Oracle® Database

Extensions for .NET Developer's Guide

19c for Microsoft Windows

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Oracle Database Extensions for .NET Developer's Guide, 19c for Microsoft Windows

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Preface

This document describes the features of Oracle Database for Windows software installed on Windows 2003, Windows 2000, and Windows XP Professional operating systems.

This guide describes Oracle Database Extensions for .NET, which provides a Common Language Runtime (CLR) host for Oracle Database and data access through Oracle Data Provider for .NET (ODP.NET) classes.

This preface contains these topics:

Audience

Oracle Database Extensions for .NET Developer's Guide is intended for programmers who are developing applications to access an Oracle Database using Oracle Database Extensions for .NET. This documentation is also valuable to systems analysts, project managers, and others interested in the development of database applications.

To use this document, you must be familiar with Microsoft .NET Framework classes and ADO.NET and have a working knowledge of application programming using Microsoft C#, Visual Basic, or another .NET language.

Users should also be familiar with the use of Structured Query Language (SQL) to access information in relational database systems.

Documentation Accessibility

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

Access to Oracle Support

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

Related Documents

For more information, see these Oracle resources:

- *Oracle Developer Tools for Visual Studio Help*
- *Oracle Data Provider for .NET Developer's Guide for Microsoft Windows*
- *Oracle Database PL/SQL Packages and Types Reference*
- *Oracle Database SQL Language Reference*
- *Oracle Database Installation Guide for Microsoft Windows*
- *Oracle Database Release Notes for Microsoft Windows*
- *Oracle Database Platform Guide for Microsoft Windows*
- *Oracle Database New Features Guide*
- *Oracle Database Net Services Reference*

Many of the examples in this book use the sample schemas, which are installed by default when you select the Basic Installation option with an Oracle Database installation. Refer to *Oracle Database Sample Schemas* for information on how these schemas were created and how you can use them yourself.

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 can be done at

`http://www.oracle.com/technetwork/index.html`

If you already have a username and password for OTN, then you can go directly to the documentation section of the OTN Web site at

`http://www.oracle.com/technetwork/documentation/index.html`

Passwords in Code Examples

For simplicity in demonstrating this product, code examples do not perform the password management techniques that a deployed system normally uses. In a production environment, follow the Oracle Database password management guidelines, and disable any sample accounts. See *Oracle Database Security Guide* for password management guidelines and other security recommendations.

Conventions

The following text conventions are used in this document:

Convention	Meaning
boldface	Boldface type indicates graphical user interface elements associated with an action, or terms defined in text or the glossary.
italic	Italic type indicates book titles, emphasis, or placeholder variables for which you supply particular values.

Convention	Meaning
`monospace`	Monospace type indicates commands within a paragraph, URLs, code in examples, text that appears on the screen, or text that you enter.

Changes in This Release for Oracle Database Extensions for .NET Developer's Guide

This preface contains:

Changes in Oracle Database 12*c* Release 2 (12.2)

The following are changes in *Oracle Database Extensions for .NET Developer's Guide* for Oracle Database 12*c* Release 2 (12.2).

New Features

The following features are new in this release:

- Unhandled exceptions are no longer automatically handled.

  Beginning with this release of Oracle Database Extensions for .NET, unhandled exceptions in .NET stored procedures or functions will terminate the process to make it easier to detect issues as soon as it happens. This behavior can be modified through the `extproc.exe.config` configuration file.

  > **See Also:**
  >
  > extproc.exe.config Configuration File

- Oracle assemblies are no longer placed in Global Assembly Cache

  The Oracle Database Extensions for .NET no longer places its assemblies in the Global Assembly Cache (GAC). The `extproc.exe.config` configuration file is configured properly by the installer with the location of these assemblies so that they can be located and loaded at runtime.

  > **See Also:**
  >
  > extproc.exe.config Configuration File

- New `TraceFileLocation` registry key

The `TraceFileLocation` registry key allows you to choose the directory in which the trace files will be generated.

> **See Also:**
>
> TraceFileLocation

Changes in Oracle Database 12*c* Release 1 (12.1)

The following are changes in *Oracle Database Extensions for .NET Developer's Guide* for Oracle Database 12*c* Release 1 (12.1).

New Features

The following features are new in this release:

- The Oracle CLR services now runs as the Oracle Home User, a potentially lower privileged user that is defined during database installation. These services are no longer automatically created by the installer. Instead, a new utility, `OraClrCtl.exe`, is used to create them.

> **See Also:**
>
> "Oracle CLR Services and the Oracle Home User Account."

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Introduction to Oracle Database Extensions for .NET

These topics introduce Oracle Database Extensions for .NET, which makes it possible to build and run .NET stored procedures or functions with Oracle Database for Microsoft Windows.

Oracle Database Extensions for .NET Overview

Oracle Database Extensions for .NET provides the following:

- A Common Language Runtime (CLR) host for Oracle Database
- Data access through Oracle Data Provider for .NET classes
- Oracle Deployment Wizard for Visual Studio

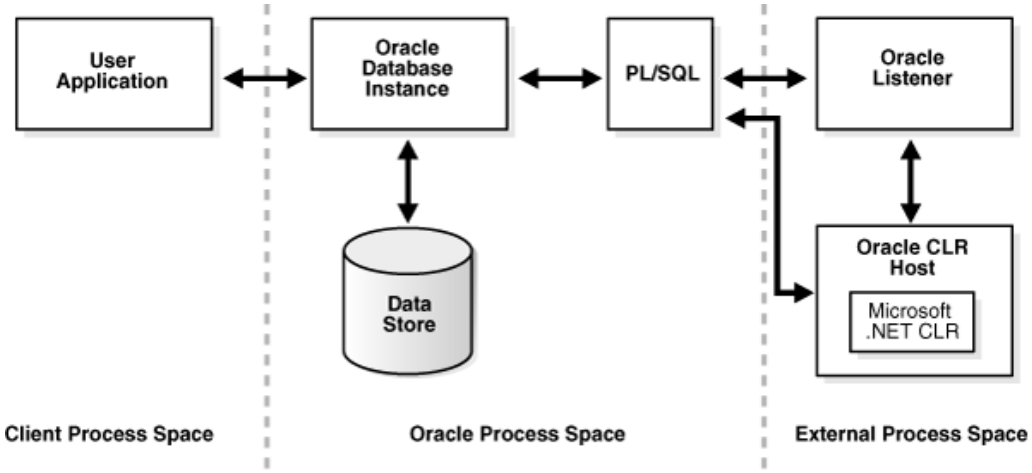
The Oracle Database hosts the Microsoft Common Language Runtime (CLR) in an external process, outside of the Oracle database process. The integration of Oracle Database with the Microsoft Common Language Runtime (CLR) enables applications to run .NET stored procedures or functions on Oracle Database, on supported Microsoft Windows operating systems.

Application developers can write stored procedures and functions using any .NET compliant language, such as C# and VB.NET, and use these .NET stored procedures in the database, in the same manner as other PL/SQL or Java stored procedures. .NET stored procedures can be called from PL/SQL packages, procedures, functions, and triggers; from SQL statements, or from anywhere a PL/SQL procedure or function can be called.

Application developers build .NET procedures or functions into a .NET assembly, typically using Microsoft Visual Studio. Oracle Data Provider for .NET is used in .NET stored procedures and functions for data access. After building .NET procedures and functions into a .NET assembly, developers deploy them in Oracle Database, using the Oracle Deployment Wizard for .NET, a component of the Oracle Developer Tools for Visual Studio.

The .NET stored procedure or function appears to the caller as a PL/SQL stored procedure or function because a PL/SQL wrapper has been generated for it. The user invokes a .NET stored procedure or function through this PL/SQL wrapper. Oracle Deployment Wizard for .NET determines the probable mappings between Oracle data types and .NET data types, which the user can override. The mappings are handled seamlessly by the PL/SQL wrapper.

Oracle Database Extensions for .NET Architecture



This architecture diagram shows the client application and then two process spaces, the Oracle process space and the external process space.

The Oracle process space includes the Oracle database instance and hosts the PL/SQL wrapper.

The external process space includes the Oracle CLR host, in which .NET stored procedures or functions are executed.

Oracle CLR Host

The Oracle CLR host is installed as part of Oracle Database Extensions for .NET installation and runs in the `extproc` process. The `extproc` process loads the Oracle CLR host which in turn loads an instance of the Microsoft Common Language Runtime (CLR), thus providing an interface for the wrapped PL/SQL procedure. These mechanics are not visible to the users. From a user's point of view, the application is invoking just another PL/SQL stored procedure or function.

> **Note:**
>
> The Microsoft .NET Framework must be installed on the same computer as the database.

External Processes

.NET stored procedures or functions are hosted in a process external to the Oracle Database. This external process is a heterogeneous service agent called `extproc`, external procedure agent, or external process. This guide uses the terms `extproc` process or `extproc` agent.

> **See Also:**
>
> *Oracle Database Heterogeneous Connectivity User's Guide*

The `extproc` process supports the following architectures:

- Dedicated Agent Architecture
- Multithreaded Agent Architecture

Dedicated Agent Architecture

In dedicated (that is, single-threaded) agent architecture, an `extproc` process is started for each user session. The process terminates when the user session ends. This architecture can consume an unnecessarily large amount of system resources since, with every user session, a new `extproc` process must be started and shut down. Therefore dedicated agent architecture does not perform well in terms of system resources and runtime efficiency.

Multithreaded Agent Architecture

A multithreaded `extproc` process uses a pool of shared threads. The tasks requested by the user sessions are put on a queue and are picked up by the first available thread.

Multithreaded agent architecture allows more efficient use of system resources than dedicated architecture.

A separate multithreaded `extproc` process must be started for each system identifier (SID). Each TNS listener that is running on a system listens for incoming connection requests for a set of SIDs. If the SID in an incoming Oracle Net connect string is one that the listener is listening for, then that listener processes the connection. If a multithreaded process has been started for the SID, then the listener passes the request to that process.

> **See Also:**
>
> - *Oracle Database Development Guide*
> - *Oracle Database Administrator's Guide*

Real Application Clusters (RAC) and External Processes

The Oracle multithreaded `extproc` process is tightly coupled with the Oracle listener. Therefore, each node in a Real Application Clusters (RAC) environment has an Oracle multithreaded `extproc` process associated with the listener on that node.

Multiple Databases Instance and External Processes

A single Oracle multithreaded `extproc` process is used with multiple database instances associated with a single Oracle home if a single listener is shared among multiple database instances.

Oracle Data Provider for .NET

Oracle Data Provider for .NET provides data access to the Oracle Database from any client application. Oracle Data Provider for .NET is available for free download on Oracle Technology Network (OTN).

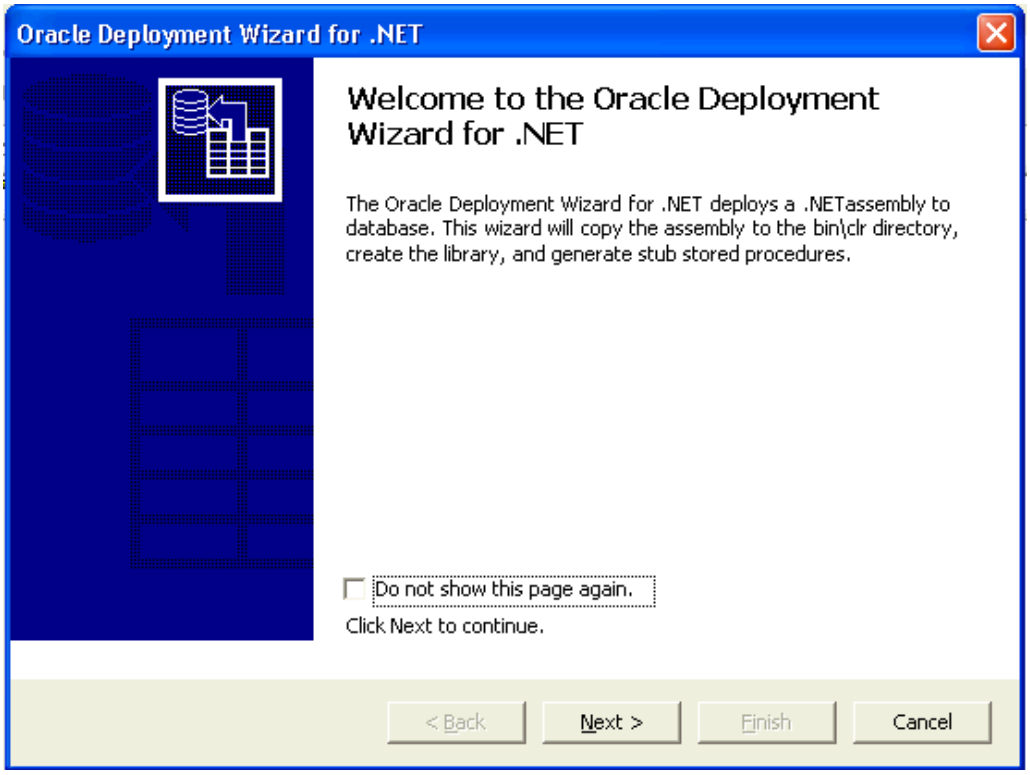
> **See Also:**
>
> *Oracle Data Provider for .NET Developer's Guide for Microsoft Windows* for detailed descriptions of ODP.NET classes

Oracle Developer Tools for Visual Studio

Oracle Developer Tools for Visual Studio is a set of application tools tightly integrated with the Visual Studio development environment. Oracle Developer Tools enables developers to execute a wide range of application development tasks, such as creating tables, editing stored procedures, and viewing data in the Oracle Database. Oracle Developer Tools for Visual Studio is available for free download on Oracle Technology Network (OTN).

> **See Also:**
>
> *Oracle Developer Tools for Visual Studio Help*

Oracle Deployment Wizard for .NET



The Oracle Deployment Wizard for .NET is a graphical tool integrated with Microsoft Visual Studio which makes it easy to deploy any .NET procedure or function into an Oracle Database. It is installed as part of Oracle Developer Tools for Visual Studio.

See Also:

Oracle Developer Tools for Visual Studio Dynamic Help, available by installing Oracle Developer Tools for Visual Studio, for more information

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Installation and Configuration

These topics describe the installation of Oracle Database Extensions for .NET, system requirements, and file locations.

System Requirements

Each release of Oracle Database Extensions for .NET has very specific version requirements. The following system requirements only apply to Oracle Database Extensions for .NET version 19.3. If you are using a different version, please see the documentation specific to your version:

- Oracle Database 19.3 on Windows.

> **Note:**
>
> Oracle Database Extensions for .NET is only supported on the Windows Platform.

- Microsoft .NET Framework
  - Oracle Database Extensions for .NET Framework 2.0 is only supported with Microsoft .NET Framework 3.5 SP 1 and later
  - Oracle Database Extensions for .NET Framework 4 is only supported with Microsoft .NET Framework 4.5.2, 4.6.x, and 4.7.x

> **Note:**
>
> Microsoft Framework 1.x is no longer supported as of Oracle Database Extensions for .NET version 11.1.0.7.20. If you have stored procedures that require .NET Framework 1.x, you will need to take some special steps to make them work with this release.

- Oracle Data Provider for .NET version 19.3 (if data access in stored procedures is required).
- Oracle Developer Tools for Visual Studio 18.3 or higher is required for .NET stored procedure deployment.

> **Note:**
>
> Oracle Developer Tools for Visual Studio is not released with Oracle Database. It can be obtained from the Oracle .NET Developer Center at OTN.

> **See Also:**
>
> - *Oracle Database Installation Guide for Microsoft Windows*
> - Mandatory Migration of .NET 1.x Stored Procedures to .NET 2.0 or Later

Requirements for .NET Stored Procedures and Functions

A .NET stored procedure or function must meet the following requirements:

- Be declared a public static method.
- Not be a constructor or a destructor.
- Use parameter types that are compatible with the Oracle native database types.

Installation

This section discusses many of the results of Oracle Database Extensions for .NET installation.

It covers these topics:

- Installation and First Use
- File Locations after Installation
- Oracle CLR Services and the Oracle Home User Account
- Using the OraClrCtl Utility to Create and Run OraClrAgent Services

Installation and First Use

In earlier releases of Oracle Database, Oracle Database Extensions for .NET required a custom installation. Beginning in Oracle Database 12*c*, Oracle Database Extensions for .NET is always installed, however it is not enabled, and Windows services for it are not created.

Before the first use of Oracle Database Extensions for .NET, do the following:

1. Install Oracle Database 19c and either allow the installer to create the database for you, or install the database software only and use Database Configuration Assistant to create a database afterwards.
2. Execute the following to create the Oracle Database Extensions for .NET windows service.

```
oraclrctl -new
```

> **See Also:**
>
> "Using the OraClrCtl Utility to Create and Run OraClrAgent Services"

Oracle CLR Services and the Oracle Home User Account

Beginning with Oracle Database 12*c*, the Oracle CLR services run as the Oracle Home User. Database installations now provide a way for users to specify at installation time a Oracle Home User account under which the various Oracle services are run. This non-privileged account can be a local user or a domain user without administrative privileges.

In earlier versions of Oracle Database, these CLR services were created automatically by the installer. Now, they are created manually, after installation, using the `OraClrCtl.exe` utility.

The database installation does not create the Oracle CLR service but still performs the necessary configuration in the database for Oracle Database Extensions for .NET to function properly. This includes the following:

- Creating the `listener.ora` entries for `extproc`.
- Creating a `clr` folder under *`ORACLE_BASE`*`\\`*`ORACLE_HOME`*`\bin`.
- Installing the `OraClrCtl.exe` utility described in Using the OraClrCtl Utility to Create and Run OraClrAgent Services.

> **See Also:**
>
> *Oracle Database Platform Guide for Microsoft Windows*

Using the OraClrCtl Utility to Create and Run OraClrAgent Services

The `OraClrCtl.exe` utility creates the `OraClrAgnt` service in the *`ORACLE_BASE`*`\ \`*`ORACLE_HOME`*`\bin` directory and configures it to run using the Oracle Home User account specified during database installation. The service can be accessed through the Service Control Panel, as `Oracle`ORACLE_HOME`ClrAgent`, where *`ORACLE_HOME`* represents your Oracle home.

`OraClrCtl.exe` can also start, stop, and delete the `OraClrAgnt` service.

Example

```
oraclrctl.exe -start -host computer-pc5
```

`OraClrCtl.exe` accepts these arguments:

`-new`: Create and start new service.

`-delete`: Delete service.

`-start`: Start Service.

`-stop`: Stop service.

`-host` *`hostname`*: Execute the operation on the specified host. If no host is specified, defaults to local host.

`OraClrCtl.exe` returns `TRUE` (1) or `FALSE` (0), and displays a `SUCCESS` or `FAILURE` message. Upon a failure, the message displays the OS error number and the corresponding message.

Configuring Extproc Agent Using Windows Service

`OraClrAgnt` is created by `OraClrCtl.exe`. The service can be accessed through the Service Control Panel, as `Oracle`*`ORACLE_HOME`*`ClrAgent`, where *`ORACLE_HOME`* represents your Oracle home.

This service accepts these parameters listed in Table 2-1.

These parameter values can be specified as part of the Start Parameters in the properties window of the Control Panel Service. In this case, the parameter values are not saved and the values must be supplied again if the service is restarted later.

To persist the parameter values, you can change the Windows registry entry for this service and provide the parameter values as command line parameters to `OraClrAgnt.exe`. To do this, set the Windows registry key, `ImagePath`, located at

```
HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\
Oracle<OracleHome>ClrAgent
```

The value should be something similar to the following:

```
ORACLE_BASE\\ORACLE_HOME\bin\OraClrAgnt.exe agent_sid=CLRExtProc
max_dispatchers=2 tcp_dispatchers=0 max_task_threads=6 max_sessions=25
ENVS="EXTPROC_DLLS=ONLY:ORACLE_BASE\\ORACLE_HOME\bin\oraclr19.dll"
```

If the service cannot be started or stopped, the error messages are logged in the Application Log of the Event Viewer, with the service name as the event source name.

> **See Also:**
>
> Oracle CLR Services and the Oracle Home User Account for a description of how `OraClrAgnt` is created by `OraClrCtl.exe`.

OraClrAgnt Service Parameters

Table 2-1 lists the parameters which can be configured using this service.

Table 2-1 OraClrAgnt Service Parameters

Parameters	Descriptions
`agent_sid`	This represents the `SID` of the `extproc` process. The default value is `CLRExtProc`. This is a mandatory parameter. If this parameter value is changed, appropriate changes need to be made in `tnsnames.ora` and `listener.ora` files.
`ENVS`	Variable that specifies the `EXTPROC_DLLS` environment variable, which restricts the DLLs that `extproc` can load. This is similar to setting environment variables to external procedures using `listener.ora`. Refer to "Table 13–5 External Procedures Settings in listener.ora" in *Oracle Database Net Services Administrator's Guide* for more information.
`listener_address`	Address on which the listener is listening. This is an optional parameter. If it is not specified, then this is set to the default value.
`max_dispatchers`	Number of maximum dispatchers in the `extproc` process. This is an optional parameter. If it is not specified, then this number is set to a default value.
`max_sessions`	Number of maximum sessions in the `extproc` process. This is an optional parameter. If it is not specified, then this number is set to a default value.
`max_task_threads`	Number of maximum task threads in the `extproc` process. This is an optional parameter. If it is not specified, then this number is set to a default value.
`shutdown_address`	Address on which the agent should listen for shutdown messages from `agtctl`. This is an optional parameter. If it is not specified, then this is set to the default value.
`tcp_dispatchers`	Number of TCP dispatchers in the `extproc` process. This is an optional parameter. If it is not specified, then this number is set to a default value.

> **See Also:**
>
> *Oracle Call Interface Programmer's Guide,* Table F-2, Configuration Parameters for `agtctl`

Tuning OraClrAgnt for Performance

You should tune the `OraClrAgnt` to match the expected load on your system.

Excessive `extproc.exe` processes being spawned is a sign that you have set the configuration values too low.

Start with the following values and increase as you test your system for performance:

OraClrAgnt Parameter	Initial Value
`max_sessions`	25
`max_task_threads`	6
`max_dispatchers`	2

File Locations after Installation

`OraClr19.dll` is installed in the *ORACLE_BASE*`\\`*ORACLE_HOME*`\bin` directory.

`Oracle.Database.Extensions.dll` is installed to the following locations:

- .NET Framework 2.0:

  ORACLE_BASE`\\`*ORACLE_HOME*`\ODE.NET\bin\2.`*x*

- .NET Framework 4:

  ORACLE_BASE`\\`*ORACLE_HOME*`\ODE.NET\bin\4`

The readme file, `readme.html`, is installed in the *ORACLE_BASE*`\\`*ORACLE_HOME*`\ODE.NET\DOC` directory.

.NET assemblies deployed by developers are copied into the *ORACLE_BASE*`\`*ORACLE_HOME*`\bin\CLR` directory (or its subdirectory) by the Oracle Deployment Wizard for .NET.

Listener and Tnsnames Files

The following are typical examples of the `listener.ora` and `tnsnames.ora` files configured for Oracle Database Extensions for .NET. By default, Oracle Database Extensions for .NET uses `CLRExtProc` as the SID, but this can be changed using the Database Configuration Assistant (DBCA).

Listener.ora file

```
SID_LIST_LISTENER =
  (SID_LIST =
    (SID_DESC =
      (SID_NAME = PLSExtProc)
      (ORACLE_HOME = C:\oracle\database_1)
      (PROGRAM = extproc)
    )
    (SID_DESC =
      (SID_NAME = CLRExtProc)
      (ORACLE_HOME = C:\oracle\database_1)
      (PROGRAM = extproc)
```

```
      (ENVS="EXTPROC_DLLS=ONLY:C:\oracle\database_1\bin\oraclr19.dll")
    )
  )

LISTENER =
  (DESCRIPTION_LIST =
    (DESCRIPTION =
      (ADDRESS = (PROTOCOL = IPC)(KEY = EXTPROC1))

    )
  )
```

Tnsnames.ora File

```
ORACLE =
  (DESCRIPTION =
    (ADDRESS_LIST =
      (ADDRESS = (PROTOCOL = TCP)(HOST = user.us.example.com)(PORT = 1521))
    )
    (CONNECT_DATA =
      (SERVER = DEDICATED)
      (SERVICE_NAME = oracle.us.example.com)
    )
  )

ORACLR_CONNECTION_DATA =
  (DESCRIPTION =
    (ADDRESS_LIST =
      (ADDRESS = (PROTOCOL = IPC)(KEY = EXTPROC1))
    )
    (CONNECT_DATA =
      (SID = CLRExtProc)
      (PRESENTATION = RO)
    )
  )

EXTPROC_CONNECTION_DATA =
  (DESCRIPTION =
    (ADDRESS_LIST =
      (ADDRESS = (PROTOCOL = IPC)(KEY = EXTPROC1))
    )
    (CONNECT_DATA =
      (SID = PLSExtProc)
      (PRESENTATION = RO)
    )
  )
```

Migrating .NET Stored Procedures from Oracle Database 12*c* Release 1 (12.1) or later

You can migrate .NET stored procedures from a source Oracle Database 12*c* Release 1 (12.1) or later as follows:

1. Select the libraries that are used by .NET stored procedures from the source database. For example,

   `SELECT` *`library_name`*`,` *`file_spec`* `FROM ALL_LIBRARIES WHERE OWNER='SYS'` and `FILE_SPEC LIKE '$ORACLE_HOME\bin\clr\%';`

library_name is usually in the format *dll_name_DLL*. For example, the library_name for Project1.dll would be PROJECT1_DLL.

2. Create a SQL file manually (for example, DotNetSP_Grant.sql) with the following SQL statements:

```
CREATE LIBRARY "SYS"."library_name" AS 'file_spec'
GRANT EXECUTE ON "SYS"."library_name" TO "schema_name"
GRANT EXECUTE ON "SYS"."DBMS_CLR" TO "schema_name"
GRANT EXECUTE ON "SYS"."DBMS_CLRTYPE" TO "schema_name"
GRANT EXECUTE ON "SYS"."DBMS_CLRPARAMTABLE" TO "schema_name"
```

3. Run Oracle Data Pump Export utility for the source database.

   For non-pluggable databases, execute the following command:

```
Expdp system schemas="schema_name" directory=ORACLECLRDIR dumpfile=DotNetSP.dmp
include=PROCEDURE,FUNCTION
```

   For pluggable databases, execute the following commands:

   a. Create directory *name* as the path to DotNetSP.dmp on the server.

```
create directory name as 'path to DotNetSP.dmp on the server';
```

   b. Run Oracle Data Pump Export utility for the source database.

```
expdp system@TNS alias for pluggable database schemas="schema_name"
directory=name dumpfile=DotNetSP.dmp include=PROCEDURE,FUNCTION
```

      where *name* is the directory name provided in step 3.a.

   c. Drop the directory name provided in step 3.a.

```
drop directory name
```

      where *name* is the directory name provided in step 3.a.

4. Copy .NET stored procedure assemblies from the source database *ORACLE_BASE**ORACLE_HOME*\bin\clr folder and its subfolders to the same directory structure in the target database.
5. Run DotNetSP_Grant.sql as SYSDBA against the target database.
6. If you are migrating to a target that is a pluggable database:

   a. Create directory *name* as the path to DotNetSP.dmp on the server.

```
create directory name as 'path to DotNetSP.dmp on the server';
```

   b. Run Oracle Data Pump Import utility for the target database.

```
impdp system@TNS alias for pluggable database schemas="schema_name"
directory=name dumpfile=DotNetSP.dmp
```

      where *name* is the directory name provided in step 6.a.

   c. Drop the directory *name* provided in step 6.a.

```
drop directory name
```

      where *name* is the directory name provided in step 6.a.

7. If you are *not* migrating to a target that is a pluggable database:

   Run Oracle Data Pump Import utility for the target database.

```
impdp system schemas="schema_name" directory=ORACLECLRDIR
dumpfile=DotNetSP.dmp
```

> **Note:**
>
> Do *not* drop directory `ORACLECLRDIR`.

Migrating .NET Stored Procedures from Oracle Database 11*g* Release 2 (11.2)

You can migrate .NET stored procedures from Oracle Database 11*g* Release 2 (11.2) as follows:

1. Select the libraries that are used by .NET stored procedures from the Oracle Database 11*g* Release 2 (11.2). For example,

   `SELECT library_name, file_spec FROM ALL_LIBRARIES WHERE OWNER='SYS' and FILE_SPEC LIKE '$ORACLE_HOME\bin\clr\%';`

   library_name is usually in the format *dll_name_DLL*. For example, the *library_name* for `Project1.dll` would be `PROJECT1_DLL`.

2. Create a SQL file manually (for example, `DotNetSP_Grant.sql`) with the following SQL statements:

   ```
   CREATE LIBRARY "SYS"."library_name" AS 'file_spec'
   GRANT EXECUTE ON "SYS"."library_name" TO "schema_name"
   GRANT EXECUTE ON "SYS"."DBMS_CLR" TO "schema_name"
   GRANT EXECUTE ON "SYS"."DBMS_CLRTYPE" TO "schema_name"
   GRANT EXECUTE ON "SYS"."DBMS_CLRPARAMTABLE" TO "schema_name"
   ```

3. Run Oracle Data Pump Export utility for the Oracle Database 11*g* Release 2 (11.2).

   ```
   Expdp system schemas="schema_name" directory=ORACLECLRDIR dumpfile=DotNetSP.dmp
   include=PROCEDURE,FUNCTION
   ```

4. Copy .NET stored procedure assemblies from Oracle Database 11*g* Release 2 (11.2) *ORACLE_BASE**ORACLE_HOME*`\bin\clr` folder and its subfolders to the same directory structure in the target database.

5. Run `DotNetSP_Grant.sql` as `SYSDBA` against the target database.

6. If you are migrating to a target that is a pluggable database:

   a. Create directory *name* as the path to `DotNetSP.dmp` on the server.

      ```
      create directory name as 'path to DotNetSP.dmp on the server';
      ```

   b. Run Oracle Data Pump Import utility for the target database.

      ```
      impdp system@TNS alias for pluggable database schemas="schema_name"
      directory=name
      dumpfile=DotNetSP.dmp
      ```

      where *name* is the directory name created in step 6.a.

   c. Drop the directory *name* provided in step 6.a.

```
drop directory name
```

where *name* is the directory name created in step 6.a.

7. If you are *not* migrating to a target that is a pluggable database:

   Run Oracle Data Pump Import utility for the target database.

```
impdp system schemas="schema_name" directory=ORACLECLRDIR
dumpfile=DotNetSP.dmp
```

> **Note:**
>
> Do *not* drop directory `ORACLECLRDIR`.

Mandatory Migration of .NET 1.x Stored Procedures to .NET 2.0 or Later

Beginning with Oracle Database Extensions for .NET version 11.1.0.7.20, .NET 1.x stored procedures are no longer supported. Specifically, Oracle Database Extensions for .NET 1.x and Oracle Data Provider for .NET 1.x are no longer included in this release. If you have existing .NET 1.x stored procedures from an earlier release, you will need to take special migration steps to ensure that they work in this release.

> **WARNING:**
>
> In some cases, this migration will require code changes. You should not install this release in a production environment if you have .NET 1.x stored procedures until you have verified in a test environment that your stored procedures have been successfully migrated. If you have already installed this release and are encountering errors in your .NET 1.x stored procedures, you should downgrade to an earlier version of Oracle Database Extensions for .NET until you are able to make any required code changes to your stored procedures.

Determining if Code Changes are Needed

You will need to analyze your .NET 1.x stored procedures to determine if code changes are required to migrate to this release. Specifically you should investigate:

- Code incompatibilities between ODP.NET for .NET 1.x and ODP.NET for .NET 2.0 (or later).
- Code incompatibilities between Oracle Database Extensions for .NET 1.x and Oracle Database Extensions for .NET 2.0 (or later).
- ADO.NET 1.x and ADO.NET 2.0 migration issues.

> **See Also:**
>
> - Addressing Code Incompatibilities Between ODP.NET for .NET 1.x and ODP.NET for .NET 2.0 or Later
> - Addressing Code Incompatibilities Between Oracle Database Extensions for .NET Versions 1.x and 2.0 or Later
> - `https://msdn.microsoft.com/en-us/default.aspx`

Migration Approaches

There are two possible approaches to allow your .NET 1.x stored procedures to work with this release:

- Recompile and redeploy your .NET 1.x stored procedures using ODP.NET for .NET 2.0 (or later). Oracle strongly recommends this approach and it is required if there are incompatibilities that require code changes.
- Configure your .NET 1.x stored procedures to run using ODP.NET for .NET 2.0 (or later). This does not require recompilation but introduces the possibility of run-time errors if there are unaddressed incompatibilities.

> **See Also:**
>
> Configure .NET 1.x Stored Procedures Using ODP.NET for .NET 2.0 or Later

Addressing Code Incompatibilities Between ODP.NET for .NET 1.x and ODP.NET for .NET 2.0 or Later

You may need to address the following code incompatibilities related to ODP.NET in your .NET 1.x stored procedures:

- In ODP.NET for .NET 2.0 (or later), `OracleParameter.Value` returns `OracleDecimal` instead of .NET native types when `OracleParameter.OracleDbType` is set to a number type, such as `Int32`, `Double`. This behavior change is summarized in the following table:

OracleParameter.OracleDbType	OracleParameter.Value Returned in .NET 1.x	OracleParameter.Value Returned in .NET 2.x
`OracleDbType.Byte`	`System.Byte`	`OracleDecimal`
`OracleDbType.Double`	`System.Double`	`OracleDecimal`
`OracleDbType.BinaryDouble`	`System.Double`	`OracleDecimal`
`OracleDbType.Int16`	`System.Int16`	`OracleDecimal`
`OracleDbType.Int32`	`System.Int32`	`OracleDecimal`
`OracleDbType.Int64`	`System.Int64`	`OracleDecimal`

OracleParameter.OracleDbType	OracleParameter.Value Returned in .NET 1.x	OracleParameter.Value Returned in .NET 2.x
`OracleDbType.Single`	`System.Single`	`OracleDecimal`
`OracleDbType.BinaryFloat`	`System.Single`	`OracleDecimal`

If any of the preceding `OracleDbType` enumeration values are used by your .NET 1.x stored procedure for an `out` or `in/out` `OracleParameter`, then it may need to be modified.

- In ODP.NET for .NET 2.0 (or later), `OracleParameter.Value` returns provider-type specific `null` value (`OracleClob.Null`) instead of `DBNull.Value` when `OracleParameter.OracleDbType` is set for connected types. For example, if `OracleParameter.OracleDbType` is set to `OracleDbType.Clob`, then `OracleParameter.Value` represents a `null` value by returning `OracleClob.Null` instead of `DBNull.Value`, which is the case in ODP.NET for .NET 1.x.

Addressing Code Incompatibilities Between Oracle Database Extensions for .NET Versions 1.x and 2.0 or Later

If any of the connected types are passed as parameters to your .NET 1.x stored procedure, and if the procedure checks for `null` values, then you may need to modify the procedure. Oracle Database Extensions for .NET 1.x uses a .NET `null` to represent a `null` value when the parameter happens to be a connected type. Oracle Database Extensions for .NET 2.0 (or later) uses provider-type specific `null` value, such as `OracleBFile.Null`, in these cases.

You can configure Oracle Database Extensions for .NET 2.0 (or later) to use .NET `null` values for connected type `null` values in place of provider-specific type `null` values. To do this, create and set the following registry value to 0:

```
HKEY_LOCAL_MACHINE\SOFTWARE\ORACLE\KEY_ORACLE_HOME\ODE\ProviderNull
```

You can find the documentation about this registry value in the section "Backward Compatibility for Nullable ODP.NET Connected Types" in *Oracle Data Provider for .NET Developer's Guide for Microsoft Windows*.

Recompile and Redeploy .NET 1.x Stored Procedures Using ODP.NET for .NET 2.0 or Later

If you find code incompatibilities, you will need to recompile your .NET 1.x stored procedures using ODP.NET for .NET 2.0 (or later).

Even if you do not find code incompatibilities, Oracle recommends that you recompile and redeploy your .NET 1.x stored procedures. Recompiling ensures that you do not get run-time errors, if there are any unaddressed compatibility issues. Redeploy the stored procedures after successful recompilation.

Configure .NET 1.x Stored Procedures Using ODP.NET for .NET 2.0 or Later

Alternatively, if there are no code incompatibilities, you can configure the .NET 1.x stored procedures to run with ODP.NET for .NET 2.0 (or later). This approach does not require you to recompile and redeploy the .NET stored procedures. However, you might get run-time errors, if there are any unaddressed incompatibilities between versions 1.x and 2.0 of Oracle Database Extensions for .NET, ODP.NET, and ADO.NET. Use the following steps to configure the .NET 1.x stored procedures to run with ODP.NET for .NET 2.0 (or later) without recompiling and redeploying them:

1. Follow steps similar to those given in Migrating .NET Stored Procedures from Oracle Database 11*g* Release 2 (11.2) to migrate your stored procedures to Oracle Database 19c.
2. Modify or create the `extproc.exe.config` file in the *`NewOracleHome`*`\bin` folder to redirect ODP.NET (`Oracle.DataAccess.dll`) 1.x references to the installed version of ODP.NET for .NET 2.0 (or later). For example, to redirect ODP.NET 1.111.6.20 references to ODP.NET 2.111.7.20, the `extproc.exe.config` file should include the following configuration section:

```
<configuration>
  <runtime>
    <legacyUnhandledExceptionPolicy enabled="1"/>
    <assemblyBinding xmlns="urn:schemas-microsoft-com:asm.v1">
      <dependentAssembly>
        <assemblyIdentity name="Oracle.DataAccess"
                          publicKeyToken="89b483f429c47342"
                          culture="neutral" />
        <bindingRedirect oldVersion="1.111.6.20"
                         newVersion="2.111.7.20"/>
      </dependentAssembly>
    </assemblyBinding>
  </runtime>
</configuration>
```

Oracle Database Extensions for .NET Registry Options

You can add functionality to Oracle Database Extensions for .NET using Windows registry entries that are located at

`HKEY_LOCAL_MACHINE\SOFTWARE\ORACLE\KEY_`*`ORACLE_HOME`*`\ODE`

Table 2-2 lists registry keys that add functionality to Oracle Database Extensions for .NET and the sections where the keys are discussed.

Table 2-2 Registry Options

Registry Key	Section
`.NETFramework`	"Selecting a .NET Run Time Version"
`ProviderNull`	"Backward Compatibility for Nullable ODP.NET Connected Types"
`RecreateAppDomain`	"Unloading .NET Assemblies for Easy Redeployment"

Table 2-2 (Cont.) Registry Options

Registry Key	Section
TraceFileLocation	"TraceFileLocation"
TraceOption	"TraceOption"
TraceLevel	"TraceLevel"

Unloading .NET Assemblies for Easy Redeployment

From release 11.1.0.6.20, you can unload .NET assemblies when .NET stored procedure execution completes. This makes it easier to repeatedly test your code during development. If this registry key is not enabled, the `exproc.exe` process must be stopped and started with each redeployment.

This feature should not be used during performance testing or for production, as it has a negative effect on performance.

To define assembly loading behavior, set the registry value `RecreateAppDomain` of type `REG_SZ` under this registry key:

`HKEY_LOCAL_MACHINE\SOFTWARE\ORACLE\KEY_`*`ORACLE_HOME`*`\ODE`

The valid values for `RecreateAppDomain` are:

`0` = .NET Assembly remains loaded when the .NET stored procedure execution completes.

`1` = .NET Assembly is unloaded when the .NET stored procedure execution completes.

Backward Compatibility for Nullable ODP.NET Connected Types

ODP.NET for .NET 2.0 (or later) supports a static `Null` property in ODP.NET Connected Types, in addition to the existing support for disconnected types such as `OracleDecimal`. It also supports a public property, `IsNull`, for each of these types to check whether or not objects of these types have been assigned a value.

This enables `Null` objects of ODP.NET Connected Types to be propagated to and from a .NET stored procedure. The list of these connected types follows:

- `OracleBlob`
- `OracleClob`
- `OracleBFile`
- `OracleXmlType`

Previous versions of .NET stored procedures expected ODP.NET connected type parameters to be passed as `NULL` rather than a `Type.Null` object. In order to support backward compatibility, the registry string `ProviderNull` can be used to retain the old behavior.

To determine how Oracle Database Extensions for .NET handles passing a `NULL` value to an ODP.NET connected type parameter in a .NET stored procedure, set the registry string `ProviderNull` under this registry key:

`HKEY_LOCAL_MACHINE\SOFTWARE\ORACLE\KEY_ORACLE_HOME\ODE`

The valid values for `ProviderNull` are:

`0` = ODP.NET connected-type parameters are passed as `NULL` rather than `Type.Null` object.

`1` = Oracle Database Extensions for .NET passes a `Type.Null` object to the .NET stored procedure in the case of a null value.

> **See Also:**
>
> *Oracle Data Provider for .NET Developer's Guide for Microsoft Windows* for more information on nullable types

Selecting a .NET Run Time Version

If multiple .NET run time versions are installed on the database computer, then Oracle Database Extensions for .NET defaults to the latest .NET run time available. However, you can configure Oracle Database Extensions for .NET to load a particular .NET run time by setting a registry value.

To specify .NET run time version, set the registry value, `.NETFramework` under this registry key:

`HKEY_LOCAL_MACHINE\SOFTWARE\ORACLE\KEY_ORACLE_HOME\ODE`

Set the registry value to the appropriate .NET run time version, for example, v2.0.50727.

Note: .NET framework 1.x is not supported in this release.

> **See Also:**
>
> Mandatory Migration of .NET 1.x Stored Procedures to .NET 2.0 or Later

Debug Tracing

Oracle Database Extensions for .NET provides debug tracing support, which allows logging of all the Oracle Database Extensions for .NET activities into one or more trace files. A Windows event log entry will be created each time a trace is generated.

Beginning in this release, if the `TraceFileLocation` option (below) is not set, by default trace files will be created in the Windows user temporary folder:

`<Windows user temporary folder>\ODE\trace>`.

The Windows user temporary folder is determined by your local Windows settings, such as your Windows `TMP` or `TEMP` environment variable. Typically, it can be `C:\temp` or `C:\Users\<user name>\AppData\Local\Temp`.

> **Note:**
>
> You can use Oracle Data Provider for .NET tracing mechanisms to troubleshoot ODP.NET specific issues.

The following registry settings should be configured under

`HKEY_LOCAL_MACHINE\SOFTWARE\ORACLE\KEY_`*`ORACLE_HOME`*`\ODE`

TraceOption

`TraceOption` specifies whether to log trace information in single or multiple files for different threads. If the multiple trace files option is requested, a Thread ID is appended to the file name to create a trace file for each thread.

The valid values for `TraceOption` are:

`0` = Single trace file

`1` = Multiple trace files

TraceFileLocation

`TraceFileLocation` specifies the trace file destination directory, for example, `D:\traces`. The default `TraceFileLocation` is `<`*`Windows user temporary folder`*`>\ODE\trace>`.

TraceLevel

`TraceLevel` specifies the level of tracing in Oracle Database Extensions for .NET.

The valid values for `TraceLevel` are:

`0` = None

`1` = Entry and exit information

> **See Also:**
>
> Debug Tracing section in *Oracle Data Provider for .NET Developer's Guide for Microsoft Windows*

extproc.exe.config Configuration File

Oracle Database Extensions for .NET will read a `extproc.exe.config` configuration file in the *`ORACLE_BASE`*`\\`*`ORACLE_HOME`*`\Bin` directory to look up configuration values such as Oracle Database Extensions for .NET and Oracle Data Provider for .NET assembly locations.

Beginning with Oracle Database Extensions for .NET 12.2, the `legacyUnhandledExceptionPolicy` will not be enabled. Thus, by default, if any

unhandled exceptions occur within the process that executes the .NET stored procedure, then the process will terminate. However, the `extproc.exe.config` file can be configured to have the same pre-12.2 behavior by enabling `legacyUnhandledExceptionPolicy` so that the process does not terminate for unhandled exceptions.

The following is an example of the `extproc.exe.config` configuration file with `legacyUnhandledExceptionPolicy` enabled:

```
<configuration>
  <runtime>
    <legacyUnhandledExceptionPolicy enabled="1"/>
  </runtime>
</configuration>
```

3

Development and Deployment with Visual Studio

These topics describe the steps that are required to develop and deploy a .NET stored procedure or function into an Oracle Database.

Step 1: Develop the Stored Procedure or Function and Build it into an Assembly

Write the stored procedure or function using Microsoft Visual Studio with an appropriate .NET language.

Use Oracle Data Provider for .NET (`Oracle.DataAccess.Client` and `Oracle.DataAccess.Types`) in a .NET stored procedure or function to provide data access.

Build the stored procedure or function into an assembly as a DLL, and not as an EXE. This is typically accomplished using a Class Library project.

Keep in mind the Oracle Data Provider for .NET limitations and restrictions, especially concerning connections and transactional semantics, when designing and developing a .NET procedure or function that uses data access.

Step 2: Run the Oracle Deployment Wizard for .NET

Run Oracle Deployment Wizard for .NET from Microsoft Visual Studio. Oracle Deployment Wizard for .NET is installed as part of the Oracle Developer Tools for Visual Studio. This wizard requires `SYSDBA` credentials, the name of the assembly to be deployed, and the database it is being deployed to.

Step 3: Choose the Procedure or Function to Deploy and Security Level

Choose the procedure or function to be deployed when the Oracle Deployment Wizard for .NET displays the list of methods for that assembly.

Also, choose the security level.

Oracle Database Extensions for .NET executes .NET stored procedures or functions at a specific security level. The security level dictates the Code Access Permissions granted to a .NET stored procedure or function. By default, .NET stored procedures or functions are executed with the SAFE security level.

The security levels are:

- Safe

  In Safe level, the .NET stored procedure or function is allowed to access only database resources. Access to any external resources such as local files, networks, and so on, is not allowed.

- External

  In External level, the .NET stored procedure or function is allowed to read or write to local files, and to access network resources such as sockets and internet nodes, and so on.

- Unsafe

  In Unsafe level, the .NET stored procedure or function is allowed unrestricted execution including execution of unmanaged code. It is a superset of all other security levels.

Note:

If ODP.NET is installed with non-machine wide configuration, then .NET stored procedures will need to be deployed and configured with the 'Unsafe' security level.

See Also:

"Step 3: Choose the Function to Deploy" for the process of entering security level

Step 4: Determine the Appropriate Parameter Type Mappings

Determine the correct mapping between .NET and Oracle data types for creating a PL/SQL wrapper for the .NET stored procedure or function. The Oracle Deployment Wizard for .NET provides default mappings, but they can be overridden.

In case of overloaded .NET stored procedures or functions, you need to provide distinct names for the PL/SQL wrappers.

Tables in Appendix A provides conversion information.

> **See Also:**
>
> "Data Type Conversion"

Step 5: Deploy the Procedure or Function

Deploy the procedure or function in the database. The wizard performs the following steps:

1. Connects as `SYSDBA`.
2. Copies the user assembly to the *`ORACLE_BASE`*`\\`*`ORACLE_HOME`*`\bin\CLR` directory or its subdirectory.
3. Creates an Oracle library object and grants execute privilege on this library object to the database user:

   ```
   CREATE OR REPLACE LIBRARY CLRLIBRARY1_DLL AS '$ORACLE_HOME\
       bin\clr\CLRLibrary1_dll;
   GRANT EXECUTE ON CLRLIBRARY1_DLL TO SCOTT;
   ```

4. Creates a PL/SQL wrapper in the user's database schema for each procedure or function, according to the parameter type mappings defined by the user.

Step 6: Test the Procedure or Function

Test the .NET stored procedure or function by calling the PL/SQL wrapper.

The PL/SQL wrapper can be located and executed easily using Oracle Developer Tools for Visual Studio, or from a tool like SQL*Plus.

Step 7: Debug the Procedure or Function

Whenever a .NET stored procedure or function is invoked, the Oracle database listener redirects the request to a multithreaded CLR external procedure agent, `extproc.exe`. Each .NET stored procedure or function is executed in the context of the `extproc.exe` process.

1. Ensure that the debug versions of the .NET assembly representing the .NET stored procedure or function and its `pdb` file and dependency DLLs, and their respective `pdb` files are copied to the *`ORACLE_BASE`*`\\`*`ORACLE_HOME`*`\bin\clr` directory or one of its subdirectories, based on the path provided while creating the library.
2. Attach the debugger to the `extproc.exe` process. Note that the debugger should be capable of debugging .NET code. If Visual Studio is used for debugging, select the Native and Common Language Runtime options in the Attach to Process dialog box. The Native option can be deselected if any .NET stored procedure has already been run in the context of the same `extproc.exe` process.
3. When the debugger is attached, open the .NET stored procedure or function source code and set any breakpoints that are needed, at the required locations.
4. Debug the .NET stored procedure.

> **Note:**
>
> You can use Oracle Data Provider for .NET tracing mechanism to troubleshoot application issues. Please see Debug Tracing section in *Oracle Data Provider for .NET Developer's Guide for Microsoft Windows*.

4

Development and Deployment of a .NET Stored Function Demo

These topics demonstrate how to develop and deploy a .NET stored function.

> **See Also:**
>
> *Oracle Developer Tools for Visual Studio Help* for further information for further information about these components

Overview of .NET Stored Function Demonstration

This demonstration uses Oracle Developer Tools for Visual Studio extensively although some processes can be performed with other Oracle tools. Also, the demonstration refers to the following components of Oracle Developer Tools for Visual Studio:

- Oracle Explorer
- Oracle Project
- Oracle Deployment Wizard for .NET

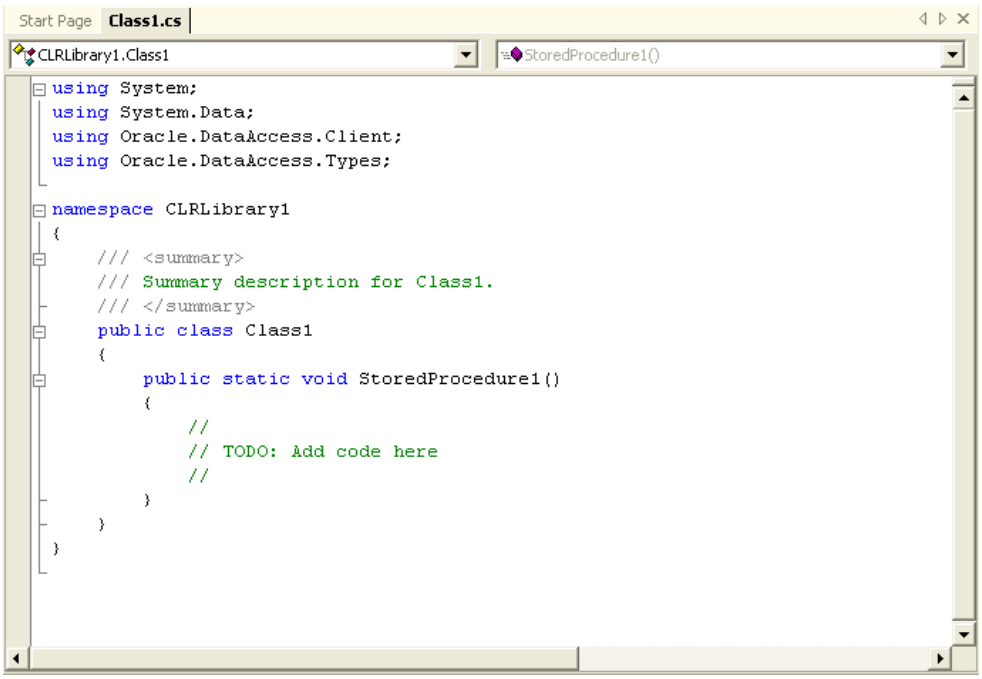
In this demonstration, you will develop and deploy a .NET stored function named `GetDeptNo`, with a PL/SQL wrapper, `GETDEPTNO`. The `GetDeptNo` function accepts an employee number (`EMPNO`), performs a query, and returns the department number (`DEPTNO`) of the employee.

Step 1: Create the GetDeptNo Function and Build it into an Assembly

This demonstration begins by opening Visual Studio, creating a function, and building it into an assembly.

1. Open Visual Studio and connect as `scott/password`. See *Oracle Developer Tools for Visual Studio Help* for information about connecting.
2. From the Visual Studio menu, select **File**, then **New Project**.
3. To create an Oracle Project template, select the project type **Visual C# Projects**, and select **Oracle Project**.
4. Name the project `CLRLibrary1` and provide a location for it.

   A class named `CLRLibrary1.Class1` appears. It contains a template for a stored procedure.



5. Copy the following code over the base class and save.

```
using System;
// use the ODP.NET provider
using Oracle.DataAccess.Client;
using Oracle.DataAccess.Types;

namespace CLRLibrary1
{
  // Sample .NET stored function returning department number for
  // a given employee number
  public class Class1
  {
    public static int GetDeptNo(int empno)
    {
      int deptno = 0;

      // Check for context connection
      OracleConnection conn = new OracleConnection();
      if( OracleConnection.IsAvailable == true )
      {
        conn.ConnectionString = "context connection=true";
      }
      else
      {
```

```
        throw new InvalidOperationException("context connection" +
          "not available");
      }

      conn.Open();
      // Create and execute a command
      OracleCommand cmd = conn.CreateCommand();
      cmd.CommandText = "SELECT DEPTNO FROM EMP WHERE EMPNO = :1";

      cmd.Parameters.Add(":1",OracleDbType.Int32,empno,
        System.Data.ParameterDirection.Input);

      OracleDataReader rdr = cmd.ExecuteReader();

      if (rdr.Read())
        deptno = rdr.GetInt32(0);

      rdr.Close();
      cmd.Dispose();
      conn.Close();

      return deptno;

    } // GetDeptNo
  } // Class1
} // CLRLibrary1
```

6. From the **Build** menu, select **Build Solution** or **Build CLRLibrary1**.

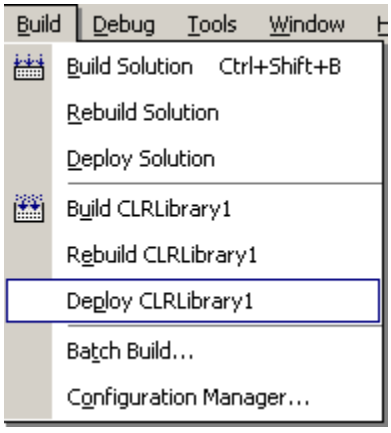
   This builds the code into an assembly.

7. Save.

Step 2: Start the Oracle Deployment Wizard for .NET

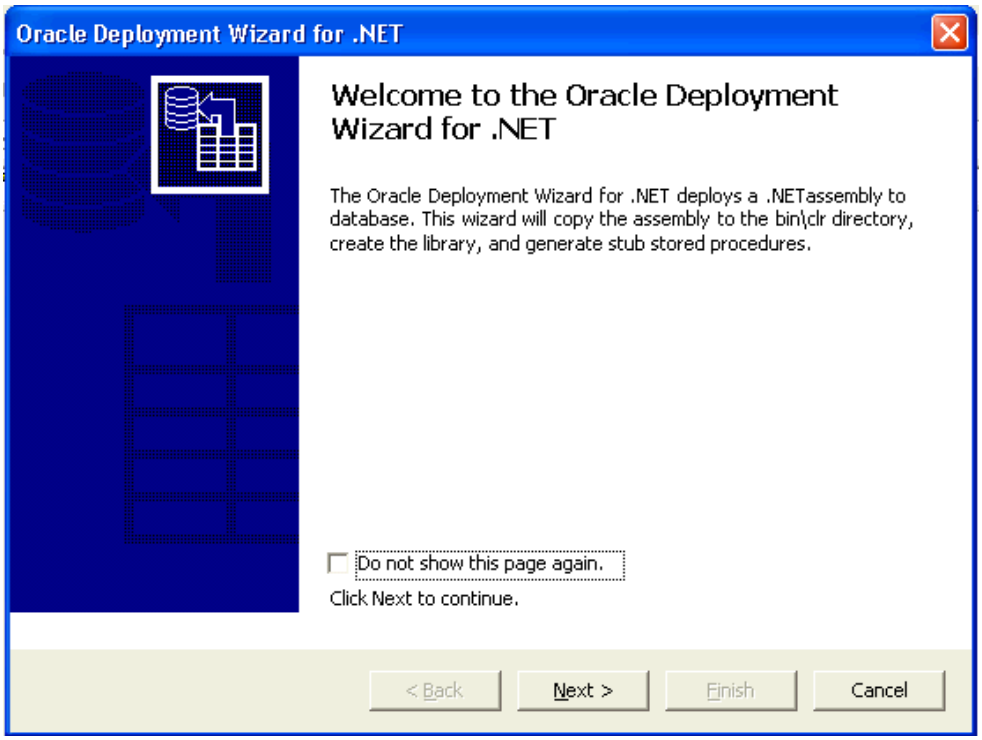
Oracle Deployment Wizard for .NET can be started from the build menu.

1. From the **Build** menu, select **Deploy CLRLibrary1**.



2. When the Welcome window appears, select **Do not show this page again**, if you want.

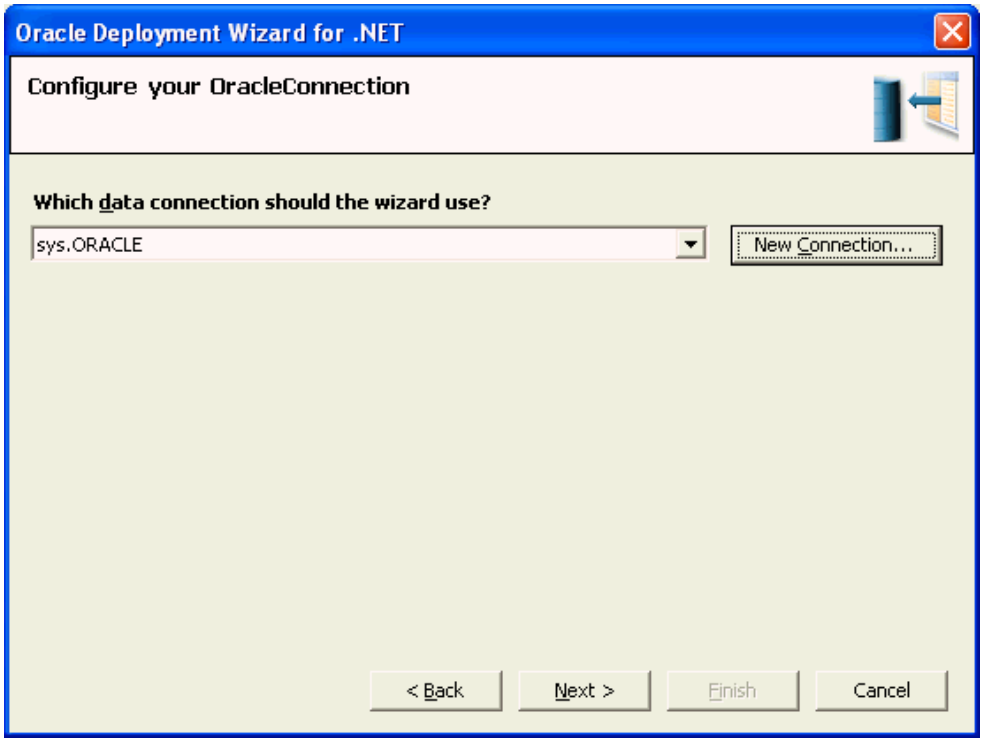
   Then, click **Next**.



3. The Configure your OracleConnection window appears.

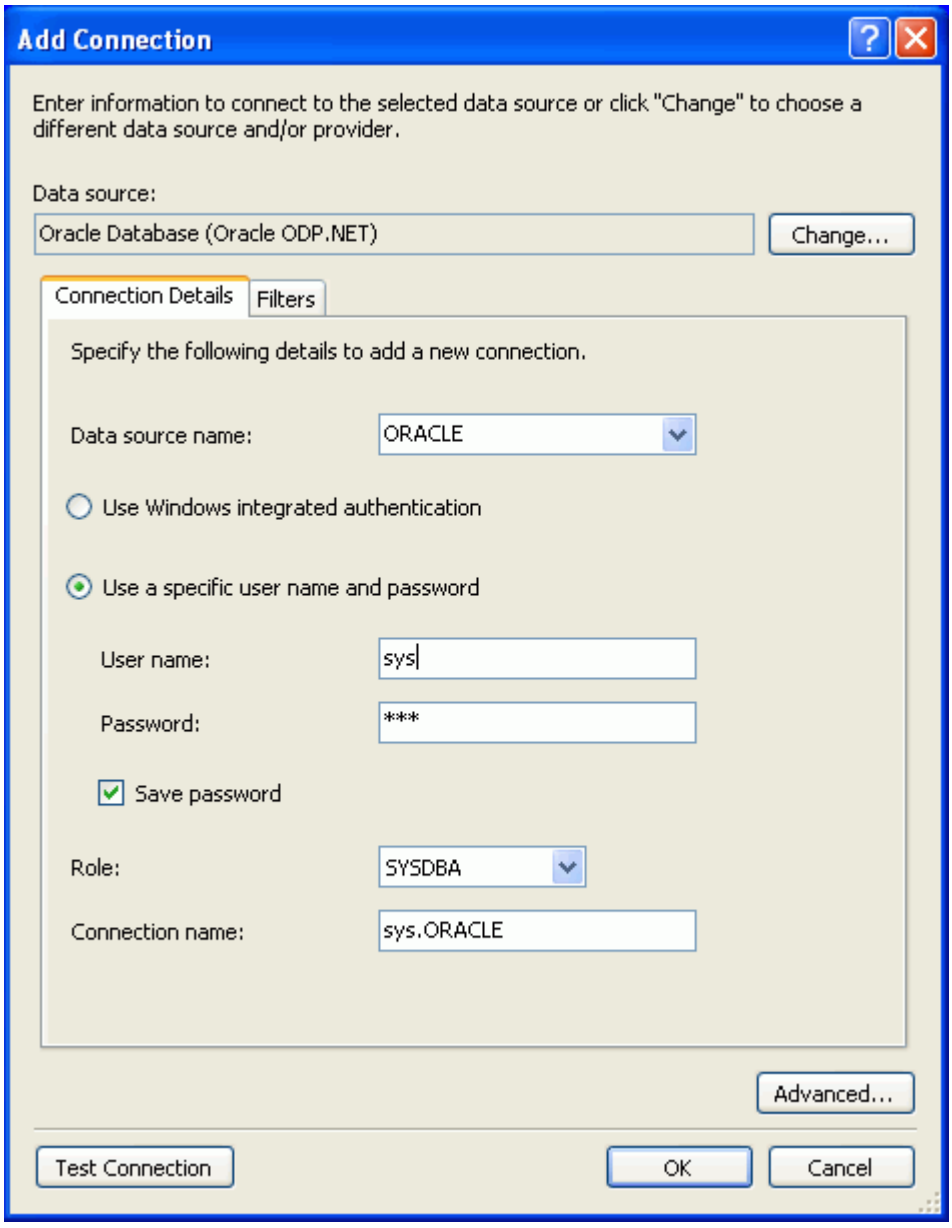
   Choose your connection from the drop-down list, and click **Next** or click **New Connection**, if you are not connected.

   You must choose or add a SYSBA connection.



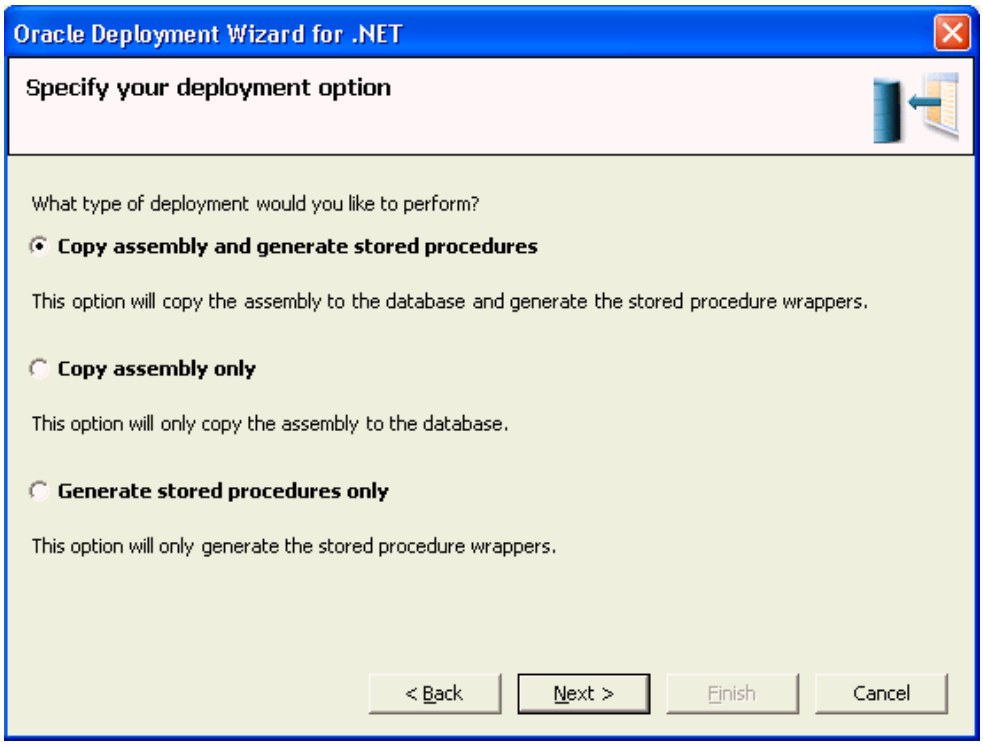
4. If you have selected New Connection, the Add Connection window appears.

   In the Connection Details tab, select the Data source name from the drop-down list.You can select an option to Use Windows integrated authentication or an option Use a specific user name and password, and enter that information.If you want, select **Save** password.The option for Role shows SYSDBA, which is the only available option.If you want to test the connection, click **Test connection**.Click **OK**,



5. The Specify your deployment option window appears.

   The first time you run the deployment wizard, select **Copy assembly and generate stored procedures**. If you later modify your function or stored procedure, you can run the deployment wizard again, and choose to perform just one of these operations.Click **Next**.

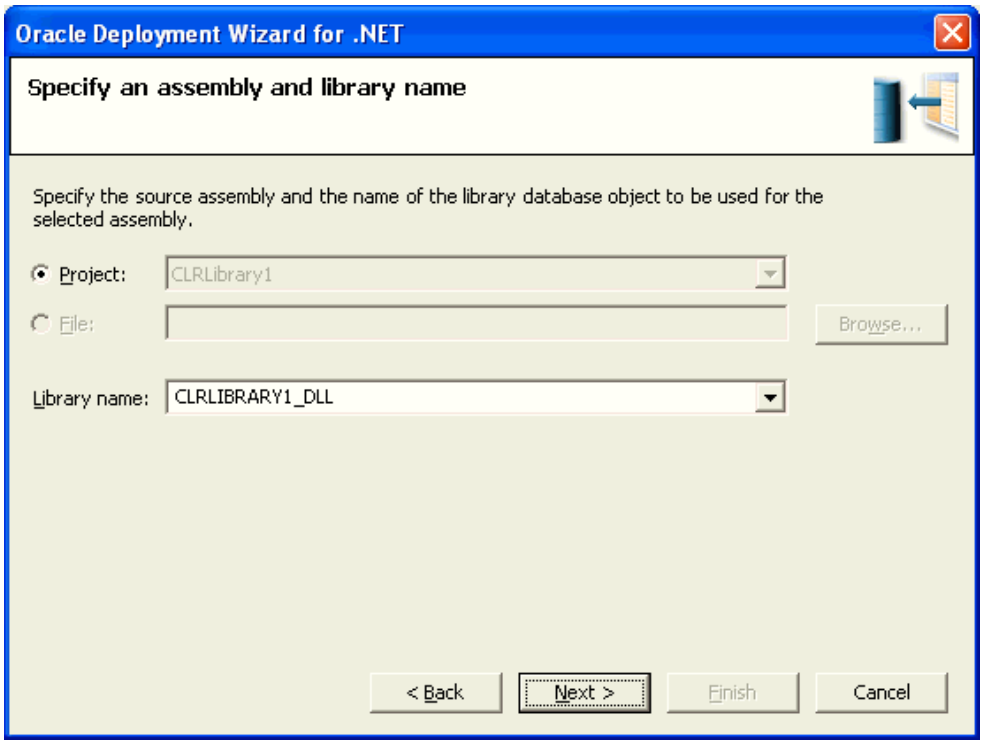


6. The Specify an assembly and library name window appears.

   To specify the assembly, select the project from the drop-down list, or select **File**, and click **Browse** to navigate to the one you want.

   To specify the name of the library database object to be used for the selected assembly, accept the default, select the name from the drop-down list, or enter a new name.

   For this demonstration, accept the default project and library name and click **Next**.



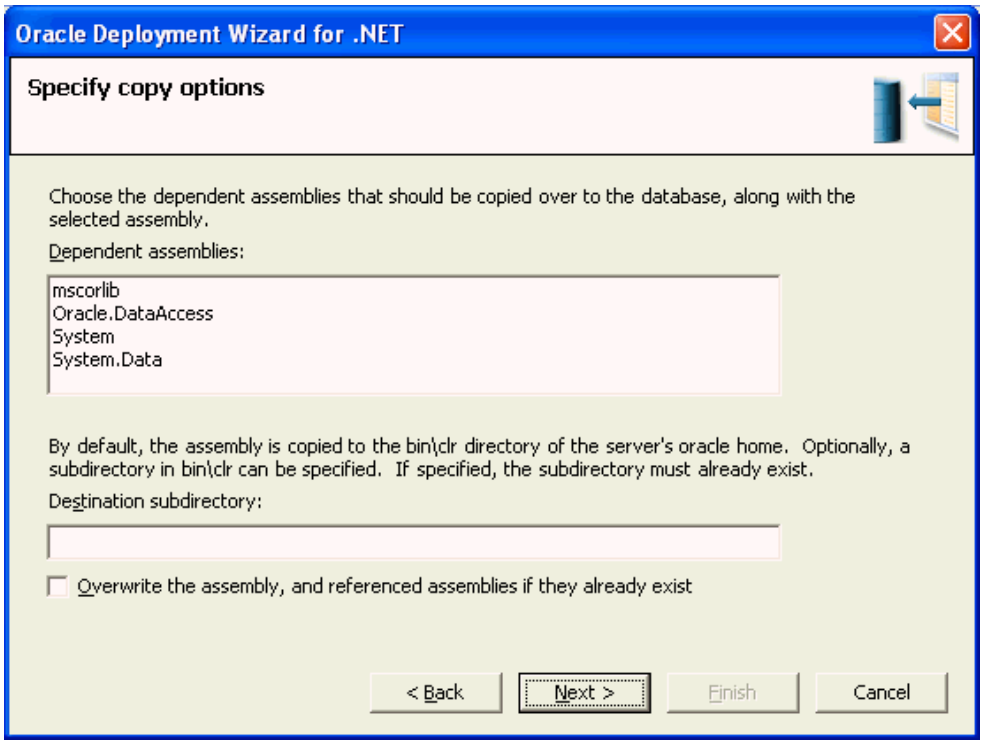
7. The Specify Copy Options window appears.

   To specify the dependent assemblies to copy to the database, select them from the list. The list displays all possible dependent assemblies. In this case, the assemblies displayed have already been copied to the database and, therefore, there is no need to copy them. To deploy the assembly to a directory other than the default `bin\clr` directory, modify the destination path. The destination must be a `bin\clr` directory or one of its existing subdirectories.

   For this demonstration, do not select any dependent assemblies, and do not modify the destination path.

   If you want to, select **Overwrite the file if it already exists in the database**.

   Then, click **Next**.



Step 3: Choose the Function to Deploy

The Specify methods and security details window appears.

You can select the entire project to deploy, or expand it to deploy specific functions. Because there is only one function in this project, selecting any one item, checks the entire project. If there were more functions or procedures, you could select individual items to deploy.

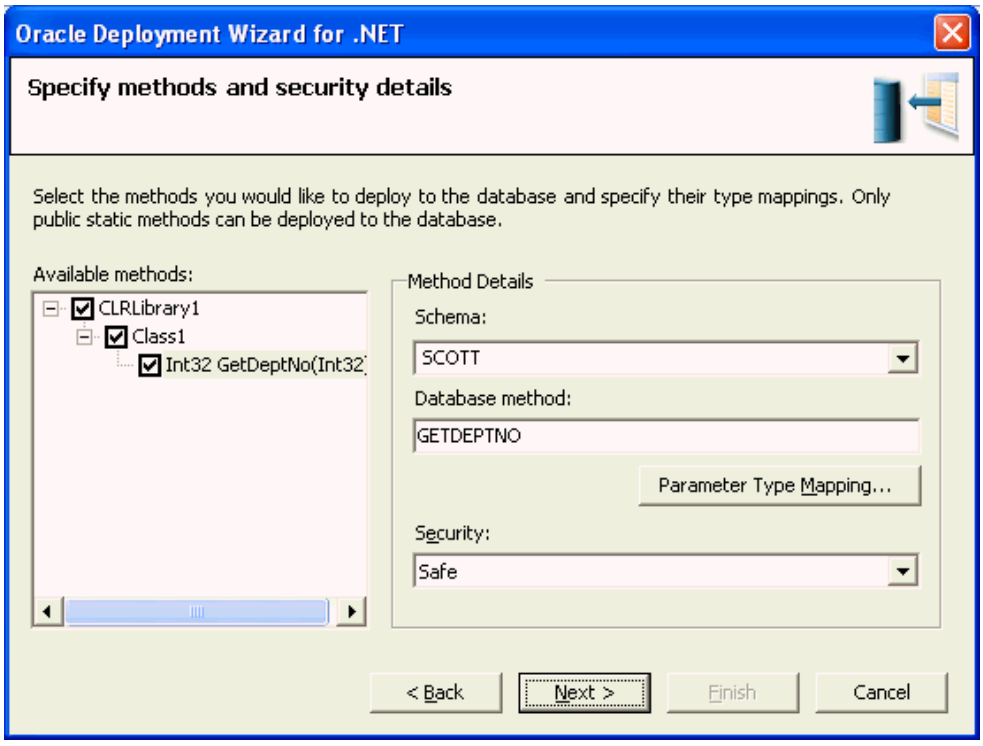
If you want to select a different schema to deploy, you can do so here. If the schema you want is not listed, you need to apply different filters. For information on this process, see *Oracle Developer Tools for Visual Studio Help*.

You can set the security level using the drop-down list. The possible levels are:

- **Safe** - (Default)
- **External**
- **Unsafe**

For this demonstration, do the following:

1. Choose `GetDeptNo()` from the list of procedures and functions contained within that assembly.
2. The schema initially says `SYS`. Change it to `Scott`, so that you can deploy it in the `scott` schema.
3. Accept the default security level. You can either click **Next** to continue, or you can click **Parameter Type Mapping...** to view the type mappings.



See Also:

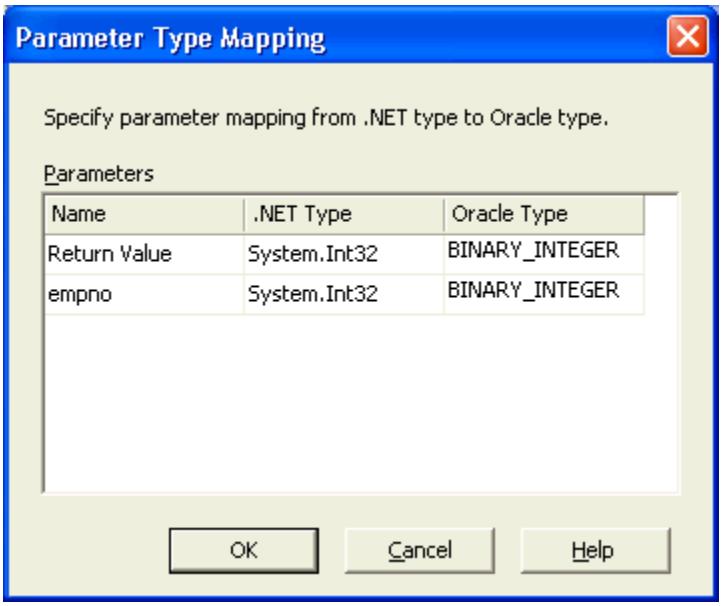
Step 3: Choose the Procedure or Function to Deploy and Security Level

Step 4: Determine the Appropriate Parameter Type Mappings

If you have selected Parameter Type Mapping..., the Parameter Type Mapping window appears, which allows you to change the data type, using the drop-down list.

For this demonstration, accept the default mappings of the .NET data type `System.Int32` to the Oracle type `BINARY_INTEGER`.

Click **OK** to return to the Specify methods and security details window.



See Also:

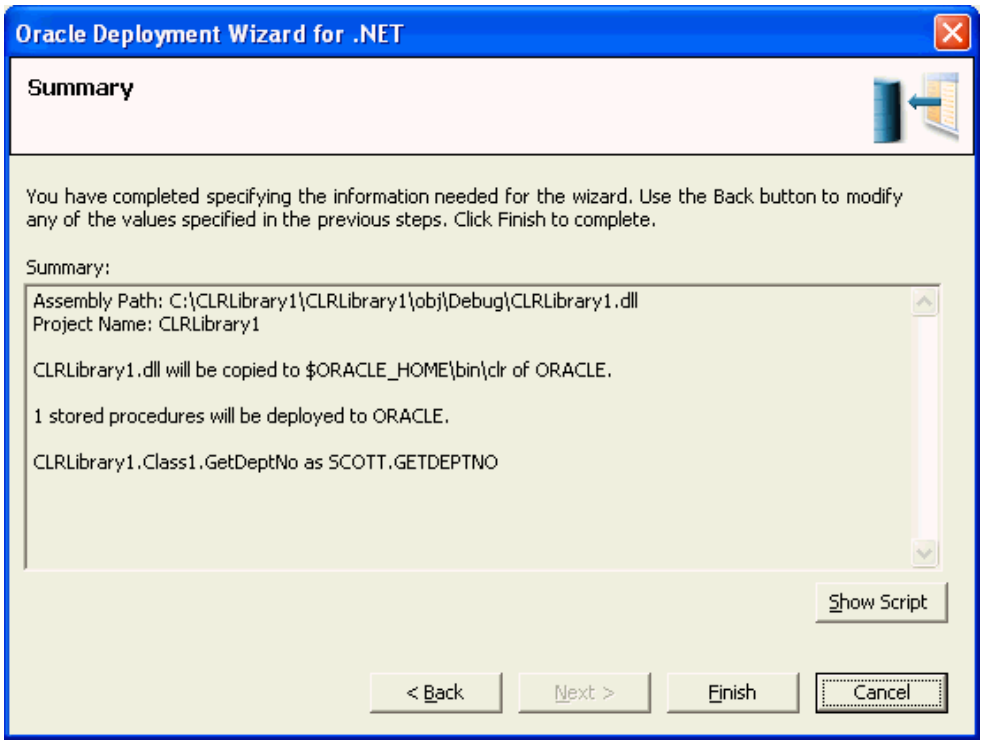
"Data Type Conversion" for data type mapping tables

Step 5: Deploy the Function to an Oracle Database

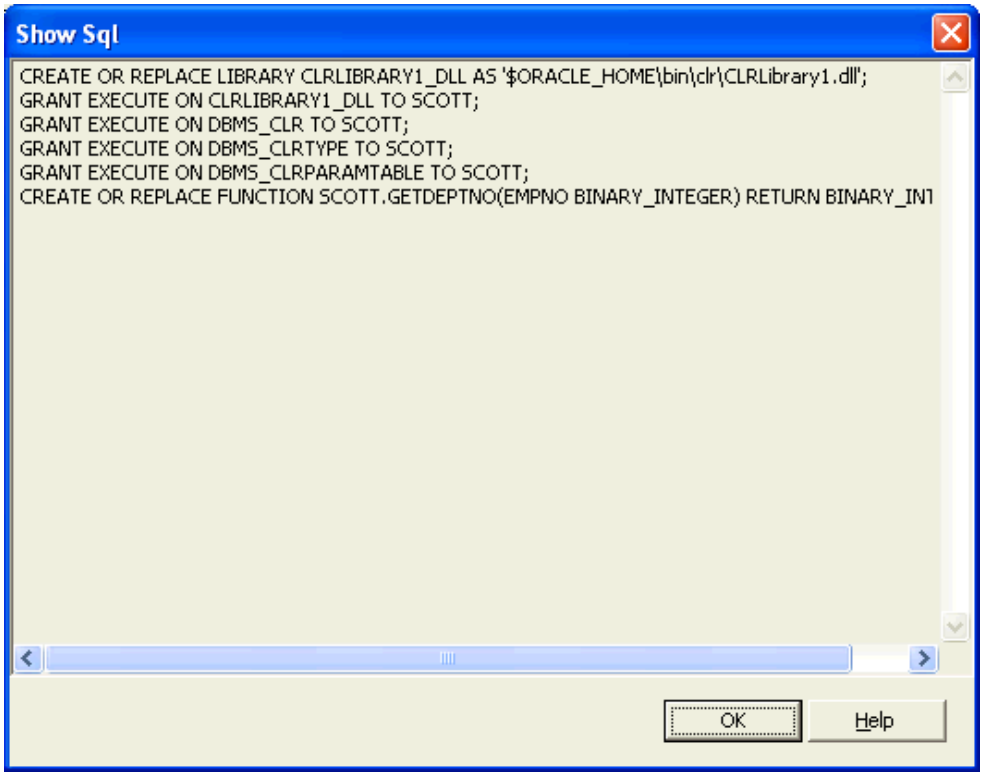
The Summary window of the Oracle Deployment Wizard for .NET appears, showing all the indicated specifications. This window permits you to modify any values by selecting Back.

To complete the demonstration, do the following:

1. Review the summary.
2. To verify SQL commands, select **Show Script**.



3. When the Show Sql window appears, review the code for the PL/SQL wrapper and click **OK** to return to the Summary window.



4. Click **Finish** to deploy the `GetDeptNo()` function.

Step 6: Test the Function

At this point, `GetDeptNo()` function has been deployed to the Oracle Database and you are ready to test it by invoking the PL/SQL wrapper function.

You must be connected as the default user, `scott`, in this demonstration, to call the function.

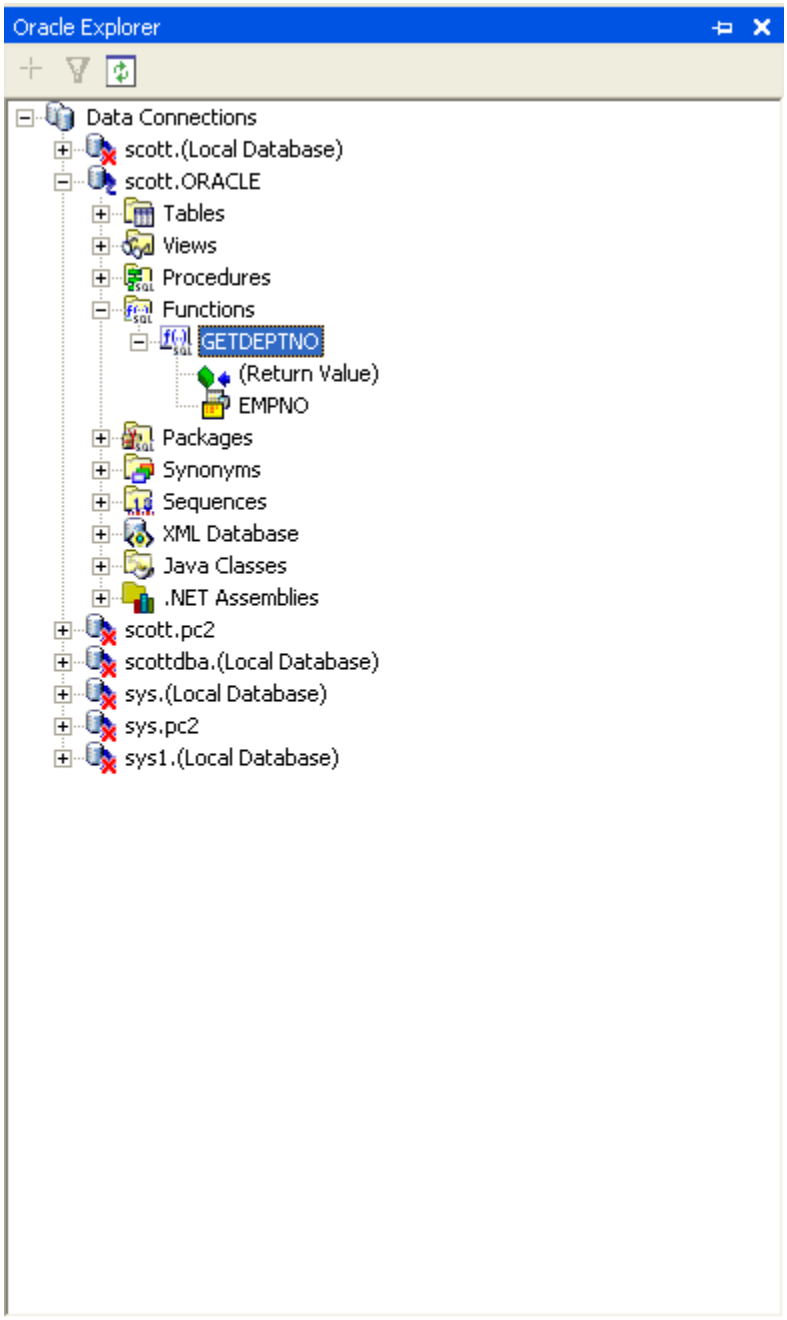
Test the function by invoking it from the following tools:

- Invoking from Oracle Developer Tools for Visual Studio
- Invoking from ODP.NET client
- Invoking from SQL*Plus

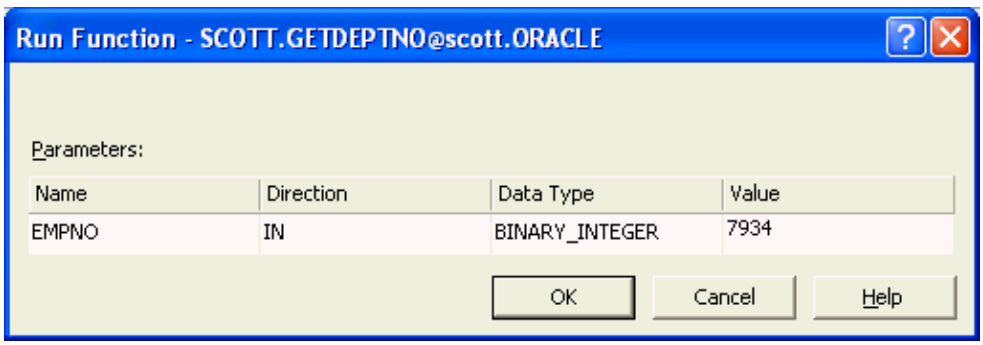
Invoking from Oracle Developer Tools for Visual Studio

To locate and call the function from Oracle Developer Tools for Visual Studio:

1. From the **View** menu, select **Oracle Explorer**.
2. Expand the **Functions** node.
3. Locate **GETDEPTNO**.
4. Right-click **GETDEPTNO** and from the menu, select **Run**.

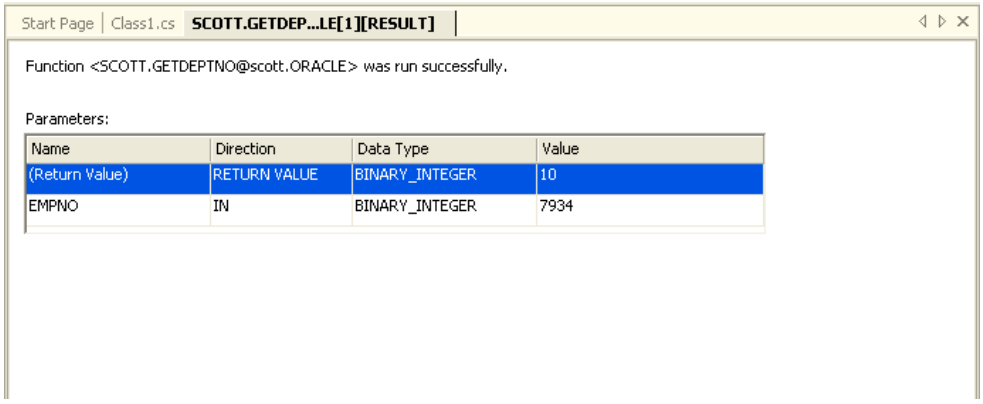


5. When the Run Function dialog box appears, enter employee number 7934 as the input value.



6. Click **OK**.

   The output value 10 appears in the Document Window, indicating that employee number 7934 belongs to department 10.



Invoking from ODP.NET client

The following code sample demonstrates how to invoke the PL/SQL wrapper for .NET function.

```
using System;
using System.Data;
using Oracle.DataAccess.Client;

namespace ODPNETClientApp
{
  public class Class1
  {
    public static void Main()
    {
      int empno  = 7934;
      int deptno = 0;

      try
      {
        // Open a connection to the database
        OracleConnection con = new OracleConnection(
          "User Id=scott; Password=tiger; Data Source=inst1");
        con.Open();

        // Create and execute the command
        OracleCommand cmd = con.CreateCommand();
        cmd.CommandType = CommandType.StoredProcedure;
        cmd.CommandText = "GETDEPTNO";

        // Set parameters
        OracleParameter retParam = cmd.Parameters.Add(":DEPTNO",
            OracleDbType.Int32, System.Data.ParameterDirection.ReturnValue);
        cmd.Parameters.Add(":EMPNO", OracleDbType.Int32, empno,
        System.Data.ParameterDirection.Input);

        cmd.ExecuteNonQuery();
        deptno = (int)retParam.Value;

        Console.WriteLine("\nEmployee# {0} working in department# {1}\n",
```

```
          empno, deptno);

        cmd.Dispose();
        con.Close();
      }
      catch (Exception e)
      {
        Console.WriteLine(e.Message);
      }
    }
  } // Class1
} // ODPNETClientApp namespace
```

Invoking from SQL*Plus

To invoke the `GetDeptNo()` function .NET function from SQL* Plus:

1. Start SQL*Plus and log in as user `scott` with the password `tiger`.
2. Enter the following commands:

```
SET SERVEROUTPUT ON;
DECLARE
deptno BINARY_INTEGER;
BEGIN
  deptno := GetDeptNo(7934);
  DBMS_OUTPUT.PUT_LINE(deptno);
END;
```

Alternatively, you can execute following statement:

```
SELECT GetDeptNo(7934) FROM DUAL;
```

A
Data Type Conversion

These topics contain the following tables used to determine the correct parameter type mappings.

- Table A-1
- Table A-2
- Table A-3
- Table A-4

Mapping of Oracle Native Data Type to .NET Framework Data Types

Table A-1 lists the supported mapping of Oracle native data types to the .NET Framework Types.

Table A-1 Mapping of Oracle Native Data Type to .NET Framework Data Types

Oracle Native Data Type	.NET Framework Data Types
BFILE *	Byte[]
BINARY_DOUBLE	Byte, Byte[], Decimal, Double, float, int, Int16, Int32, Int64, long, SByte, short, Single, String, uint, Uint16, Uint32, Uint64, ulong, ushort
BINARY_FLOAT	Byte, Byte[], Decimal, Double, float, int, Int16, Int32, Int64, long, SByte, short, Single, String, uint, Uint16, Uint32, Uint64, ulong, ushort
BINARY_INTEGER	Byte, Byte[], Char, Decimal, Double, float, int, Int16, Int32, Int64, long, SByte, short, Single, String, uint, Uint16, Uint32, Uint64, ulong, ushort
BLOB	Byte[]
BOOLEAN	*Not Supported*
CHAR	Byte, Char, Char[], DateTime, Decimal, Double, float, int, Int16, Int32, Int64, long, SByte, short, Single, String, uint, Uint16, Uint32, Uint64, ulong, ushort
CLOB	Byte, Char, Char[], DateTime, Decimal, Double, float, int, Int16, Int32, Int64, long, SByte, short, Single, String, uint, Uint16, Uint32, Uint64, ulong, ushort
DATE	Byte[], Char[], String, DateTime
FLOAT	Byte, Byte[], Decimal, Double, float, int, Int16, Int32, Int64, long, SByte, short, Single, String, uint, Uint16, Uint32, Uint64, ulong, ushort
INTERVAL DAY TO SECOND	Byte[], Char, Char[], String, TimeSpan

Table A-1 (Cont.) Mapping of Oracle Native Data Type to .NET Framework Data Types

Oracle Native Data Type	.NET Framework Data Types
INTERVAL YEAR TO MONTH	Byte, Byte[], Char, Char[], int, Int16, Int32, Int64, long, short, String
LONG	Byte, Char, Char[], DateTime, Decimal, Double, float, int, Int16, Int32, Int64, long, SByte, short, Single, String, uint, Uint16, Uint32, Uint64, ulong, ushort
LONG RAW	Byte[]
NCHAR	Byte, Char, Char[], DateTime, Decimal, Double, float, int, Int16, Int32, Int64, long, SByte, short, Single, String, uint, Uint16, Uint32, Uint64, ulong, ushort
NCLOB	Byte, Char, Char[], DateTime, Decimal, Double, float, int, Int16, Int32, Int64, long, SByte, short, Single, String, uint, Uint16, Uint32, Uint64, ulong, ushort
NUMBER	Byte, Byte[], Char, DateTime, Decimal, Double, float, int, Int16, Int32, Int64, long, SByte, short, Single, String, uint, Uint16, Uint32, Uint64, ulong, ushort
NVARCHAR2	Byte, Char, Char[], DateTime, Decimal, Double, float, int, Int16, Int32, Int64, long, SByte, short, Single, String, uint, Uint16, Uint32, Uint64, ulong, ushort
PLS_INTEGER	Byte, Byte[], Char, Decimal, Double, float, int, Int16, Int32, Int64, long, SByte, short, Single, String, uint, Uint16, Uint32, Uint64, ulong, ushort
RAW	Byte[]
REAL	Byte, Byte[], Decimal, Double, float, int, Int16, Int32, Int64, long, SByte, short, Single, String, uint, Uint16, Uint32, Uint64, ulong, ushort
ROWID	Char[], String
TIMESTAMP	Byte[], Char[], String, DateTime
TIMESTAMP WITH LOCAL TIME ZONE	Byte[], Char[], String, DateTime
TIMESTAMP WITH TIME ZONE	Byte[], Char[], String, DateTime
UROWID	Char[], String
VARCHAR2	Byte, Char, Char[], DateTime, Decimal, Double, float, int, Int16, Int32, Int64, long, SByte, short, Single, String, uint, Uint16, Uint32, Uint64, ulong, ushort
XMLType	Char[], String

Mapping of .NET Framework Data Types to Oracle Native Data Types

Table A-2 lists the supported mapping of .NET Framework Types to Oracle native data types.

Table A-2 Mapping of .NET Framework Data Types to Oracle Native Data Types

.NET Framework Data Types	Oracle Native Data Type
Byte	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR, CLOB, FLOAT, INTERVAL YEAR TO MONTH, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, REAL, VARCHAR2
Byte[]	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, BLOB, DATE, FLOAT, INTERVAL YEAR TO MONTH, LONG RAW, NUMBER, PLS_INTEGER, RAW, REAL, TIMESTAMP, TIMESTAMP WITH LOCAL TIME ZONE, TIMESTAMP WITH TIME ZONE
Char	BINARY_INTEGER, CHAR, CLOB, INTERVAL DAY TO SECOND, INTERVAL YEAR TO MONTH, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, VARCHAR2, XMLType
Char[]	CHAR, CLOB, DATE, INTERVAL DAY TO SECOND, INTERVAL YEAR TO MONTH, LONG, NCHAR, NCLOB, NVARCHAR2, ROWID, TIMESTAMP, TIMESTAMP WITH LOCAL TIME ZONE, TIMESTAMP WITH TIME ZONE, UROWID, VARCHAR2, XMLType
DateTime	CHAR, CLOB, DATE, LONG, NCHAR, NCLOB, NVARCHAR2, TIMESTAMP, TIMESTAMP WITH LOCAL TIME ZONE, TIMESTAMP WITH TIME ZONE, VARCHAR2
Decimal	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR,CLOB, FLOAT, LONG, NCHAR, NCLOB, NVARCHAR2, NUMBER, PLS_INTEGER, REAL, VARCHAR2
Double	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR, CLOB, FLOAT, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, REAL, VARCHAR2
float	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR, CLOB, FLOAT, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, REAL, VARCHAR2
int	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR, CLOB, FLOAT, INTERVAL YEAR TO MONTH, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, REAL, VARCHAR2
Int16	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR, CLOB, FLOAT, INTERVAL YEAR TO MONTH, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, REAL, VARCHAR2
Int32	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR, CLOB, FLOAT, INTERVAL YEAR TO MONTH, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, REAL, VARCHAR2
Int64	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR, CLOB, FLOAT, INTERVAL YEAR TO MONTH, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, REAL, VARCHAR2
long	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR, CLOB, FLOAT, INTERVAL YEAR TO MONTH, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, REAL, VARCHAR2

Table A-2 (Cont.) Mapping of .NET Framework Data Types to Oracle Native Data Types

.NET Framework Data Types	Oracle Native Data Type
SByte	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR, CLOB, FLOAT, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, REAL, VARCHAR2
short	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR, CLOB, FLOAT, INTERVAL YEAR TO MONTH, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, REAL, VARCHAR2
Single	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR, CLOB, FLOAT, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, REAL, VARCHAR2
String	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR, CLOB, DATE, FLOAT, INTERVAL DAY TO SECOND, INTERVAL YEAR TO MONTH, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, REAL, ROWID, STRING, TIMESTAMP, TIMESTAMP WITH LOCAL TIME ZONE, TIMESTAMP WITH TIME ZONE, UROWID, VARCHAR2, XMLTYPE
TimeSpan	INTERVAL DAY TO SECOND
uint	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR, CLOB, FLOAT, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, REAL, VARCHAR2
Uint16	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR, CLOB, FLOAT, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, REAL, VARCHAR2
Uint32	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR, CLOB, FLOAT, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, REAL, VARCHAR2
Uint64	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR, CLOB, FLOAT, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, REAL, VARCHAR2
ulong	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR, CLOB, FLOAT, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, REAL, VARCHAR2
ushort	BINARY_DOUBLE, BINARY_FLOAT, BINARY_INTEGER, CHAR, CLOB, FLOAT, LONG, NCHAR, NCLOB, NUMBER, NVARCHAR2, PLS_INTEGER, REAL, VARCHAR2

Mapping of Oracle Native Data Type to ODP.NET Data Types

Table A-3 lists the supported mapping of Oracle native data types to the ODP.NET Types.

Table A-3 Mapping of Oracle Native Data Types to ODP.NET Data Types

Oracle Native Data Type	ODP.NET Type
BFILE *	OracleBFile
BINARY_DOUBLE	OracleDecimal OracleString
BINARY_FLOAT	OracleDecimal OracleString
BINARY_INTEGER	OracleDecimal OracleString
BLOB	OracleBinary OracleBlob
BOOLEAN	*Not Supported*
CHAR	OracleString
CLOB	OracleClob OracleString
DATE	OracleDate OracleString OracleTimeStamp OracleTimeStampTZ OracleTimeStampLTZ
FLOAT	OracleDecimal OracleString
INTERVAL DAY TO SECOND	OracleString OracleIntervalDS
INTERVAL YEAR TO MONTH	OracleIntervalYM OracleString
LONG	OracleString
LONG RAW	OracleBinary
NCHAR	OracleString
NCLOB	OracleClob OracleString
NUMBER	OracleDecimal OracleString
NVARCHAR2	OracleString
PLS_INTEGER	OracleDecimal OracleString
RAW	OracleBinary
REAL	OracleDecimal OracleString

Table A-3 (Cont.) Mapping of Oracle Native Data Types to ODP.NET Data Types

Oracle Native Data Type	ODP.NET Type
ROWID	OracleString
TIMESTAMP	OracleDate
	OracleString
	OracleTimeStamp
	OracleTimeStampTZ
	OracleTimeStampLTZ
TIMESTAMP WITH LOCAL TIME ZONE	OracleDate
	OracleString
	OracleTimeStamp
	OracleTimeStampTZ
	OracleTimeStampLTZ
TIMESTAMP WITH TIME ZONE	OracleDate
	OracleString
	OracleTimeStamp
	OracleTimeStampTZ
	OracleTimeStampLTZ
UROWID	OracleString
VARCHAR2	OracleString
XMLType	OracleClob
	OracleString
	OracleXmlType

Mapping of ODP.NET Data Types to Oracle Native Data Types

Table A-4 lists the supported mapping of the ODP.NET Types to the Oracle native data types.

Table A-4 Mapping of ODP.NET Data Types to Oracle Native Data Types

ODP.NET Type	Oracle Native Data Type
OracleBFile	BFILE *
OracleBinary	BLOB
	LONG RAW
	RAW
OracleBlob	BLOB
OracleClob	CLOB
	NCLOB
	XMLType

Table A-4 (Cont.) Mapping of ODP.NET Data Types to Oracle Native Data Types

ODP.NET Type	Oracle Native Data Type
OracleDate	DATE
	TIMESTAMP
	TIMESTAMP WITH LOCAL TIME ZONE
	TIMESTAMP WITH TIME ZONE
OracleDecimal	BINARY_DOUBLE
	BINARY_INTEGER
	BINARY_FLOAT
	FLOAT
	NUMBER
	PLS_INTEGER
	REAL
OracleIntervalDS	INTERVAL DAY TO SECOND
OracleIntervalYM	INTERVAL YEAR TO MONTH
OracleString	BINARY_DOUBLE
	BINARY_FLOAT
	BINARY_INTEGER
	CHAR
	CLOB
	DATE
	FLOAT
	INTERVAL DAY TO SECOND
	INTERVAL YEAR TO MONTH
	LONG
	NCHAR
	NCLOB
	NVARCHAR2
	NUMBER
	PLS_INTEGER
	REAL
	ROWID
	STRING
	TIMESTAMP
	TIMESTAMP WITH LOCAL TIME ZONE
	TIMESTAMP WITH TIME ZONE
	UROWID
	VARCHAR2
	XMLType

Table A-4 (Cont.) Mapping of ODP.NET Data Types to Oracle Native Data Types

ODP.NET Type	Oracle Native Data Type
OracleTimeStamp	DATE
	TIMESTAMP
	TIMESTAMP WITH LOCAL TIME ZONE
	TIMESTAMP WITH TIME ZONE
OracleTimeStampTZ	DATE
	TIMESTAMP
	TIMESTAMP WITH LOCAL TIME ZONE
	TIMESTAMP WITH TIME ZONE
OracleTimeStampLTZ	DATE
	TIMESTAMP
	TIMESTAMP WITH LOCAL TIME ZONE
	TIMESTAMP WITH TIME ZONE
OracleXmlType	XMLType

*** BFILE Mapping to .NET Framework**

An Oracle native BFILE type parameter can be converted to a .NET Byte[]. However, converting a Byte[] to an Oracle native BFILE type is not supported. This means BFILE to .NET Byte[] conversion can be done only if the BFILE parameter type on the database side is an IN parameter and the corresponding parameter on the .NET stored procedure is an IN parameter of type Byte[]. For a BFILE INOUT, or OUT parameter or a RETURN VALUE, the corresponding .NET stored procedure parameters must be of type Oracle.DataAccess.Types.OracleBFile. Otherwise, an exception is thrown.

PL\SQL Associative Array

PL\SQL Associative array is not supported.

B
Troubleshooting Common Errors

This appendix discusses common errors.

Users may encounter various errors while running the PL/SQL wrapper. Causes and recommended actions for such errors are listed below.

ORA-03113: end-of-file on communication channel
Cause: The connection between Client and Server process was broken. It may also happen if the external agent `extproc` crashes for some reason.

Action: There was a communication error that requires further investigation. First, check for network problems and review the SQL*Net setup. Also, look in the `alert.log` file for any errors. Finally, test to see whether the server process is dead and whether a trace file was generated at failure time. There may be some system calls in the .NET function which might terminate the process. Remove such calls.

ORA-03114: not connected to ORACLE
Cause: The connection between Client and Server process was broken. This may also happen if the external agent `extproc` crashes for some reason.

Action: There was a communication error which requires further investigation. First, check for network problems and review the SQL*Net setup. Also, look in the `alert.log` file for any errors. Finally, test to see whether the server process is dead and whether a trace file was generated at failure time. There may be some system calls in the .NET function which might terminate the process. Remove such calls.

ORA-20100: System.BadImageFormatException. The format of the file is invalid.
Cause: The .NET Assembly is not in the proper format.

Action: Fix the .NET assembly format that contains the .NET stored procedures or functions. You need to recompile the .NET assembly.

ORA-20100: System.IO.FileNotFoundException. File or assembly name <assemblyname>.dll, or one of its dependencies, was not found.
Cause: The .NET Assembly or one of its dependent assemblies is not available in *`ORACLE_BASE`*`\\`*`ORACLE_HOME`*`\bin\clr` or in one of the subdirectories as specified during the creation of the library object by the wizard.

Action: Copy the .NET assembly and all its dependent assemblies to *`ORACLE_BASE`*`\\`*`ORACLE_HOME`*`\bin\clr` or to one of its subdirectories as appropriate.

ORA-20100: System.MissingMethodException
Cause: `MissingMethodException` is thrown for many possible reasons including:

- The stored procedure or function name does not match the actual stored procedure or function name defined in the .NET assembly.
- The number, sequence, and type of parameters passed do not match the actual parameters in the .NET stored procedure.

Action: Check the name of the called stored procedure or function for spelling mistakes or case mismatch (upper or lower). Check the number of parameters and check that the type and sequence of the parameters match those of the stored procedure or function defined in the .NET assembly.

ORA-20100: System.Reflection.TargetException. <typename> type not found
Cause: The namespace and/or the class name used in the PL/SQL wrapper is not defined in the .NET Assembly.

Action: Check the class name for spelling mistakes or case mismatch. Check the .NET assembly code for the type.

ORA-20100: System.Security.SecurityException
Cause: .NET stored procedure or function could not be executed with current security level.

Action: Use the appropriate security level. For example, if the .NET stored procedure or function requires file system access, then it should be created with EXTERNAL security level.

ORA-28575: unable to open RPC connection to external procedure agent
Cause: Initialization of a network connection to the `extproc` agent did not succeed. This problem can be caused by network problems, incorrect listener configuration, or incorrect transfer code.

Action: Check listener configuration in `LISTENER.ORA` and `TNSNAMES.ORA`, or check Oracle Names Server. Verify that the multithreaded `extproc` configuration entries are correct.

ORA-28578: protocol error during callback from an external procedure
Cause: An internal protocol error occurred. This could be due to some registration issue during creation of PL/SQL wrapper.

Action: Recreate the PL/SQL wrapper using the wizard.

PLS-00201: identifier 'DBMS_CLR' must be declared
Cause: Either Oracle Database Extensions for .NET is not installed and configured properly or the .NET stored procedure has not been deployed correctly using the Oracle Deployment Wizard for .NET.

Action: Use the Database Configuration Assistant to configure Oracle Database Extensions for .NET, if it has not been installed already. Deploy the .NET stored procedure using the Oracle Deployment Wizard for .NET.

Glossary

assembly

Assembly is the Microsoft term for the module that is created when a DLL or .EXE is complied by a .NET compiler.

Common Language Runtime

Microsoft Common Language Runtime (CLR) is the component of the .NET framework that allows many languages to create and develop applications using the same library.

Dynamic Link Library (DLL)

An executable file that a Windows application can load when needed.

external procedure

A function written in a third-generation language (3GL), such as C, and callable from within PL/SQL or SQL as if it were a PL/SQL function or procedure.

implicit database session

The database session of the caller.

Microsoft .NET Framework Class Library

The Microsoft .NET Framework Class Library provides the classes for the .NET framework model.

namespace

- .NET:

  A namespace is naming device for grouping related types. More than one namespace can be contained in an assembly.

- XML Documents:

  A namespace describes a set of related element names or attributes within an XML document.

Oracle Net Services

The Oracle client/server communication software that offers transparent operation to Oracle tools or databases over any type of network protocol and operating system.

PL/SQL

Oracle's procedural language extension to SQL.

result set

The output of a SQL query, consisting of one or more rows of data.

stored function

A stored function is a PL/SQL block that Oracle stores in the database and can be executed from an application.

stored procedure

A stored procedure is a PL/SQL block that Oracle stores in the database and can be executed from an application.

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