sum(salary) FROM employee</td>
<td>CREATE OR REPLACE PROCEDURE PROC1( Status INTEGER DEFAULT 0, RC1 IN OUT PROC1pkg.RCT1 AS SELECT * as x FROM employee WHERE Status = 0)</td>
</tr>
<tr>
<td></td>
<td>BEGIN</td>
</tr>
<tr>
<td></td>
<td>OPEN RC1 FOR</td>
</tr>
<tr>
<td></td>
<td>SELECT SUM(SALARY) &quot;X&quot; FROM EMPLOYEE;</td>
</tr>
<tr>
<td></td>
<td>END PROC1;</td>
</tr>
<tr>
<td></td>
<td>/</td>
</tr>
</tbody>
</table>

Comments

The Migration Workbench can convert Microsoft SQL Server-specific column aliases to the equivalent Oracle format. No manual changes are required.
UPDATE with FROM Statement

Table 3-31   Comparison of UPDATE with FROM Statement in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE PROC proc1 AS</td>
<td>CREATE OR REPLACE PROCEDURE proc1 AS</td>
</tr>
<tr>
<td>UPDATE table1</td>
<td>StoO_selcnt INTEGER;</td>
</tr>
<tr>
<td>SET col1 = 1</td>
<td>StoO_error INTEGER;</td>
</tr>
<tr>
<td>FROM table1, table2</td>
<td>StoO_rowcnt INTEGER;</td>
</tr>
<tr>
<td>WHERE table1.id = table2.id</td>
<td>BEGIN</td>
</tr>
<tr>
<td></td>
<td>UPDATE table1</td>
</tr>
<tr>
<td></td>
<td>SET</td>
</tr>
<tr>
<td></td>
<td>col1 = 1 /* FROM table1,table2 --</td>
</tr>
<tr>
<td></td>
<td>MANUAL CONVERSION */</td>
</tr>
<tr>
<td></td>
<td>WHERE table1.id = table2.id;</td>
</tr>
<tr>
<td></td>
<td>StoO_rowcnt := SQL%ROWCOUNT;</td>
</tr>
<tr>
<td></td>
<td>EXCEPTION</td>
</tr>
<tr>
<td></td>
<td>WHEN OTHERS THEN</td>
</tr>
<tr>
<td></td>
<td>StoO_error := SQLCODE;</td>
</tr>
<tr>
<td></td>
<td>END;</td>
</tr>
</tbody>
</table>

Comments

An UPDATE with a FROM clause cannot be converted. Instead, the Migration Workbench provides a comment indicating that manual conversion is required.

There are two ways to convert UPDATE with a FROM statements, and these are illustrated below.

Method 1:

Use the subquery in the SET clause if columns are being updated to values coming from a different table. For example, consider the following T/SQL statement:

```sql
UPDATE titles
SET pub_id = publishers.pub_id
FROM titles, publishers
WHERE titles.title like 'C%'
AND publishers.pub_name = 'new age'
```
Convert this statement to the following PL/SQL statement in Oracle:

```sql
UPDATE titles
SET pub_id = (SELECT a.pub_id
              FROM publishers a
              WHERE publishers.pub_name = 'new age')
WHERE titles.title like 'C%'
```

**Method 2:**

Use the subquery in the WHERE clause for all other UPDATE...FROM statements. For example, consider the following T/SQL statement:

```sql
UPDATE shippint_parts
SET qty = 0
FROM shipping_parts sp, suppliers s
WHERE sp.supplier_num = s.supplier_num
AND s.location = "USA"
```

Convert this statement to the following PL/SQL statement in Oracle:

```sql
UPDATE shipping_parts
SET qty = 0
WHERE supplier_num IN (
    SELECT supplier_num
    FROM suppliers
    WHERE location = 'USA')
```
DELETE with FROM Statement

Table 3-32  Comparison of DELETE with FROM Statement in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE PROC proc1 AS</td>
<td>CREATE OR REPLACE PROCEDURE PROC1 AS</td>
</tr>
<tr>
<td>DELETE FROM table1 FROM table1, table2 WHERE table1.id = table2.id</td>
<td>StoO_selcnt INTEGER;</td>
</tr>
<tr>
<td></td>
<td>StoO_error INTEGER;</td>
</tr>
<tr>
<td></td>
<td>StoO_rowcnt INTEGER;</td>
</tr>
<tr>
<td></td>
<td>StoO_errmsg VARCHAR2(255);</td>
</tr>
<tr>
<td></td>
<td>StoO_sqlstatus INTEGER;</td>
</tr>
<tr>
<td></td>
<td>UF1_rowid ROWID;</td>
</tr>
<tr>
<td></td>
<td>UF1_oval1 TABLE1.COL1%TYPE;</td>
</tr>
<tr>
<td>CURSOR UF1_cursor IS</td>
<td>BEGIN</td>
</tr>
<tr>
<td>SELECT TABLE1.ROWID, 1 FROM</td>
<td>OPEN UF1_cursor;</td>
</tr>
<tr>
<td>TABLE1, TABLE2 WHERE TABLE1.ID = TABLE2.ID</td>
<td>LOOP</td>
</tr>
<tr>
<td>FOR UPDATE OF TABLE1.COL1;</td>
<td>FETCH UF1_cursor INTO UF1_rowid, UF1_oval1;</td>
</tr>
<tr>
<td></td>
<td>EXIT WHEN UF1_cursor%NOTFOUND;</td>
</tr>
<tr>
<td></td>
<td>BEGIN</td>
</tr>
<tr>
<td></td>
<td>StoO_error := 0;</td>
</tr>
<tr>
<td></td>
<td>StoO_rowcnt := 0;</td>
</tr>
<tr>
<td></td>
<td>UPDATE TABLE1 SET COL1 = UF1_oval1 WHERE ROWID = UF1_rowid;</td>
</tr>
<tr>
<td></td>
<td>StoO_rowcnt := SQL%ROWCOUNT;</td>
</tr>
<tr>
<td>WHEN OTHERS THEN</td>
<td>EXCEPTION</td>
</tr>
<tr>
<td>StoO_error := SQLCODE;</td>
<td>WHEN OTHERS THEN</td>
</tr>
<tr>
<td>StoO_errmsg := SQLERRM;</td>
<td>StoO_error := SQLCODE;</td>
</tr>
<tr>
<td></td>
<td>StoO_errmsg := SQLERRM;</td>
</tr>
<tr>
<td>END;</td>
<td>END</td>
</tr>
<tr>
<td>END LOOP;</td>
<td>END PROC1;</td>
</tr>
</tbody>
</table>
| CLOSE UF1_cursor;                                | /

Triggers and Stored Procedures  3-65
Comments

A DELETE with FROM..FROM clause must be converted manually.

While converting DELETE with FROM..FROM clause, remove the second FROM clause. For example consider the following T/SQL statement:

```sql
DELETE
FROM sales
FROM sales,titles
WHERE sales.title_id = titles.title_id
AND titles.type = 'business'
```

Convert the above statement to the following PL/SQL statement in Oracle:

```sql
DELETE
FROM sales
WHERE title_id IN (SELECT title_id
FROM titles
WHERE type = 'business')
```
Temporary Tables

Table 3–33 Comparison of Temporary Tables in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE PROC proc1 AS</td>
<td>CREATE OR REPLACE PROCEDURE PROC1 AS</td>
</tr>
<tr>
<td>SELECT col1, col2 INTO #Tab FROM table1 WHERE table1.id = 100</td>
<td>SHO0_selcnt INTEGER;</td>
</tr>
<tr>
<td></td>
<td>SHO0_error INTEGER;</td>
</tr>
<tr>
<td></td>
<td>SHO0_rowcnt INTEGER;</td>
</tr>
<tr>
<td></td>
<td>SHO0_errmsg VARCHAR2(255);</td>
</tr>
<tr>
<td></td>
<td>SHO0_sqlstatus INTEGER;</td>
</tr>
<tr>
<td>BEGIN</td>
<td>BEGIN</td>
</tr>
<tr>
<td>/<em>CONVERTING SELECT INTO t_Tab</em>/</td>
<td>/<em>CONVERTING SELECT INTO t_Tab</em>/</td>
</tr>
<tr>
<td>/<em>TO INSERT INTO t_Tab</em>/</td>
<td>/<em>TO INSERT INTO t_Tab</em>/</td>
</tr>
<tr>
<td>INSERT INTO t_Tab</td>
<td>BEGIN</td>
</tr>
<tr>
<td>SELECT USERENV('SESSIONID'), COL1, COL2 FROM TABLE1 WHERE TABLE1.ID = 100;</td>
<td>SHO0_rowcnt := SQL%ROWCOUNT;</td>
</tr>
<tr>
<td></td>
<td>EXCEPTION</td>
</tr>
<tr>
<td></td>
<td>WHEN TOO_MANY_ROWS THEN</td>
</tr>
<tr>
<td></td>
<td>SHO0_rowcnt := 2;</td>
</tr>
<tr>
<td></td>
<td>WHEN OTHERS THEN</td>
</tr>
<tr>
<td></td>
<td>SHO0_rowcnt := 0;</td>
</tr>
<tr>
<td></td>
<td>SHO0_selcnt := 0;</td>
</tr>
<tr>
<td></td>
<td>SHO0_error := SQLCODE;</td>
</tr>
<tr>
<td></td>
<td>SHO0_errmsg := SQLERRM;</td>
</tr>
<tr>
<td>END; END PROC1; /</td>
<td>END; END PROC1; /</td>
</tr>
</tbody>
</table>

Comments

Temporary tables are supported by Oracle9i and Oracle8i. The Migration Workbench utilizes this feature in Oracle9i and Oracle8i.
Also, `SELECT..INTO..#TEMPTAB` is converted to an `INSERT` statement. You must make manual changes to ensure that rows are unique to a particular session and all the rows for that session are deleted at the end of the operation. This requires that you add an extra column to the table definition and the value of `USERENV('session_id')` for all the rows inserted. At the end, delete all rows for that `session_id`. If many procedures use the same temp table in the same session, `SEQUENCE` can be used to make sure that the rows are unique to a particular `session_id`/`SEQUENCE` combination.

**Result Set (Converted Using a Cursor Variable)**

Command Option -M

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
</table>
| CREATE PROC proc1 AS
  SELECT col1, col2
  FROM table1 | CREATE OR REPLACE PACKAGE PROC1Pkg AS
  TYPE RT1 IS RECORD ( 
    COL1 TABLE1.COL1%TYPE,
    COL2 TABLE1.COL2%TYPE
  );
  TYPE RCT1 IS REF CURSOR RETURN RT1;
  BEGIN
    OPEN RC1 FOR
    SELECT COL1, COL2 FROM TABLE1;
  END PROC1; |

| CREATE OR REPLACE PROCEDURE PROC1(
  RC1 IN OUT PROC1Pkg.RCT1)
  AS
  StoO_selcnt INTEGER;
  StoO_error INTEGER;
  StoO_rowcnt INTEGER;
  StoO_errmsg VARCHAR2(255);
  StoO_sqlstatus INTEGER;
  BEGIN
    OPEN RC1 FOR
    SELECT COL1, COL2 FROM TABLE1;
  END PROC1; |
Comments

Convert an Microsoft SQL Server and Sybase Adaptive Server procedure that returns a multi-row result set to a PL/SQL packaged function by selecting the appropriate parse option in the property sheet for a stored procedure.

The T/SQL SELECT statement is converted to a cursor and a cursor variable is added as an OUT parameter to return the data back to the calling program. Use the cursor referenced by the cursor variable to fetch the result rows.

For more details on how Result Sets are handled by the Migration Workbench, see T/SQL and PL/SQL Language Elements section in this chapter.

---

**Note:** The conversion to a packaged function does not work in all cases. Carefully check the input source and decide whether it can be converted to a packaged function. Also check the output for accuracy.
Cursor Handling

Table 3–35  Comparison of Cursor Handling Result Set in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE PROC cursor_demo AS</td>
<td>CREATE OR REPLACE PROCEDURE CURSOR-demo AS</td>
</tr>
<tr>
<td>DECLARE @empno INT</td>
<td>AS</td>
</tr>
<tr>
<td>DECLARE @ename CHAR(100)</td>
<td>StoO_selcnt INTEGER;</td>
</tr>
<tr>
<td>DECLARE @sal FLOAT</td>
<td>StoO_error INTEGER;</td>
</tr>
<tr>
<td>DECLARE cursor_1 CURSOR</td>
<td>StoO_rowcnt INTEGER;</td>
</tr>
<tr>
<td>FOR SELECT empno, ename, sal FROM emp</td>
<td>StoO_errmag VARCHAR2(255);</td>
</tr>
<tr>
<td>OPEN cursor_1</td>
<td>StoO_sqlstatus INTEGER;</td>
</tr>
<tr>
<td>CURSOR_1 INTO @empno, @ename, @sal</td>
<td>empno INTEGER;</td>
</tr>
<tr>
<td>IF CURSOR_1%NOTFOUND THEN</td>
<td>name CHAR(100);</td>
</tr>
<tr>
<td>END IF;</td>
<td>sal NUMBER;</td>
</tr>
<tr>
<td>CLOSE cursor_1</td>
<td>/<em>[SPCONV-ERR(xxx)]:Deallocate Cursor is not supported</em>/</td>
</tr>
<tr>
<td>DEALLOCATE CURSOR cursor_1</td>
<td>NULL;</td>
</tr>
<tr>
<td>END cursor demo</td>
<td>END CURSOR демо;</td>
</tr>
<tr>
<td></td>
<td>/</td>
</tr>
</tbody>
</table>

/*[SPCONV-ERR(xxx)]:Deallocate Cursor is not supported*/
Comments

Microsoft SQL Server and Sybase Adaptive Server introduced cursors in T/SQL. Syntactical conversion of cursors from Microsoft SQL Server and Sybase Adaptive Server to Oracle is very straightforward.

---

**Note:** In PL/SQL, deallocation of cursors is not required as it happens transparently.
Transaction Handling Statements

Table 3–36  Comparison of Transaction-Handling Statements in Oracle and Microsoft SQL Server and Sybase Adaptive Server

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE PROC proc1 AS</td>
<td>CREATE OR REPLACE FUNCTION PROC1 RETURN INTEGER AS</td>
</tr>
<tr>
<td>BEGIN TRAN tran1</td>
<td></td>
</tr>
<tr>
<td>UPDATE table1</td>
<td></td>
</tr>
<tr>
<td>SET id = id + 1</td>
<td></td>
</tr>
<tr>
<td>WHERE name = 'Event'</td>
<td></td>
</tr>
<tr>
<td>IF @@Rowcount != 1</td>
<td></td>
</tr>
<tr>
<td>BEGIN</td>
<td></td>
</tr>
<tr>
<td>ROLLBACK TRAN tran1</td>
<td></td>
</tr>
<tr>
<td>RETURN 25700</td>
<td></td>
</tr>
<tr>
<td>COMMIT TRAN tran1</td>
<td></td>
</tr>
<tr>
<td>RETURN 0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments

3-72  Reference Guide for Microsoft SQL Server and Sybase Adaptive Server Migrations
The Migration Workbench does a one-to-one mapping when converting Microsoft SQL Server and Sybase Adaptive Server transaction commands to their Oracle equivalents. For more details about how transactions are handled in Oracle, see the Transaction-Handling Semantics topic later in this chapter.

**Note:** Make sure that the functionality remains the same, as the transaction models may differ in Microsoft SQL Server and Sybase Adaptive Server and Oracle.

### T/SQL and PL/SQL Language Elements

T/SQL is the Microsoft SQL Server and Sybase Adaptive Server procedural SQL language and PL/SQL is the Oracle procedural SQL language. This section discusses the following T/SQL and PL/SQL language elements:

- Transaction Handling Semantics
- Exception-Handling and Error-Handling Semantics
- Special Global Variables
- Operators
- Built-in Functions
- Sending Data to the Client: Result Sets
- DDL Constructs within Microsoft SQL Server and Sybase Adaptive Server Stored Procedures

### Transaction Handling Semantics

**Microsoft SQL Server and Sybase Adaptive Server**

Microsoft SQL Server and Sybase Adaptive Server offer two different transaction models: the ANSI-standard implicit transaction model and the explicit transaction model.

Microsoft SQL Server and Sybase Adaptive Server provide options to support ANSI-standard transactions. These options can be set or un-set using the SET command.

The following SET command sets the implicit transaction mode:

```sql
set chained on
```
The following SET command sets the isolation level to the desired level:

```
set transaction isolation level {1|3}
```

*Isolation level 1 prevents dirty reads. Isolation level 2 prevents un-repeatable reads. Isolation level 3 prevents phantoms. Isolation level 3 is required by ANSI standards. For Microsoft SQL Server and Sybase Adaptive Server, the default is isolation level 1.*

To implement isolation level 3, Microsoft SQL Server and Sybase Adaptive Server apply HOLDLOCK to all the tables taking part in the transaction. In Microsoft SQL Server and Sybase Adaptive Server, HOLDLOCK, along with page-level locks, can block users for a considerable length of time, causing poor response time.

If the Microsoft SQL Server and Sybase Adaptive Server application implements ANSI-standard chained (implicit) transactions with isolation level 3, the application migrates smoothly to Oracle because Oracle implements the ANSI-standard implicit transaction model, which ensures repeatable reads.

In a non-ANSI standard application, Microsoft SQL Server and Sybase Adaptive Server transactions are explicit. A logical transaction has to be explicitly started with the statement BEGIN TRANSACTION. The transaction is committed with a COMMIT TRANSACTION or rolled back with a ROLLBACK TRANSACTION statement. The transactions can be named. For example, the following statement starts a transaction named `account_tran`.

```
BEGIN TRANSACTION account_tran
```

The explicit transaction mode allows nested transactions. However, the nesting is only syntactical. Only outermost BEGIN TRANSACTION and COMMIT TRANSACTION statements actually create and commit the transaction. This could be confusing as the inner COMMIT TRANSACTION does not actually commit.

The following example illustrates the nested transactions:

```
BEGIN TRANSACTION
    /* T/SQL Statements */
BEGIN TRANSACTION
    /* T/SQL Statements */
    BEGIN TRANSACTION account_tran
        /* T/SQL Statements */
    IF SUCCESS
        COMMIT TRANSACTION account_tran
    ELSE
```
ROLLBACK TRANSACTION account_tran
END IF
/* T/SQL Statements */
IF SUCCESS
   COMMIT TRANSACTION
ELSE
   ROLLBACK TRANSACTION
END IF
/* T/SQL Statements */
COMMIT TRANSACTION

When BEGIN TRANSACTION and COMMIT TRANSACTION statements are nested, the outermost pair creates and commits the transaction while the inner pairs only keep track of nesting levels. The transaction is not committed until the outermost COMMIT TRANSACTION statement is executed. Normally the nesting of the transaction occurs when stored procedures containing BEGIN TRANSACTION /COMMIT TRANSACTION statements call other procedures with transaction-handling statements. The global variable @@trancount keeps track of the number of currently active transactions for the current user. If you have more than one open transaction, you need to ROLLBACK, then COMMIT.

The named and unnamed inner COMMIT TRANSACTION statements have no effect. The inner ROLLBACK TRANSACTION statements without the name roll back the statements to the outermost BEGIN TRANSACTION statement and the current transaction is canceled. The named inner ROLLBACK TRANSACTION statements cancel the respective named transactions.

Oracle

Oracle applies ANSI-standard implicit transaction methods. A logical transaction begins with the first executable SQL statement after a COMMIT, ROLLBACK, or connection to the database. A transaction ends with a COMMIT, ROLLBACK, or disconnection from the database. An implicit COMMIT statement is issued before and after each DDL statement. The implicit transaction model prevents artificial nesting of transactions because only one logical transaction per session can be in effect. The user can set SAVEPOINT in a transaction and roll back a partial transaction to the SAVEPOINT.

For example:

```
UPDATE test_table SET col='value_1';
SAVEPOINT first_sp;
UPDATE test_table SET col='value_2';
ROLLBACK TO SAVEPOINT first_sp;
COMMIT; /* col is 'value_1'*/
```
Conversion Preparation Recommendations

Logical transactions are handled differently in Microsoft SQL Server and Sybase Adaptive Server and Oracle. In Microsoft SQL Server and Sybase Adaptive Server, transactions are explicit by default. Oracle implements ANSI-standard implicit transactions. This prevents a direct conversion from T/SQL transaction-handling statements to PL/SQL transaction-handling statements.

Also, Microsoft SQL Server and Sybase Adaptive Server require that transactions in stored procedures be allowed to nest, whereas Oracle does not support transaction nesting.

The following table compares Microsoft SQL Server and Sybase Adaptive Server to Oracle transaction-handling statements:

<table>
<thead>
<tr>
<th>Microsoft SQL Server and Sybase Adaptive Server</th>
<th>Oracle</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEGIN TRAN</td>
<td></td>
</tr>
<tr>
<td>BEGIN TRAN tran_1</td>
<td>SAVEPOINT tran_1</td>
</tr>
<tr>
<td>COMMIT TRAN</td>
<td>COMMIT</td>
</tr>
<tr>
<td>(for the transaction with nest level=1)</td>
<td></td>
</tr>
<tr>
<td>COMMIT TRAN</td>
<td></td>
</tr>
<tr>
<td>(for the transaction with nest level&gt;1)</td>
<td></td>
</tr>
<tr>
<td>COMMIT TRAN tran_1</td>
<td>COMMIT</td>
</tr>
<tr>
<td>(for the transaction with nest level=1)</td>
<td></td>
</tr>
<tr>
<td>COMMIT TRAN tran_1</td>
<td>COMMIT</td>
</tr>
<tr>
<td>(for the transaction with nest level&gt;1)</td>
<td></td>
</tr>
<tr>
<td>ROLLBACK TRAN</td>
<td>ROLLBACK</td>
</tr>
<tr>
<td>ROLLBACK TRAN tran_1</td>
<td>ROLLBACK TO SAVEPOINT tran_1</td>
</tr>
</tbody>
</table>

At the time of conversion, the Migration Workbench cannot determine the nest level of the current transaction-handling statement. The variable @@trancount is a runtime environment variable.

Table 3-38 shows the currently implemented Microsoft SQL Server and Sybase Adaptive Server to Oracle conversion strategy for the transaction-handling statements.
Because of the difference in the way the two databases handle transactions, you may want to consider some reorganization of the transactions.

Try to design client/server applications so that the transaction-handling statements are part of the client code rather than the stored procedure code. This strategy should work because the logical transactions are almost always designed by the user and should be controlled by the user.

For the conversion of stored procedures, consider setting a SAVEPOINT at the beginning of the procedures, and roll back only to the SAVEPOINT. In Microsoft SQL Server and Sybase Adaptive Server, make the changes so that at least the outermost transaction is controlled in the client application.

### Exception-Handling and Error-Handling Semantics

**Microsoft SQL Server and Sybase Adaptive Server**

In Microsoft SQL Server and Sybase Adaptive Server, you must check for errors after each SQL statement because control is passed to the next statement regardless of any error conditions generated by the previous statement. The client `ERROR_`
HANDLER routine is invoked as a call-back routine if any server error occurs, and the error conditions can be handled in the call back routine.

Stored procedures use the RAISERROR statement to notify the client of any error condition. This statement does not cause the control to return to the calling routine.

Microsoft SQL Server and Sybase Adaptive Server allow you to customize the error messages using a system table. The system procedures allow the user to add error messages to this table.

**Oracle**

In Oracle, each SQL statement is automatically checked for errors before proceeding with the next statement. If an error occurs, control immediately jumps to an exception handler if one exists. This frees you from needing to check the status of every SQL statement. For example, if a SELECT statement does not find any row in the database, an exception is raised. The corresponding exception handler part of the block should include the code to deal with this error. The built-in RAISE_APPLICATION_ERROR procedure notifies the client of the server error condition and returns immediately to the calling routine.

Oracle places an implicit SAVEPOINT at the beginning of a procedure. The built-in RAISE_APPLICATION_ERROR procedure rolls back to this SAVEPOINT or the last committed transaction within the procedure. The control is returned to the calling routine.

The Oracle RAISE_APPLICATION_ERROR statement allows the user to customize the error message. If an exception is raised, SQLCODE is returned automatically by PL/SQL to the caller. It keeps propagating until it is handled.

**Recommendations**

To simulate Microsoft SQL Server and Sybase Adaptive Server behavior in Oracle, you must enclose each SQL statement in an equivalent PL/SQL block. This block must deal with the exceptions that need to be trapped for the SQL statement.

See the **T/SQL Versus PL/SQL Constructs** section in this chapter for more information about the extra code required to simulate Microsoft SQL Server and Sybase Adaptive Server behavior.

If the RAISERROR statement in an Microsoft SQL Server and Sybase Adaptive Server stored procedure is immediately followed by the RETURN statement, these two statements can be converted to the Oracle RAISE_APPLICATION_ERROR statement.

You can customize error messages with the help of a user-defined table. You can write standard routines to add and retrieve error messages to this table. This
method serves a two-fold purpose: it ensures that the system is portable, and it
gives the administrator centralized control over the error messages.

Special Global Variables

Microsoft SQL Server and Sybase Adaptive Server
The following global variables are particularly useful in the conversion process:

@@error:
The server error code indicating the execution status of the most recently executed
T/SQL statement. For code examples, see the @@Rowcount and @@Error Variables
topic.

@@identity:
Returns the last identity value generated by the statement. It does not revert to a
previous setting due to ROLLBACKS or other transactions.

@@rowcount:
The number of rows affected by the most recently executed T/SQL statement. For
code examples, see the @@Rowcount and @@Error Variables topic.

@@servername:
The name of the local Microsoft SQL Server and Sybase Adaptive Server server.

@@sqlstatus:
The status information resulting from the last FETCH statements.

@@tranchained:
The current transaction mode of the T/SQL procedure. If @@tranchained returns 1,
the TL/SQL procedure is in chained, or implicit transaction mode.

@@trancount:
Keeps track of the nesting level for the nested transactions for the current user.

@@transtate:
The current state of the transaction.

Oracle

SQLCODE:
The server error code indicating the execution status of the most recently executed
PL/SQL statement.

SQL%ROWCOUNT:
The variable attached to the implicit cursor associated with each SQL statement
executed from within the PL/SQL procedures. This variable contains the number of
rows affected by the execution of the SQL statement attached to the implicit cursor.
Recommendations:
The `@@error` variable has a direct equivalent in Oracle, and that is the SQLCODE function. The SQLCODE function returns the server error code.

The `SQL%ROWCOUNT` variable in Oracle is functionally equivalent to `@@rowcount`.

There are many more special global variables available with PL/SQL. Not all those variables are listed here. There are more special global variables available in T/SQL also. Not all those variables are listed here because they do not play a major role in the conversion process.

Operators

See the Data Manipulation Language section in Chapter 2 for a discussion of Microsoft SQL Server and Sybase Adaptive Server and Oracle operators.

Built-in Functions

See the Data Manipulation Language section in Chapter 2 for a discussion of built-in functions in Microsoft SQL Server and Sybase Adaptive Server and Oracle.

Sending Data to the Client: Result Sets

Single Result Set

Microsoft SQL Server and Sybase Adaptive Server stored procedures can return data to the client by means of a Result Set. A SELECT statement that does not assign values to the local variables sends the data to the client in the form of byte-stream.

In a case where a third-party user interface product uses the result set capability of Microsoft SQL Server and Sybase Adaptive Server, consult with the vendor to make sure that the same functionality is available for the Oracle database.

The following example procedure sends the data out as a result set. More appropriately, an OUTPUT parameter holding the value "YES" or "NO" (depending upon the evaluation of `<condition>`) or a function returning "YES" or "NO" should have been used.

```sql
CREATE PROCEDURE x
AS
BEGIN
...
IF <condition> THEN
```
Multiple Result Sets
Avoid Microsoft SQL Server and Sybase Adaptive Server stored procedures that return multiple result sets to the calling routine.

The following procedure returns two different result sets, which the client is responsible for processing:

```sql
CREATE PROCEDURE example_proc
AS
BEGIN

SELECT empno, empname, empaddr FROM emp
WHERE empno BETWEEN 1000 and 2000
SELECT empno, deptno, deptname FROM emp, dept
WHERE emp. empno = dept. empno
AND emp. empno BETWEEN 1000 and 2000
END
```

Recommendations
Some alternatives to simulating the result set in PL/SQL procedures are presented below:

- Packaged procedures with PL/SQL tables as output parameters

  This is an extension of the first method. Instead of fetching one row at a time, now we fetch many rows (ARRAY FETCH) at a time and assign the values to PL/SQL tables. These tables are available to the client after the execution of the procedure.

- Packaged procedures with a cursor variable as output parameter

  This alternative is possible in Oracle. Oracle allows you to define a cursor type variable to clearly return query results. This cursor type variable is similar to the user-defined record type and array variable. The cursor stored in the cursor variable is like any other cursor. It is a reference to a work area associated with a multi-row query. It denotes both the set of rows and a current row in that set. The cursor referred to in the cursor variable can be opened, fetched from, and closed just like any other cursor. Since it is a PL/SQL variable, it can be passed into and out of procedures like any other PL/SQL variable. This is a more direct
equivalent to the result set in Microsoft SQL Server and Sybase Adaptive Server.

- Procedure or function that populates a temporary table with result set rows
- This temporary table has an additional column to hold the SESSION_ID of the current session to keep the rows separate for each session of the user. The client program can then retrieve the rows from this temporary table with a simple SELECT statement.
- The Migration Workbench adopts the third option to convert the result set.

### About Converting a T/SQL Procedure with a Result Set

#### Method 1

A T/SQL procedure with a result set may need some manual changes after conversion to an Oracle package with a member function. The problems are described in detail below.

For example, consider the following T/SQL procedure:

```tsql
CREATE PROC test_proc
AS
BEGIN
  T/SQL block1
  T/SQL block2
  SELECT statement corresponding to the result set
END
```

This procedure executes two T/SQL blocks before executing the SELECT statement associated with the result set. The procedure is converted to an Oracle package as follows:

```sql
CREATE OR REPLACE PACKAGE BODY test_proc_pkg
AS
BEGIN
  FUNCTION test_proc;
END;
CREATE OR REPLACE PACKAGE BODY test_proc_pkg
AS
BEGIN
  cursor declaration for the SELECT statement associated with the result set in the source T/SQL procedure;
  FUNCTION test_proc
  RETURN INTEGER
  AS
```

```sql
```
BEGIN
    PL/SQL version of T/SQL block1;
    PL/SQL version of T/SQL block2;
    FETCH loop for the cursor declared in the package body;
END;
END;

The two T/SQL blocks in the source T/SQL procedure are executed only once when the procedure is called, and the result set is sent to the client.

In Oracle client, to simulate the fetching of the result set, the TEST_PROC_PKG.TEST_PROC function must be called repeatedly until all the rows from the cursor are fetched. The two PL/SQL blocks in the function are executed with each call to the function. This behavior differs from that in the source application.

You must manually separate the code associated with the FETCH loop for the cursor for the result set from the remaining code in the procedure. Changes to the client have to be made so that the rest of the procedure’s code is called in accurate sequence with the repeated calls to the function returning rows from the result set.

The final Oracle package should be as follows:

```
CREATE OR REPLACE PACKAGE BODY test_proc_pkg
AS
BEGIN
    PROCEDURE proc1;
    FUNCTION test_proc;
END;
CREATE OR REPLACE PACKAGE BODY test_proc_pkg
AS
BEGIN
    cursor declaration for the SELECT statement associated with the result set in the source T/SQL procedure;
    PROCEDURE proc1
    AS
    BEGIN
        PL/SQL version of T/SQL block1;
        PL/SQL version of T/SQL block2;
    END;
    FUNCTION test_proc
    RETURN INTEGER
    AS
    BEGIN
        FETCH loop for the cursor declared in the package body;
    END;
END;
```
The client should call the TEST_PROC_PKG.PROC1 procedure before repeatedly calling the TEST_PROC_PKG.TEXT_PROC function in order to achieve functionality similar to the source T/SQL procedure.

The variables that are common to these two parts should be either declared globally within the package body or should be passed as parameters to the procedure and the function.

**DDL Constructs within Microsoft SQL Server and Sybase Adaptive Server Stored Procedures**

Microsoft SQL Server and Sybase Adaptive Server allow DDL constructs to be part of the stored procedures. Oracle allows DDL statements as part of the dynamic SQL. Oracle issues an implicit COMMIT statement after each DDL statement.

Most of the T/SQL DDL constructs give syntax errors. You must remove the DDL statements from the T/SQL source to convert the T/SQL procedure to PL/SQL using the Migration Workbench.

The following DDL statements are ignored by the Migration Workbench. The statements appear commented in the output with a message "statement ignored."

```sql
CREATE TABLE
DROP TABLE
CREATE VIEW
DROP VIEW
CREATE INDEX
DROP INDEX
```
Distributed Environments

This chapter includes the following sections:

- Distributed Environments
- Application Development Tools

A distributed environment is chosen for various applications where:

- The data is generated at various geographical locations and needs to be available locally most of the time.
- The data and software processing is distributed to reduce the impact of any particular site or hardware failure.

Accessing Remote Databases in a Distributed Environment

When a relational database management system (RDBMS) allows data to be distributed while providing the user with a single logical view of data, it supports "location transparency." Location transparency eliminates the need to know the actual physical location of the data. Location transparency thus helps make the development of the application easier. Depending on the needs of the application, the database administrator (DBA) can hide the location of the relevant data.

To access a remote object, the local server must establish a connection with the remote server. Each server requires unique names for the remote objects. The methods used to establish the connection with the remote server, and the naming conventions for the remote objects, differ from database to database.
Oracle and Remote Objects

Oracle allows remote objects (such as tables, views, and procedures) throughout a distributed database to be referenced in SQL statements using global object names. In Oracle, the global name of a schema object comprises the name of the schema that contains the object, the object name, followed by an "at" sign (@), and a database name. For example, the following query selects information from the table named scott.emp in the SALES database that resides on a remote server:

```sql
SELECT * FROM scott.emp@sales.division3.acme.com
```

A distributed database system can be configured so that each database within the system has a unique database name, thereby providing "effective" global object names.

Furthermore, by defining synonyms for remote object names, you can eliminate references to the name of the remote database. The synonym is an object in the local database that refers to a remote database object. Synonyms shift the responsibility of distributing data from the application developer to the DBA. Synonyms allow the DBA to move the objects as desired without impacting the application.

The synonym can be defined as follows:

```sql
CREATE PUBLIC SYNONYM emp FOR scott.emp@sales.division3.acme.com;
```

Using this synonym, the SQL statement outlined above can be changed to the following:

```sql
SELECT * FROM emp;
```

Microsoft SQL Server and Sybase Adaptive Server and Remote Objects

Microsoft SQL Server and Sybase Adaptive Server require schema objects throughout a distributed database to be referenced in SQL statements by fully qualifying the object names. The complete name of a schema object has the following format:

```
server_name.database_name.object_owner_name.object_name
```

The `server_name` is the name of a remote server. The `database_name` is the name of a remote database on the remote server.
Microsoft SQL Server and Sybase Adaptive Server do not support the concept of synonyms or location transparency. In a distributed environment, objects cannot be moved around without impacting the application, as the developers must include the location of the object in the application code.

Most of the static queries tend to include the references to the remote server and remote database. Some applications maintain a user table to map the complete object names (including the remote server name and the database name) to dummy object names. The queries refer to these dummy object names. The translations are performed in real-time with the help of the map in the user table. This limitation precludes any common scheme of referring to remote objects that can work for Oracle and Microsoft SQL Server and Sybase Adaptive Server.

The Microsoft SQL Server and Sybase Adaptive Server Omni SQL Gateway server allows location transparency, but this requires that the schema definitions of all the databases participating in the distribution must be available with the Omni SQL Gateway server.

**Replication**

Replication functionality in Microsoft SQL Server and Sybase Adaptive Server has the following characteristics:

- Unidirectional
- Table-based, not transaction-based
- No automatic conflict resolution (must be manual)
- Heterogeneous replication through Open Database Connectivity (ODBC)

In addition to the characteristics listed above, Microsoft SQL Server 7.0 replication provides heterogeneous replication through ODBC.

Oracle replication has richer replication functionality, which includes the following:

- Bi-directional
- Any database object can be replicated
- Automatic resynchronization
- Automatic conflict resolution
- Heterogeneous replication provided through gateways

Since Oracle distributed environment and replication support is a superset of Microsoft SQL Server and Sybase Adaptive Server, conversion of distributed
applications from Microsoft SQL Server and Sybase Adaptive Server to Oracle is feasible.

**Application Development Tools**

Several application development tools that are currently available use specific features of one of the various database servers; you may have to invest significant effort to port these products to other database servers. With critical applications, it is sometimes best to develop and maintain a different set of application development tools that work best with the underlying database, as ODBC support is not adequate in such cases.

The majority of Microsoft SQL Server and Sybase Adaptive Server applications are written using ODBC application programming interfaces (APIs) or Visual Basic. DB-Library is widely used to develop 3GL applications with Microsoft SQL Server and Sybase Adaptive Server as the backend.

Since Oracle provides ODBC connectivity, it is possible to convert ODBC-based Microsoft SQL Server and Sybase Adaptive Server applications to work with an Oracle backend.

If a Visual Basic application is written with ODBC as the connection protocol to access Microsoft SQL Server and Sybase Adaptive Server, it is possible to modify and fix the Visual Basic application to work with an Oracle backend.

Many Visual Basic applications use VB-SQL which is DB-Library for Visual Basic. VB-SQL allows Visual Basic programs to access Microsoft SQL Server and Sybase Adaptive Server natively (as opposed to using ODBC). Such applications can also be converted to work with an Oracle backend, if you replace the VB-SQL database access routines with Oracle Objects for OLE.

Oracle provides a call interface known as Oracle Call Interface (OCI), which is functionally equivalent to the DB-Library API. Conversion of DB-Library applications to OCI applications is feasible.
Temporary tables are available in Oracle9i and Oracle8i. However, because Oracle9i and Oracle8i temporary tables differ from Microsoft SQL Server temporary tables you should still replace or emulate temporary tables within Oracle to ease migrations from Microsoft SQL Server.

The emulation of temporary tables has been simplified by using temporary tables instead of permanent tables. See the Oracle9i and Oracle8i temporary table syntax for Example 2 in the Implementation of Temporary Tables as Permanent Tables section.

This chapter discusses temporary tables under the following headings:

- Temporary Table Usage
- Replace Temporary Tables
- Emulate Temporary Tables
- Definition of t_table_catalog
- Package Body t_table

**Temporary Table Usage**

In Microsoft SQL Server and Sybase Adaptive Server, temporary tables are used to:

- Simplify Coding
- Simulate Cursors when Processing Data from Multiple Tables
- Improve Performance In a Situation Where Multi-Table Joins are Needed
- Associate Rows from Multiple Queries in One Result Set (UNION)
- Eliminate Re-Querying Data Needed for Joins
Simplify Coding

Instead of writing complicated multi-table join queries, temporary tables allow a query to be broken into different queries, where result sets of one query are stored in a temporary table and subsequent queries join this temporary table with actual database tables.

This type of code can be converted to Oracle as follows:

- Rewrite the queries to use multi-table joins
- Create permanent temporary tables
- Tune the complicated query using the parallel query option

**Microsoft SQL Server and Sybase Adaptive Server:**

```sql
WHILE @cur_dt > @start_dt
BEGIN
   INSERT #TEMP1
   SELECT @cur_dt
   SELECT @cur_dt = dateadd(dd, -7, @cur_dt)
END
/
******** create a temp table *****/
INSERT #TEMP2
SELECT t2.col1,
       t4.col2,
       *
       t5.col3,
       t2.col4,
       t3.col5,
       t2.col6,
       t2.col7,
       t4.col8,
       t4.col9
FROM
   db1..TABLE1 t1,
   db2..TABLE2 t2,
   db2..TABLE3 t3,
   db2..TABLE4 t4,
   db1..TABLE5 t5
WHERE t1.col10 =@col10
AND t1.col11 = @flag1
AND t1.col2 = t4.col2
```
AND     t1.col2 = t5.col2
AND     t2.col4 between @start_col4 and @end_col4
AND     t3.col5 between @start_col5 and @end_col5
AND     t3.col12 = @flag2
AND     t2.col13 = @flag1
AND     t4.col2 like @col2
AND     t4.col14 = @flag3
AND     t4.col12 = @flag2
AND     t2.col11 = t4.col11
AND     t3.col11 = t2.col11
AND     t4.col11 = t3.col11
AND     t5.col12 like @col12
AND     t4.col12 = t5.col12
AND     t4.col15 = t5.col15
AND     t5.col13 like @var1
AND     t2.col16 <= @end_dt
AND     (t2.col17 >= @start_dt OR t2.col17 = NULL)
AND     t4.col18 <= @end_dt
UPDATE TABLE4
SET     t4.col2 = col16
FROM    #TEMP2 t1, db2..TABLE4 t4
WHERE   t1.col1 = t4.col1
AND     t4.col12 = @flag2
AND     t4.col14 = @flag4

Oracle Pseudo Code:

Use a PL/SQL table to simulate #TEMP1
For the INSERT #TEMP2 statement
Declare a cursor with the same SELECT statement
(as used in Microsoft SQL Server and Sybase Adaptive Server)
For the UPDATE statement do the following:
loop
    fetch the cursor
    if cursor not found
        then exit;
    end if;
    -- update TABLE4 for each row that matches the criteria
    -- Note : i_col17 and i_col1 are local PL/SQL variables
    -- which are populated by each fetch
    UPDATE TABLE4
    SET     col2 = i_col17
    WHERE   col1 = i_col1
    AND     col12 = @flag2
    AND     col14 = @flag4
Simulate Cursors when Processing Data from Multiple Tables

Oracle supports cursors, so this type of code can be converted to Oracle using cursors.

The following code is part of a procedure written in Microsoft SQL Server. Compare it with the Oracle example (much simpler coding) that performs the same function.

**Microsoft SQL Server:**

```sql
... 
SELECT * INTO #emp FROM emp WHERE emp.dept = 10 
SELECT @cnt = @@rowcount 
WHILE @cnt > 0 
BEGIN 
SELECT @name = name, @emp_id = emp_id 
FROM #emp 
WHERE emp_id = (SELECT MAX (emp_id) FROM #emp) 
/* process this row */ 
DELETE FROM #emp WHERE emp_id = @emp_id 
SELECT @cnt = @cnt -1 
END 
... 
```

**Oracle:**

```sql
FOR emp_rec IN (SELECT name, emp_id FROM emp WHERE dept = 10) 
LOOP /*process emp_rec.name and emp_rec.emp_id*/ 
END LOOP
```

Improve Performance In a Situation Where Multi-Table Joins are Needed

In Microsoft SQL Server and Sybase Adaptive Server, you sometimes use temporary tables to avoid multi-table joins. These cases can be converted to Oracle, as Oracle performs complex multi-table queries more efficiently than Microsoft SQL Server and Sybase Adaptive Server.
See the sample code provided in the To Simplify Coding section for more information in this regard.

**Associate Rows from Multiple Queries in One Result Set (UNION)**

Oracle provides a UNION relational operator to achieve similar results.

**Microsoft SQL Server and Sybase Adaptive Server:**

```sql
INSERT #EMPL_TEMP
SELECT emp.empno,
dep.tdept_no
location.location_code
emp.start_date
emp.end_date
FROM emp,
dep,
location
WHERE emp.empno = location.empno
AND depdeptno = emp.deptno
AND depdeptno = location.deptno
AND emp.start_date BETWEEN @start_date AND @end_date
INSERT INTO #EMPL_TEMP VALUES ( 10000, 10, 15,getdate(),NULL )
...
```

**Oracle:**

```sql
SELECT emp.empno,
dep.tdept_no
location.location_code
emp.start_date
emp.end_date
FROM emp,
dep,
location
WHERE emp.empno = location.empno
AND depdeptno = emp.deptno
AND depdeptno = location.deptno
AND emp.start_date BETWEEN i_start_date AND i_end_date
UNION
SELECT 10000,
10,
15,
SYSDATE,
```
NULL
FROM DUAL

Eliminate Re-Querying Data Needed for Joins

Permanent tables can be created in Oracle to hold the data. The data in these tables can be deleted at the end of processing. If no COMMIT is performed and no DDL is issued, the records in these tables are not recorded in the database. If a COMMIT is performed, the records from these tables can be deleted at the end of the process. Records in these tables can be kept separate for different users by having an additional column that holds a SESSION_ID.

If it is not possible to create the tables ahead of time, tables can be created dynamically with Oracle, using the DBMS_SQL package. In dynamically-created tables, the extra SESSION_ID columns are no longer needed, and space management issues such as fragmentation are eliminated. Performance may be affected, but deleting a large number of rows from a permanent temporary table also affects performance. In dynamic SQL, tables can be truncated or dropped.

Microsoft SQL Server and Sybase Adaptive Server:

```sql
INSERT #EMPL_TEMP
SELECT emp.empno
    dept.dept_no
    emp.start_date
    emp.end_date
FROM emp,
    dept ,
WHERE emp.empno = dept.deptno
AND emp.start_date BETWEEN @start_date AND @end_date
....
/* Later in the code, one needs to select from the temp table only, it is not necessary to do a join of EMP and DEPT */
SELECT * FROM #EMPL_TEMP
```

Oracle:

```sql
SELECT emp.empno
    dept.dept_no
    emp.start_date
    emp.end_date
FROM emp,
    dept ,
WHERE emp.empno = dept.deptno
```
AND emp.start_date BETWEEN i_start_date AND i_end_date;
/* The above join has to be performed every time one needs to get this result set */

Consolidate the Data for Decision Support Data Requirements
You often need to consolidate data across servers in a distributed database environment. You can use predefined views to consolidate this type of data. Oracle snapshots can replicate the data from remote databases. In addition, you can create permanent tables for Microsoft SQL Server and Sybase Adaptive Server temporary tables if queries need to perform joins against these tables.

Replace Temporary Tables
You should replace temporary tables to give the best performance in Oracle. You should always try to replace temporary tables with standard Oracle SQL. To do this, you must first determine the function of the temporary table. The function of the temporary table is one of the following:

- To store an intermediate result
- To collect data

Emulate Temporary Tables
If it is not possible to replace temporary tables, you should emulate them as follows:

- Use PL/SQL tables to emulate temporary tables
- Create temporary tables as ordinary tables whenever they are needed.
- Create permanent tables and maintain them for multiple users.

Implementation as PL/SQL Tables
Temporary tables can be implemented as a PL/SQL table of records. Although this concept is quite appealing, you cannot use SQL on a PL/SQL table. Therefore, this concept is limited to simple uses of temporary tables. However, for simple uses of temporary tables, you should always consider replacing these temporary tables completely with standard SQL.

Implications of Creating Temporary Tables Dynamically
Since temporary tables can be created by any session “on the fly”, you may have multiple instances of the same temporary table within one schema. As this type of
multiple instance is not possible in Oracle, you should attach the SESSION_ID to the table name to make it unique. The result is a variable table name, which requires that all accesses to that table must be created with dynamic SQL. This process would complicate all types of migration tools.

As all DDL operations have an implicit commit, the creation of a temporary table would disturb the transactional behavior of the migrated application. The programs would have to be changed so that the creation of a temporary table always occurs at the start of a transaction. This process would also complicate migration tools.

**Implications of Creating Permanent Tables**
Currently, several users can share one table. Therefore, you need to maintain an additional column in the table for the SESSION_ID. As the SESSION_ID is unique in the lifetime of a database, there are no access conflicts. The enforcement of the SESSION_ID can be accomplished with a view and a trigger. The cleanup in this option may be slower, as you must now delete rows and cannot do a simple DROP TABLE. You can execute this operation asynchronously with the JOBQUEUE package, or use the TRUNCATE TABLE command whenever you are the only user of the table. To avoid bottlenecks on the temporary tables, it is possible to create multiple incarnations of them and point the users via private synonyms. Also, the upcoming SQL3 Standard implements temporary tables as permanent tables, which have an incarnation per session.

These arguments show that the permanent table option is the best choice.

**Implementation of Temporary Tables as Permanent Tables**
The migration utility must first extract from the source database code all commands that create a temporary table.

The following Microsoft SQL Server and Sybase Adaptive Server T-SQL examples illustrate two types of commands that create temporary tables:

**Example 1**

```sql
CREATE TEMP TABLE tmpdate(
    FromDt datetime year to minute,
    ToDt datetime year to minute);
```

**Example 2**

```sql
SELECT aaufromdt date
from anforord aau, order ord, case cas, casetype ctp
where ctp.ctp_id = CtpId
```
You should modify all commands that create temporary tables as follows:

- Change the syntax to Oracle syntax.
- Identify and substitute alternative values for Oracle reserved words.
- Prefix the name of the temporary table with `t_`.

When you have completed these steps, Example 1 type statements may be executed. For statements of the same type as Example 2, you must also perform the following steps:

- Remove all bind variables, such as CtpId, and replace them with constants.
- Embed the statement in the following wrapper and execute it:

```sql
create table t_<temptable>
as select *
from (<original statement>)
where 1=0; -- or similar logic to create the table without any rows
```

The complete Oracle code for Example 2 is as follows:

```sql
create table t_tmpfromdate
as select *
from (SELECT aaufromdt inf_date
from anforord aau, order ord, case cas, casetype ctp
where ctp.ctp_id  = 'X' -- CtpId
and ctp.ctpambukz = 'N'
and cas.ctp_id    =  ctp.ctp_id
and ord.cas_id    = cas.cas_id
and aau.ord_id    = ord.ord_id
and cas.casgtg    = 'Y'
and ordstozt is null)
where 0=1;
```

**Oracle9i and Oracle8i Temporary Tables**
Oracle9i and Oracle8i temporary table data is not visible across sessions so the SESSION_ID column is not required.

The Oracle9i and Oracle8i temporary table syntax for Example 2 is as follows:

```sql
create table global temporary t_<temptable> on commit preserve rows
as select * from (<original statement>)
where 1=0
```

The Migration Workbench does the following when it encounters a temporary table in a stored procedure or trigger:

- Generates the DDL to create the table
- Renames the table to `t_tmpfromdate`
- Checks the column names for reserved words
- Adds the SESSION_ID column (if Oracle9i and Oracle8i temporary tables are not being used)

With this setup, you can use the table `tmpfromdate` as if it is available once per session.

**Maintenance of Temporary Tables**

To maintain the temporary tables, you need a dictionary table `t_table_catalog` (see Definition of `t_table_catalog`) and the supporting package `t_t_table` (see Package Body `t_table`). The `t_table` package performs all maintenance for temporary tables. To generate it, you need the following grants:

```sql
grant select on v_$session to <xxx>;
grant execute on dbms_sql to <xxx>;
grant execute on dbms_lock to <xxx>;
grant create public synonym to <xxx>;
grant create view to <xxx>;
grant create trigger to <xxx>;
```

The available functionality is explained in the comments of the package `t_table` as follows:

```sql
create or replace PACKAGE t_table IS

   procedure convert_to_temp (table_name in varchar2,
                             use_dbms_output in boolean default false);

--
```

5-10  Reference Guide for Microsoft SQL Server and Sybase Adaptive Server Migrations
Convert an ordinary table to a temporary table.

procedure register (table_name in varchar2);
-- Register the usage of temporary table in t_table_catalog
-- This procedure is called out of the pre-insert trigger
-- on the temporary table.
procedure drop_t_table (table_name in varchar2);
-- Check usage in t_table_catalog, delete the data of the
-- session and unregister the table

procedure cleanup_session;
-- Find all temporary table usages of the session, delete or truncate
-- the temporary table and unregister the usage.
-- This procedure commits!

END;

Definition of t_table_catalog

create table t_table_catalog
(session_id number,
table_name varchar2(30),
constraint t_table_catalog_pk
primary key (session_id, table_name))

Package Body t_table

create or replace PACKAGE BODY t_table IS

  last_table varchar2(30) := ; -- Store the last used
  -- object for the register procedure

  use_truncate constant boolean := true;

  procedure parse_sql (user_cursor in number,
    sql_text in varchar2) is
    begin
      dbms_sql.parse (user_cursor, sql_text, dbms_sql.v7);
    exception

when others then
    raise_application_error (-20100, 'Parsing Error ' ||
      to_char(sqlcode) || ' at ' ||
      to_char(dbms_sql.last_error_position + 1) ||
      ' starting with: ' ||
      substr(sql_text, dbms_sql.last_error_position + 1, 30)
     ||
      '...', true);
end;

procedure execute_sql (sql_text in varchar2) is
  ignore  number;
  user_cursor     number;
begin
  user_cursor := dbms_sql.open_cursor;
  parse_sql (user_cursor, sql_text);
  ignore := dbms_sql.execute (user_cursor);
  dbms_sql.close_cursor(user_cursor);
exception
  when others then
    if dbms_sql.is_open(user_cursor) then
      dbms_sql.close_cursor(user_cursor);
    end if;
    raise;
end;

function get_lock_id (object_name in varchar2) --
  -- This function returns the lock_id for a specific object.
  -- It is calculated as the object_id from oracle + 1000000
  --
  return number is
    object_number   number;
begin
  select object_id
  into   object_number
  from   user_objects uo
  where  uo.object_name = get_lock_id.object_name
  and    uo.object_type = 'VIEW';
  return object_number + 1000000;
exception
  -- Object not found ==> Raise error
  when no_data_found then
    raise_application_error (-20100, 'Object ' ||
                            object_name || ' does not exists');
end;
end;

procedure convert_to_temp (table_name in varchar2,
                      use_dbms_output in boolean default false) is

-- Convert an ordinary table to a temporary table.
--
sql_stmt   varchar2 (32000);
col_sep    varchar2 (2) := null;
con_list   varchar2 (100) := 'session_id';
sel_table  varchar2 (30);
procedure add (s in varchar2)
  is
    -- Print one line of SQL code on sql_stmt or dbms_output
    begin
      if use_dbms_output then
        dbms_output.put_line (chr (9) || s);
      else
        sql_stmt := sql_stmt || chr (10) || s;
      end if;
    end add;

procedure execute_immediate
  as
    begin
      if ( use_dbms_output ) then
        dbms_output.put_line ( '/' );
      else
        execute_sql (sql_stmt);
        dbms_output.put_line(
          substr( sql_stmt, 2, instr( sql_stmt, chr(10), 2)-2 )
          )
        
        sql_stmt := NULL;
      end if;
    end;

begin
  if ( use_dbms_output ) then
    sel_table := upper (table_name);
  else
    sel_table := 't_' || upper (table_name);
  end if;
-- Rename the table to t_XXX

  add ('rename ' || table_name);

Migrating Temporary Tables to Oracle  5-13
add ('to t_' || table_name);
execute_immediate;
-- In the next step we need to add the support for the sessionid column.
-- The column is added with the following statement:
add ('alter table t_' || table_name);
add ('add session_id number not null');
execute_immediate;
-- Create a view for the original table
add ('create view ' || table_name);
add ('as select ');
for col_rec in
  (select column_name, table_name
   from user_tab_columns
   where table_name = sel_table
   and   column_name != 'SESSION_ID'
   order by column_id) loop
    add (col_sep || col_rec.column_name);
  end loop;
add (' from t_' || table_name);
add ('where session_id = userenv ('''sessionid''');');
execute_immediate;
-- To allow public access we need to create a public synonym and
-- grant public access.
add ('create public synonym ' || table_name);
add ('for ' || table_name);
execute_immediate;
add ('grant select, insert, update, delete');
add ('on ' || table_name);
add ('to public');
execute_immediate;
-- To maintain the session_id information a pre-insert - per row trigger
-- is created.
add ('create trigger t_' || table_name || '_bir');
add ('before insert');
add ('on t_' || table_name);
add ('for each row');
add ('begin');
add (':new.session_id := userenv ('''sessionid''');');
ad ('end;');
execute_immediate;
-- To register the usage of a temporary table for a specific session.
-- The procedure register has to be called in a pre-insert -
-- per statement trigger.
add ('create trigger t_' || table_name || '_bis');
add ('before insert');
add ('on t_' || table_name);
add ('begin');
add ('  t_table.register (''' || upper (table_name) || '''');');
add ('end');
execute Immediate;
end;

procedure register (table_name in varchar2) is
  dummy            varchar2(1);
  return_value     number;
  lock_id          number;
begin
  -- Check if we just registered the table
  if last_table = table_name then
    return;
  end if;
  last_table := table_name;
  -- Check if we have ever registered the table for our session
  begin
    select 'x' into dummy
    from t_table_catalog ttc
    where ttc.table_name = register.table_name
    and session_id = userenv ('sessionid');
  exception
    when no_data_found then
      if use_truncate then
        lock_id := get_lock_id (table_name);
        return_value :=
                    dbms_lock.request (lock_id,
                             dbms_lock.s_mode, 5,
                             FALSE);
        if return_value not in (0, 4) then
          raise_application_error (-20100,
Disconnected Source Model Loading

The Disconnected Source Model Load feature of the Migration Workbench allows consultants to work on a customer’s database migration without having to install and run the Migration Workbench at the customer site.

To perform the disconnected source model load option a customer must generate delimited flat files containing schema metadata from the database to be migrated. You generate the flat file by running a predefined Migration Workbench script against the source database. The flat files are sent to a consultant who uses the Migration Workbench to load the metadata files into a source and Oracle model. You can then map this schema to Oracle.

Generating Database Metadata Flat Files

Microsoft SQL Server and Sybase Adaptive Server databases use the Bulk Copy Program (BCP) to generate delimited metadata flat files. Predefined scripts installed with the Migration Workbench invoke the BCP, and generate the flat files for each database. The BCP outputs delimited metadata files from the database with a .dat extension. However, for a successful migration of a database the .dat metadata files are converted into XML files by the Migration Workbench. The Migration Workbench converts the .dat files when the source metadata files are selected during the capture phase of the migration, and outputs the generated .xml files to the same root directory as the source .dat files.

Flat File Generation Scripts

The predefined script files are stored in the %ORACLE_HOME%\Omwb\DSML_ Scripts\<plugin> directory. Refer to the following table to locate the correct Migration Workbench script:
Table 6–1 Location and Name of Script Files and Name of Associated Files

<table>
<thead>
<tr>
<th>Plug-in</th>
<th>Directory Location</th>
<th>Script File Name</th>
<th>Associated Files</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsoft SQL Server 6.5</td>
<td>%ORACLE_HOME%\DSML_</td>
<td>SS6_DSML_SCRIPT.BAT</td>
<td>CREATE_SS65_INDEX_TABLES.SQL DROP_SS65_INDEX_TABLES.SQL</td>
</tr>
<tr>
<td></td>
<td>scripts\sqlserver6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microsoft SQL Server 7</td>
<td>%ORACLE_HOME%\DSML_</td>
<td>SS7_DSML_SCRIPT.BAT</td>
<td>Not Applicable</td>
</tr>
<tr>
<td></td>
<td>scripts\sqlserver7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microsoft SQL Server 2000</td>
<td>%ORACLE_HOME%\DSML_</td>
<td>SS2K_DSML_SCRIPT.BAT</td>
<td>Not Applicable</td>
</tr>
<tr>
<td></td>
<td>scripts\sqlserver2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sybase Adaptive Server 11</td>
<td>%ORACLE_HOME%\DSML_</td>
<td>SYBASE11_DSML_SCRIPT.BAT</td>
<td>CREATE_SYBASE_INDEX_TABLES.SQL DROP_SYBASE_INDEX_TABLES.SQL</td>
</tr>
<tr>
<td></td>
<td>scripts\ybase11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sybase Adaptive Server 12</td>
<td>%ORACLE_HOME%\DSML_</td>
<td>SYBASE12_DSML_SCRIPT.BAT</td>
<td>CREATE_SYBASE_INDEX_TABLES.SQL DROP_SYBASE_INDEX_TABLES.SQL</td>
</tr>
<tr>
<td></td>
<td>scripts\ybase12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Running the Scripts
To run a script file for a plugin from the %ORACLE_HOME%\DSML_scripts\<plugin> directory, use the following command line:

<script file name> <database> <password> <server>

For example, to run the Microsoft SQL Server 2000 script file to generate metadata flat files, use the following command:

SS2K_DSML_SCRIPT <database> <password> <server>
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