Progress®



# Manage ABL Applications

OpenEdge®

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**July 2021**

**Product version:** Progress OpenEdge 12.4

**Updated: 2021/06/28**

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# Preface

## Purpose

This guide describes how to manage ABL (Advanced Business Language) client applications. The first part describes the ABL client application deployment process and application administration concepts and procedures. The second part describes the steps required to deploy ABL applications and the trade-offs between different deployment scenarios. It also describes components provided with OpenEdge that help you through the deployment process. The final part contains appendices which supplement the rest of the material.

## Audience

The first part of this guide is intended for OpenEdge application administrators. The second part is intended for experienced ABL programmers preparing applications for wider distribution or resale.

## Organization

### ABL and R-code Deployment and Management

ABL Client Deployment Overview on page 17

Presents an overview of the client deployment process, and outlines the deployment and administration tasks you must perform.

Manage Client Access to Databases on page 21

Describes how to connect and disconnect databases for OpenEdge clients.

Maintain Application Security on page 41

Describes how OpenEdge implements application security, including designating security administrators and setting table and field permissions.

Maintain User Environments on page 53

Describes how to maintain OpenEdge user interface environments in Windows and on UNIX.

Manage Client Performance on page 107

Describes how to monitor and tune OpenEdge client application performance.

Manage Procedure Libraries on page 117

Describes ABL procedure libraries and how to use the PROLIB utility.

Manage Print Devices on page 135

Describes how to set up print devices on OpenEdge-supported operating systems.

**Deployment Considerations**

Choose a Code Format on page 147

Describes the different types of code formats you can choose to deploy an OpenEdge application.

Initial Deployment on page 153

Describes the initial deployment process using the different code formats.

Upgrades on page 163

Describes how to upgrade OpenEdge applications.

Deployment Topics and Tasks on page 171

Describes how to perform several tasks related to deploying OpenEdge applications.

**Appendices**

Build OpenEdge Executables on page 183

Describes the process and requirements for building customized OpenEdge executables. It also provides instructions for using the Make utility in Windows and on UNIX.

R-code Features and Functions on page 191

Describes the structure and management of ABL r-code, the executable code into which OpenEdge compiles ABL procedures. It also describes techniques for tuning r-code size and performance, and the use of cyclic redundancy checks (CRCs) to maintain r-code and database integrity.

OpenEdge Application Limits on page 215

Describes the OpenEdge limits you must consider when developing an OpenEdge client application.

Deployment Utilities and Scripts on page 219

Provides reference information about utilities and scripts you can use when deploying your application.

## Documentation conventions

See Documentation Conventions for an explanation of the terminology, format, and typographical conventions used throughout the OpenEdge content library.

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# ABL and R-code deployment and management

For details, see the following topics:

- ABL Client Deployment Overview
- Manage Client Access to Databases
- Maintain Application Security
- Maintain User Environments
- Manage Client Performance
- Manage Procedure Libraries
- Manage Print Devices

# 1

# ABL Client Deployment Overview

Deploying an ABL (Advanced Business Language) client application is a process that involves developing an application and installing that application in end-user environments. Once you have deployed your application, you must manage the end-user environments and system resources for your users.

This set of topics presents an overview of the client deployment process, and outlines the deployment and administration tasks you must perform.

For details, see the following topics:

- Client deployment process
- Client deployment and administration tasks
- Additional deployment documentation

## Client deployment process

While deployment requirements vary between applications, you follow a basic deployment process to deploy any ABL client application.

The client deployment process consists of three basic phases:

- **Planning** — The phase in which you identify your deployment requirements and define your deployment strategy
- **Development** — The phase in which you design, develop, and debug your client application
- **Installation and Configuration** — The phase in which you deliver your client application to end-users, and set up the end-user environment

Each phase of the client deployment process has its own set of requirements and dependencies that you must consider when defining your client deployment strategy. Decisions made in an earlier phase will affect the following phases and the process as a whole.

Progress Software Corporation provides you with the following services to help you identify your client deployment options and accomplish the client deployment process for your application:

- The Progress Software Consulting Services organization which can assist you in all phases of the client deployment process
- The Progress Technical Services staff which can answer your questions about OpenEdge tools, ABL usage, and database administration

## Client deployment and administration tasks

The following are some of the ABL client application deployment and administration tasks you must perform:

- Manage client access to databases
- Maintain application security
- Manage client performance
- Maintain user environments
- Manage procedure libraries
- Manage print devices

The remaining chapters in this guide provide detailed information about each of these tasks, as well as the procedures and utilities you use to accomplish them. The appendixes provide useful information about building OpenEdge executables and OpenEdge application limits.

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**Note:** Certain deployment and administration tasks will differ among operating systems.

---

For information about designing and coding an ABL client application, see *Develop ABL Applications*.

For information about creating and maintaining an OpenEdge RDBMS, see *Manage the OpenEdge Database*.

For information about Progress Application Server for OpenEdge deployment and administration tasks, see *Manage Progress Application Server for OpenEdge*.

## Additional deployment documentation

This guide provides information about deploying an OpenEdge application. For information about other types of deployment, see the guides listed in the following table.

**Table 1: Deployment information in OpenEdge guides**

| Product area | Guide |
|---|---|
| Progress Application Server for OpenEdge | *Manage Progress Application Server for OpenEdge* |
| Database | *Manage the OpenEdge Database* |

| Product area | Guide |
| --- | --- |
| Open Client | *Use the Open Client Toolkit*<br>*Develop .NET Open Clients*<br>*Develop Java Open Clients*<br>*Develop Web Services for OpenEdge* |
| WebClient | *Develop Web Clients* |
| Internationalization | *Internationalize ABL Applications* |

# 2

# Manage Client Access to Databases

This set of topics describes how to connect and disconnect databases for ABL (Advanced Business Language) clients and provides information about the following topics:


- Connect clients to databases on page 21
- Select a working database for client use on page 31
- Disconnect databases for clients on page 32
- Learn about automatic database reconnect on page 33


For details, see the following topics:

- Connect clients to databases
- Select a working database for client use
- Disconnect databases for clients
- Learn about automatic database reconnect

## Connect clients to databases

To access a database, you must connect to the database. You can connect to one or more databases during a single OpenEdge session. You can also start an OpenEdge session without connecting to a database, and connect later.

**Note:** On UNIX, the kernel configuration's file descriptor limit imposes a practical limit on connected databases. "Unable to open file" or "Unable to allocate I-Node" messages often mean your system's file descriptors have been exhausted. "Unable to allocate shared memory" often means your shared memory has been exhausted on your system. For more information about kernel configurations, see *Manage the OpenEdge Database*.

When connecting to databases, consider the following factors:


- Logical database names on page 22
- Connection modes on page 23
- Connection parameters on page 23
- Connection techniques on page 23
- Connect to a non-OpenEdge database on page 29
- Connection denials when the user count is exceeded on page 30
- Reduce connection times on page 31
- Start clients without connecting to a database on page 31


## Logical database names

A *logical database name* is a database reference that represents the name of a connected physical database. OpenEdge uses the logical database name to resolve database references. When a procedure is compiled against a database, OpenEdge stores the logical database name in the procedure's r-code. When a procedure executes, its database references must match the logical name of a connected database.

A database has a logical name whenever it is connected. When you connect to a database, OpenEdge automatically assigns a default logical name for the current session. The default logical name consists of the physical database name without the `.db` suffix. For example, if you connect to a database with the physical name `mydb1.db`, the default logical database name is `mydb1`. Alternatively, you can use the Logical Database Name (-ld) startup parameter to specify a logical database name other than the default.

For example, to assign the logical name `firstdb` to the physical database `mydb1.db` using the PRO command, enter the following command:

```
pro mydb1 -ld firstdb
```

Logical database names allow you to run procedures on different physical databases without recompiling. To run a compiled procedure on a second physical database, the database must meet the following criteria:

- It must have the identical structure (data definitions) as the database you compiled the procedure against.
- It must be connected with the same logical name as the database you compiled the procedure against.

A database connection fails if the logical database name of the database that you are connecting has the same logical name as an already connected database. If you try to connect a database with a logical database name that matches the logical database name of an existing connected database of the same database type (OpenEdge RDBMS, ORACLE, etc.), OpenEdge assumes that database is connected and ignores the request.

You can change a database's logical name in an ABL procedure with the `CREATE ALIAS` statement. For more information about logical and physical database names and aliases, and the `CREATE ALIAS` statement, see *ABL Reference* and *OpenEdge Programming Interfaces*.

## Connection modes

A database is connected in one of the following connection modes:

- **Single-user** — Only the current OpenEdge session can access the specified database. If the database is already in use by another user, you cannot connect to the database from the current OpenEdge session.
- **Multi-user client** — The current OpenEdge session accesses the database through a server process. Multi-user client is the default connection mode on non-shared-memory systems and when you use the Host Name (-H) and Service Name (-S) parameters on shared-memory systems. All remote (over a network) connections access the database through a database server and are in multi-user client mode.
- **Multi-user direct access** — The current OpenEdge session accesses the database directly using shared memory. A process connected in multi-user direct-access mode is a self-service client type of connection. Direct access is available only on shared-memory systems and is the default connection mode on these systems. For information about self-service clients, see *OpenEdge Database Essentials*.

  You cannot connect to remote databases in multi-user direct-access mode.

When you connect to a database with an OpenEdge multi-user startup command, each database you specify on the command line is connected in the default multi-user mode. Each database you specify in a startup file or in a `CONNECT` statement in an application is also connected in the default multi-user mode for the current machine.

The first database specified after the OpenEdge single-user or OpenEdge single-user batch command is connected in single-user mode by default. Any additional databases specified with the Database Name (-db) connection parameter are connected in the default multi-user mode for the system. Use the Single-user Mode (-1) startup parameter to override the default multi-user connection mode for a database and connect to the database in single-user mode.

For more information about the Host Name (-H), Service Name (-S), Database Name (-db), and Single-user Mode (-1) startup parameters, see *Startup Command and Parameter Reference*.

## Connection parameters

*Connection parameters* control how you connect to databases and are a subset of the OpenEdge startup parameters. All of the database connection techniques provide a way for you to specify connection parameters.

You can use a parameter file to specify connection parameters with any of the connection techniques. A *parameter file* is an operating system file that contains one or more startup parameters. A parameter file has a `.pf` extension. Use the Parameter File (`-pf`) startup parameter to invoke a parameter file.

Parameter files are an important factor in developing database connection strategies for multi-database applications. For example, you can use parameter files to maintain the startup parameters for a particular database, group of users, or system configuration.

For more information about startup parameters and parameter files, see *Startup Command and Parameter Reference*.

## Connection techniques

The following are the five ways to connect a database:

- As an argument when starting OpenEdge
- With the `CONNECT` statement (in the Procedure Editor or in an ABL procedure)
- With the OpenEdge Data Dictionary

- With the OpenEdge Data Administration tool
- Using the Auto-connect feature

**Note:** Starting a server or broker for a database is distinct from connecting to a database. You must start a server or broker for a database before you can connect to the database in multi-user mode. For information about starting a server or broker, see *Manage Progress Application Server for OpenEdge with OpenEdge Management* or *Starting Up and Shutting Down a Database*.

This section explains how to connect to databases using these various techniques. *OpenEdge Programming Interfaces* explains why you might choose one technique instead of another.

## Connect at startup

You can connect to databases at session startup with one of the OpenEdge startup commands or with an application startup file. For example, the following PRO command starts a single-user session and connects to three databases:

```
pro -db mydb1 -db mydb2 -db mydb3
```

**Note:** To retain compatibility with earlier versions, OpenEdge does not require you to specify the Database Name (-db) connection parameter for the first database on the command line.

If you specify more than one database when you start a session, it is important to specify the connection parameters for each database directly after the database name to which they apply, and before the next Database Name (-db) connection parameter. OpenEdge applies database connection parameters only to the previously specified database.

The following syntax illustrates the correct location for database connection parameters:

## Syntax

```
mpro [ -db ]db1-name[db1-parameters]    [ -db db2-name[db2-parameters]]...
```

You can specify all other parameters anywhere on the command line. If you specify the same parameter more than once, OpenEdge uses the value you specified for the last instance of the parameter.

You can also use a parameter file to specify database connection parameters. The following example shows a UNIX startup script for a client application where the last line invokes the _progres executable:

```
DLC=${DLC-/usr/dlc}; export DLC
PATH=:$PATH:$DLC; export PATH
PROPATH=:$DLC; export PROPATH
exec $DLC/_progres -pf parm1.pf -pf parm2.pf -p $APPL/start.p
```

The previous startup script sets up environment variables for an application and starts an ABL client application session using two parameter files called `parm1.pf` and `parm2.pf`. The `parm1.pf` parameter file contains the following entry:

```
-db appldb1 -1 bi-file1
```

The `parm2.pf` parameter file contains the following entry:

```
-db appldb2 -1 bi-file2
```

This example illustrates a common approach to connecting multiple databases when you start OpenEdge using a parameter file for each database. Each parameter file is specified on the command line with the Parameter File (`-pf`) startup parameter.

## Connect from a procedure with the CONNECT statement

The `CONNECT` statement allows you to connect to a database from an ABL procedure or from the Procedure Editor.

The following `CONNECT` statements connect the appldb1 database in single-user mode, the appldb2 database in multi-user mode, and the databases specified in the parameter file, `parm3.pf` (respectively):

```
CONNECT appldb1 -1.
CONNECT appldb2.
CONNECT -pf parm3.pf.
```

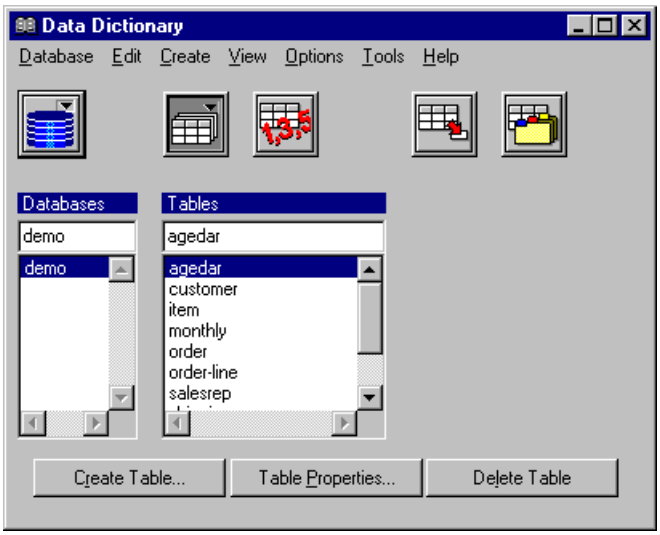
Connecting with the `CONNECT` statement is very similar to connecting at startup. Although it is possible to connect to several databases within one `CONNECT` statement, it is a good idea to connect only one database per `CONNECT` statement. A connection failure for one database causes a termination of the current `CONNECT` statement, leaving any subsequent database specified with the `CONNECT` statement unconnected. For detailed information about the `CONNECT` statement, see *OpenEdge Programming Interfaces*.

## Connect with the Data Dictionary

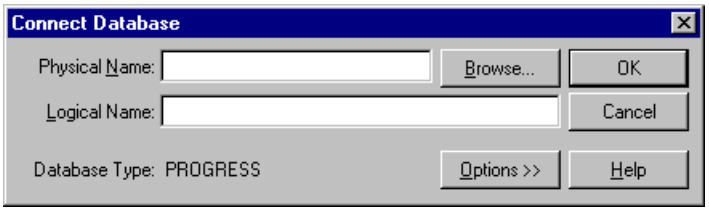
You can connect to a database during an OpenEdge session using the Data Dictionary.

To connect to a database with the Data Dictionary:

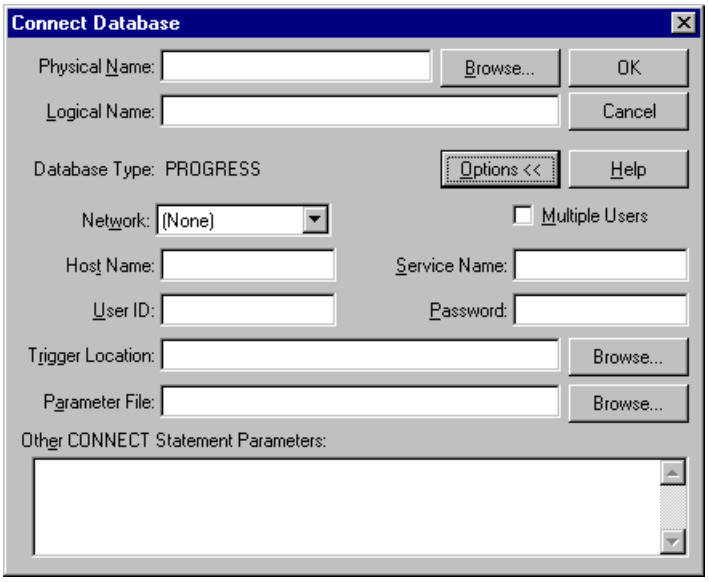
1. Open the **Data Dictionary** from the Windows **Start** menu or from the **Tools** menu of OpenEdge tools, such as AppBuilder and Progress Developer Studio for OpenEdge. If you already have a database connected, for example, the `demo` database, the following window appears:




2. Choose **Database** > **Connect**. The **Connect Database** dialog box appears:




3. Choose the **Options** button. The **Connect Database** dialog box expands to show optional connection controls:




4. Enter the following information:

   - **Physical Name** — Specifies the actual name of the database on a disk.
   - **Logical Name** — Specifies the database name that references a connected physical database.

- **Database Type** — Specifies the database type. The only possible value is PROGRESS.
- **Network** — Specifies the network type, if you are connecting to a network server. The only possible value is TCP.
- **Multiple Users** — Specifies whether you want multiple users to be able to access this database simultaneously.
- **Host Name** — Specifies the database server machine in a network environment.
- **Service Name** — Specifies the broker or server service name in a network environment.
- **User ID** — Identifies your user ID.
- **Password** — Identifies your password.
- **Trigger Location** — Identifies a directory or an ABL procedure library where trigger code is stored.
- **Parameter File** — Specifies the parameter filename that contains the startup parameters for the database.
- **Other CONNECT Statement Parameters** — Specifies any other startup parameters for the database that are not included in the parameter file.

5. Click **OK**.

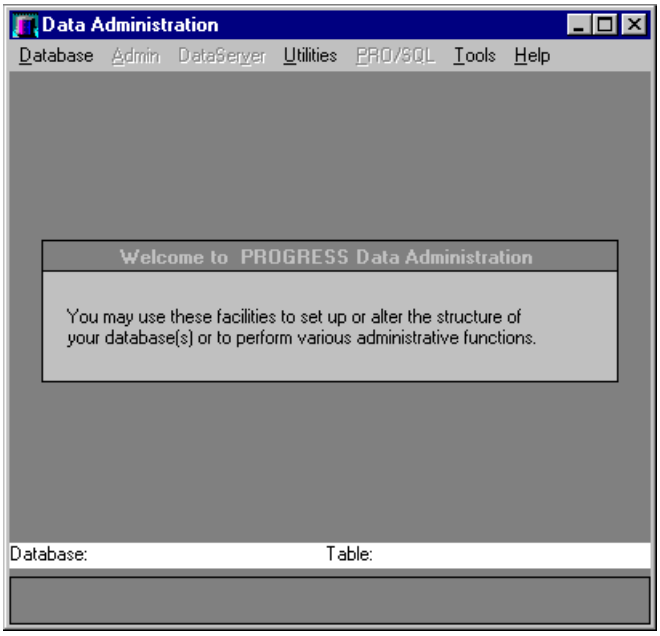
OpenEdge returns you to the Data Dictionary main window. The Data Dictionary constructs (and executes) a `CONNECT` statement using the information you supply. Therefore, any rules that apply to the `CONNECT` statement also apply to database connections using the Data Dictionary.

## Connect with the Data Administration tool

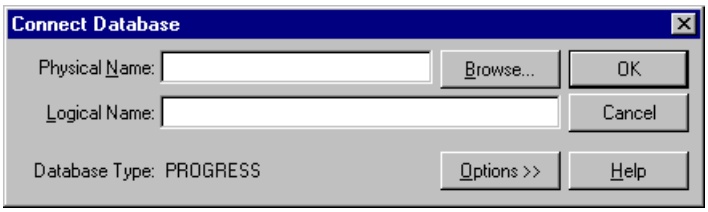
You can also connect to a database during an OpenEdge session using the Data Administration tool.

connect to a database with the Data Administration tool:

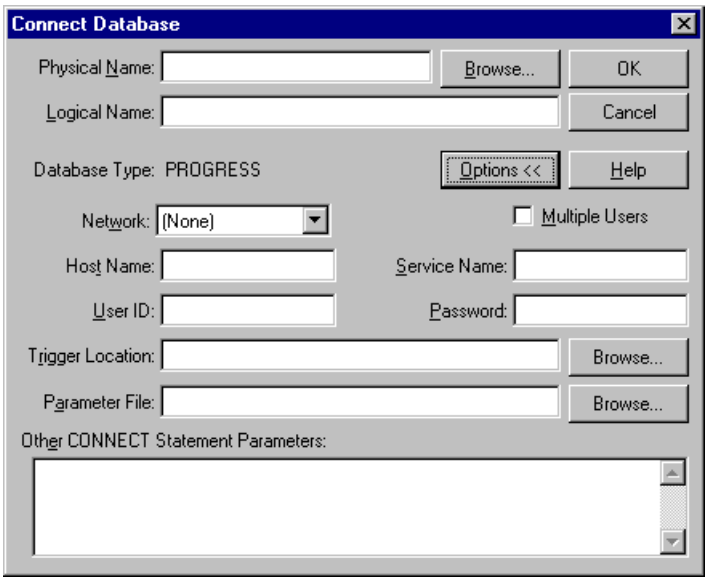
1. Open the **Data Administration** tool from the Windows **Start** menu or from the **Tools** menu of OpenEdge tools, such as AppBuilder and Progress Developer Studio for OpenEdge. The following window appears:



2. Choose **Database** > **Connect**. The **Connect Database** dialog box appears:




3. Choose the **Options** button. The **Connect Database** dialog box expands to show optional connection controls:




4. Enter the following information, then click **OK**:

   - **Physical Name** — Specifies the actual name of the database on a disk.
   - **Logical Name** — Specifies the database name that references a connected physical database.
   - **Database Type** — Specifies the database type. The only possible value is PROGRESS.
   - **Network** — Specifies the network type, if you are connecting to a network server. The only possible value is TCP.
   - **Multiple Users** — Specifies whether you want multiple users to be able to access this database simultaneously.
   - **Host Name** — Specifies the database server machine in a network environment.
   - **Service Name** — Specifies the broker or server service name in a network environment.
   - **User ID** — Identifies your user ID.
   - **Password** — Identifies your password.
   - **Trigger Location** — Identifies a directory or ABL procedure library where trigger code is stored.
   - **Parameter File** — Specifies the parameter filename that contains the startup parameters for the database.

- **Other CONNECT Statement Parameters** — Specifies any other startup parameters for the database that are not included in the parameter file.

OpenEdge returns you to the Data Administration main window. The Data Administration tool constructs (and executes) a `CONNECT` statement using the information you supply. Therefore, any rules that apply to the `CONNECT` statement also apply to database connections using the Data Administration tool.

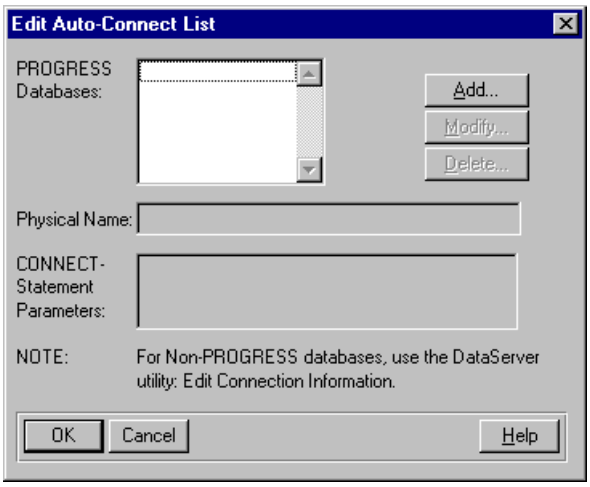
### Connect with auto-connect

The OpenEdge auto-connect feature allows you to connect to databases automatically as required during program execution. To perform an auto-connect operation, OpenEdge uses information stored in a primary database to connect to a secondary application database, before running compiled procedures that access the second database. The primary database (the one that contains the auto-connect information for one or more additional databases) must be connected before OpenEdge can perform an auto-connect.

Use the Data Administration tool to build an auto-connect list for a primary database.

To create or to edit an auto-connect list:

1. Access the **Data Administration** tool.
2. Choose **Edit Progress Auto-Connect ListUtilities**. **The Edit Auto-Connect List** dialog box appears:




3. Enter or edit connection information for a database.

If you connect to a database with the `CONNECT` statement, and that database also has an auto-connect entry in an already connected database, the connection information from both the `CONNECT` statement and the auto-connect list is merged. In this situation, the connection information in the `CONNECT` statement takes precedence. For more information about the `CONNECT` statement, see *ABL Reference*.

If the primary database is a schema holder for a DataServer schema, the DataServer schema is automatically included in the auto-connect list, but it does not appear on the auto-connect list as viewed from the Data Dictionary.

## Connect to a non-OpenEdge database

You can also use the OpenEdge tools to connect to a non-OpenEdge database.

To connect to a non-OpenEdge database:

1. Create an OpenEdge RDBMS. This database stores the target database's structure as an OpenEdge schema; it is a *schema holder*. A schema that corresponds to a non-OpenEdge database is a *DataServer schema*.
2. Connect the schema holder.
3. Use the appropriate Create Schema parameter from the Data Dictionary's database menu to create the DataServer schema in the schema holder. This parameter:
   - Creates a _Db table record (auto-connect entry) for the non-OpenEdge database in the schema holder database
   - Connects to the non-OpenEdge schema (through a DataServer)
   - Displays the menu so that you can choose the tables that you want to include in the OpenEdge schema
4. Connect the DataServer schema.

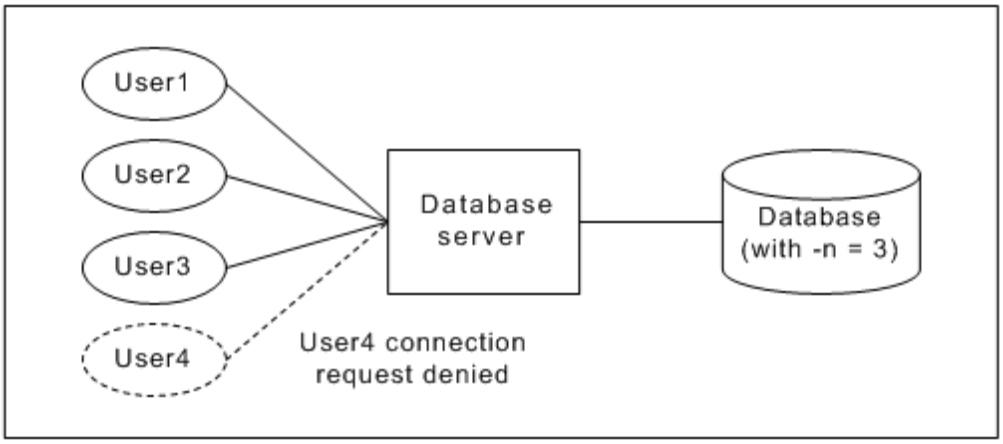
   For complete information about connecting and using non-OpenEdge databases, see the OpenEdge DataServer guides (*Use the Microsoft SQL Data Server* or *Use the Oracle Data Server*).

## Connection denials when the user count is exceeded

When a user attempts to connect to a database using either the command line or a `CONNECT` statement and exceeds the maximum number of users allowed to connect to the database, as specified with the Number of Users (`-n`) startup parameter, OpenEdge denies the connection request and displays an error message. OpenEdge also records the connection denial in the database log file.

The following figure shows a connection denial when a connection request exceeds the maximum number of users. In this example, the Number of Users (`-n`) startup parameter allows a maximum of three user connections. When the fourth user attempts to connect, OpenEdge denies the connection.

**Figure 1: Connection denial when the user count is exceeded**




When OpenEdge denies a user connection because the maximum number of users is exceeded, you must terminate an existing connection before the user can establish a new connection.

You can use database usage reporting features to track user connections to databases. For information about database usage reporting features see *Manage the OpenEdge Database*.

For more information about the Number of Users (-n) startup parameter, see *Startup Command and Parameter Reference*. For information about coding applications to handle connection denials, see *OpenEdge Programming Interfaces*.

## Reduce connection times

To perform database activities, the ABL client keeps a copy of the database schema, called the *schema cache*, in memory. By default, OpenEdge creates the schema cache by reading the database schema stored in the database file. The client reads the schema in two parts:

- During connection, the client reads all the _Db and _File records.
- When the database is referenced, the client reads all the _Index, _Index-field, _File-trig, and _Field-trig records.

The time required to read the schema is usually minimal. However, the time required to read the schema might be unacceptable under the following conditions:

- If the client connects to the database over a wide area network.
- When a large number of clients connect to a database simultaneously. For example, after a database shutdown or crash.

To reduce the amount of time required to connect, OpenEdge lets you store the schema cache as a binary file, called a *schema cache file*, on a local disk. The client can then read the schema directly from the schema cache file.

To create the schema cache file, you build the desired schema cache and save it to a binary file using the ABL statement SAVE CACHE. The schema cache file is portable across systems, so you can create the file once and distribute it across a heterogeneous network of systems. For information about building and saving the schema cache file, see *OpenEdge Programming Interfaces*. For information about the SAVE CACHE statement, see *ABL Reference*.

To connect using the local schema cache file, specify the Schema Cache File (-cache) startup parameter when you connect to a database. If the schema cache file is valid, OpenEdge reads the schema from the local file instead of from the database. The schema cache is valid if the time stamp of the schema cache file matches the time stamp in the database master block. If the time stamps do not match, or for some reason OpenEdge cannot read the file, OpenEdge issues a warning message and reads the schema from the database. For information about the Schema Cache File (-cache) startup parameter, see *Startup Command and Parameter Reference*.

## Start clients without connecting to a database

To permit maximum flexibility for your application, you might want to start OpenEdge without connecting to a database. For example, you can start OpenEdge and name a startup procedure, such as a main menu procedure. This startup procedure (or a procedure that it calls) can connect to a database based on an end user's menu selection. To start OpenEdge without connecting to a database, execute the OpenEdge startup command without specifying a database name. On UNIX, use the PRO command; in Windows, use the PROWIN32 command. For more information about startup commands, see *Startup Command and Parameter Reference*.

# Select a working database for client use

A *working database* is the database that you are currently accessing through the Data Dictionary or the Database Administration tool. The working database is also known as the *active database*.

## Select a database with the Data Dictionary

You can select a working database with the Data Dictionary when using either a graphical or character interface.

To select a working database with the Data Dictionary when using a graphical interface:

1. Access the **Data Dictionary**. The **Data Dictionary** displays the connected databases and their tables and fields.
2. Select the **database** you want for the working database.

### Select a working database with the Data Dictionary when using a character interface

To select a working database with the Data Dictionary when using a character interface:

1. Access the **Data Dictionary**. The **Data Dictionary** appears.
2. Choose **Database** > **Select a Working Database**. OpenEdge lists the connected databases.
3. Select the new working database, then press **ENTER** to return to the **Data Dictionary** main window.

### Select a database with the Data Administration tool

You can select a working database with the Data Administration tool only when using a graphical interface.

To select a working database with the Data Administration tool:

1. Access the Data Administration tool.
2. Choose **Database** > **Select a Working Database**. OpenEdge lists the connected databases.
3. Select the new working database, then choose **OK** to return to the **Data Administration** main window.

## Disconnect databases for clients

By default, OpenEdge disconnects all connected databases at the end of a session. To explicitly disconnect a database from an ABL client application, use the `DISCONNECT` statement. For more information about the `DISCONNECT` statement, see *ABL Reference* and *OpenEdge Programming Interfaces*.

---

**Note:** When you have more than one database connected and you disconnect the working database, OpenEdge automatically switches to the next connected database on the list.

---

### Use the Data Dictionary to disconnect

You can disconnect a database with the Data Dictionary when using either a graphical or character interface.

To disconnect a database with the Data Dictionary when using a graphical interface:

1. Access the **Data Dictionary**. The Data Dictionary displays the connected databases and their tables and fields.
2. Select the database you want to disconnect from the database selection list.
3. Choose **Database** > **Disconnect**.
4. At the prompt, verify that you want to disconnect the database.

### Disconnect a database with the Data Dictionary when using a character interface

To disconnect a database with the Data Dictionary when using a character interface:

1. Access the **Data Dictionary**.
2. Choose **Database** > **Disconnect**. OpenEdge lists the connected databases.
3. Select the database you want to disconnect, then press **ENTER**.
4. At the prompt, verify that you want to disconnect the database.

### Use the Data Administration tool to disconnect

You can disconnect a database with the Data Administration tool only when using a graphical interface.

To disconnect a database with the Data Administration tool:

1. Access the **Data Administration** tool.
2. Choose **Database** > **Disconnect**. OpenEdge lists the connected databases.
3. Select the database you want to disconnect, then choose **OK**.
4. At the prompt, verify that you want to disconnect the database.

## Learn about automatic database reconnect

OpenEdge provides a mechanism for automatically connecting to an alternate database, if the connection to the primary database fails. This high-availability feature uses database connection parameters to specify alternates.The collection of primary and alternate databases, along with an optional retry count and pause interval, is known as a *connection set*. An alternate database is typically a replication target database, but it could also be a backup, or some other database. This feature is only available when using a client-server connection. It is not available for a single-user or a self-service (shared-memory) connection.

---

**Note:** If using this feature with OpenEdge replication, see Automatic database reconnection with OpenEdge replication on page 38 for additional information.

---

To use this feature, you define a connection set consisting of the primary database and up to two alternate databases. You can also specify the number of times to retry the connection set and a pause interval for waiting in between. These connection options are implemented using parameters. The parameters can be defined as session startup parameters, in the `CONNECT` statement, or in a parameter file ( `.pf` ).

For a demo of this feature, see Automatic database reconnect demo and code on page 37.

### Use database connection parameters to enable feature

The database connection parameters that can be used to enable this feature are: `-dbalt1`, `-dbalt2`, `-retryConnect`, `-retryConnectPause` and `-autoReconnect`. `-dbalt1` and `-dbalt2` are parameters that specify connection information (database name, host, and port) about the alternate databases. If you only have one alternate you need only use one of these parameters. `-retryConnect` specifies the number of retry attempts allowed for the connection set as a whole, before giving up. `-retryConnectPause` specifies the time to wait, in seconds, before retrying the connection set. `-autoReconnect` applies to GUI or character-mode clients and indicates that if an unhandled STOP condition occurs, you want to try reconnecting databases connected using startup parameters before rerunning the `-p` procedure. `-autoReconnect` is also used with OpenEdge replication, to automatically include the OpenEdge replication primary target database in the connection set. The syntax for each parameter is described below.

- `-dbalt1` — The first alternate database to attempt to connect to.

```
-dbalt1 "dbname [-H hostname] -S port"
```

If *hostname* is not specified, *localhost* is used. All arguments for -dbalt1 must be enclosed in quotes. -H and -S are the only arguments allowed.

- -dbalt2 — The second alternate database to attempt to connect to.

```
-dbalt2 "dbname [-H hostname] -S port"
```

If *hostname* is not specified, *localhost* is used. All arguments for -dbalt2 must be enclosed in quotes. -H and -S are the only arguments allowed.

- -retryConnect — The number of times to retry the connection set before giving up.

```
-retryConnect retry-count
```

All connections in the set (primary, -dbalt1, -dbalt2) are tried in turn before retrying the set. The default value for *retry-count* is 0. The maximum value is 100.

- -retryConnectPause — The pause interval (in seconds) to wait before retrying the connection set.

```
-retryConnectPause pause-interval
```

All connections in the set (primary, -dbalt1, -dbalt2) are tried in turn before the pause occurs. The default *pause-interval* is 5 seconds. The maximum value you can set is 300 seconds.

- -autoReconnect — For GUI or character-mode clients, indicates that if an unhandled STOP condition occurs, you want to try reconnecting databases connected using startup parameters before rerunning the startup procedure.

```
-autoReconnect
```

When running without -autoReconnect, the ABL session is reset and and the startup procedure is run, without attempting to reconnect to any databases that were specified at startup using startup parameters.

-autoReconnect is also used with OpenEdge replication, to automatically include the OpenEdge replication primary target database in the connection set.

-ct (Connection Retry Attempts) is an independent, but related, startup parameter, which controls the number of connection retries for an *individual* database connection. The connection attempts are done in succession on the same database connection and have a default value of 50 attempts. This differs from -retryConnect, which applies to the connection set as a whole. If using both -ct and -retryConnect, you may want to set -ct to 0, or to a value lower than the default.

## Database connection parameter considerations

- Like other database startup parameters, -dbalt1, -dbalt2, -retryConnect, and -retryConnectPause apply only to the last database parameter (-db) encountered in the parameter list thus far.
- You must specify the primary database first, before listing an alternate, otherwise the AVM issues an error.
- If both -dbalt1 and -dbalt2 are specified and the connection to the primary database fails, -dbalt1 is tried first and -dbalt2 is tried second.
- If you only specify -dbalt2, it becomes the first alternate.

- If the AVM is unable to connect to any database the `CONNECT` statement goes through the usual error handling.
- Any database parameters from the primary database, except for `-H` and `-S`, are also applied to the alternate databases, such as `-ld`, `-U` and `-P`.
- The logical name of the alternate database is always taken from the primary database, even if not explicitly set with `-ld`.
- If the same parameter is encountered more than once within the argument list for `-dbalt1` or `-dbalt2`, the last one is used. This is consistent with the parsing rules for parameters in general.
- If multiple `-dbalt1` or `-dbalt2` parameters are encountered within the parameter list for a particular primary database, the last one is used.

## Example configurations

**Example: Specify a primary database with one alternate:**

```
-db mainDb -H PrimarySrvr -S 6999
-dbalt1 'altDb -H AltSrvr1 -S 7999'
-retryConnect 3
```

In this example the AVM would:

1. Try to connect to `mainDb`.
2. If that fails, it would try to connect to `altDb`.
3. If that fails, it would pause 5 seconds (default for `-retryConnectPause`) and repeat from step 1, three more times (because `-retryConnect` is 3).

**Example: Specify a primary database with two alternates:**

```
-db myDb -H PrimarySrvr -S 6999
-dbalt1 'myDbTarget1 -H AltSrvr1 -S 7999'
-dbalt2 'myDbTarget2 -H AltSrvr2 -S 8999'
-retryConnect 10 -retryConnectPause 4
```

**Example: Specify multiple primary databases with alternates:**

```
-db myDb -H PrimarySrvr -S 6999
-dbalt1 'myDbTarget1 -H AltSrvr1 -S 7999'
-dbalt2 'myDbTarget2 -H AltSrvr2 -S 8999'
-retryConnect 10 -retryConnectPause 4
-db otherDb -H OtherDbSrvr -S 3999
-dbalt1 'otherDbTarget1 -H AltOtherSrvr1 -S 4999'
-dbalt2 'otherDbTarget2 -H AltOtherSrvr2 -S 5999'
-retryConnect 8 -retryConnectPause 3
```

## Usage of parameters in the CONNECT statement

You may also use these database connection parameters in a `CONNECT` statement. For `-dbalt1` and `-dbalt2` each alternate database name, along with its host and port parameters, must be enclosed in quotes. In the following example, the arguments to `-dbalt1` and `-dbalt2` are surrounded by single quotes and the connection string is surrounded by double quotes. You can reverse this and use double quotes to surround the inner arguments and use single quotes for the outer connection string.

In the following example code, one alternate database is specified:

```
CONNECT -db myDb -H PrimarySrvr -S 6999 -dbalt1 'myDbBackup -H AltSrvr1 -S 7999'.
```

The following example code assigns the connection string to a CHARACTER variable. It uses single quotes to enclose the inner `-dbalt1` parameters and double quotes for the outer string:

```
conn = "-db myDb -H PrimarySrvr -S 6999 -dbalt1 'myDbBackup -H AltSrvr1 -S 7999'".
CONNECT VALUE(conn).
```

The following example code specifies two alternate databases:

```
conn = "-db myDb -H PrimarySrvr -S 6999
  -dbalt1 'myDbBackup -H AltSrvr1 -S 7999'
  -dbalt2 'myDbBackup -H AltSrvr2 -S 8999'
  -retryConnect 10 -retryConnectPause 4".
CONNECT VALUE(conn).
```

## Automatic Database Reconnect with Progress Application Server (PAS) for OpenEdge

The automatic restart behavior controlled by the `-autoReconnect` parameter does not apply to PAS for OpenEdge sessions. To achieve this behavior with a PAS for OpenEdge session, create a PAS for OpenEdge instance Activate procedure for connecting to the database. The following example code is an Activate procedure called `dbconnect.p`:

```
/* dbconnect.p */

IF NOT CONNECTED("sports2020") THEN
    CONNECT "-pf my.pf".
```

You set the Activate procedure in the `openedge.properties` file. For example:

```
sessionActivateProc=dbconnect.p
```

## Enable logging for troubleshooting

The `DB.Connects` log entry type (`-logentrytypes DB.Connects`) turns on logging for database connections. (For information on configuring and enabling logging, see Logging infrastructure overview in *Troubleshoot ABL Applications*.) Normally, connect and disconnect messages are logged at the basic level (2 or higher). With this feature, additional messages are logged if the initial attempt to connect to the primary database fails. Consider the following connection string:

```
-db prim -H PrimarySrvr -S 1234
-dbalt1 "alt1 -H AltSrvr1 -S 2345"
-dbalt2 "alt2 -H AltSrvr2 -S 3456"
-retryConnect 2
-retryConnectPause 3
```

At logging level 2 or higher, when there is a successful connection to an alternate database, a message is logged indicating the connection is to an alternate:

```
CONN           Connected to alternate database alt2
```

At logging level 3 or higher, additional messages are logged showing the connection attempts:

```
CONN           Attempting to connect to database prim (primary)
CONN           Failed to connect to database prim
CONN           Failover: attempting to connect to database alt1 (-dbalt1)
CONN           Failed to connect to database alt1
CONN           Failover: attempting to connect to database alt2 (-dbalt2)
```

At logging level 3 or higher, an additional message showing the pause between connection attempts, is logged before the connection set as a whole is tried again. The pause length is controlled by the value set for `-retryConnectPause`.

```
CONN           Pausing 3 seconds between connection attempts
```

At logging level 3 or higher, if the session is restarted due to an unhandled STOP condition, for a GUI or character-mode client, and `-autoReconnect` is enabled, a message is logged:

```
CONN           Session restart: attempting to reconnect any disconnected databases
```

### See also

Alternate Database 1 (-dbalt1)

Alternate Database 2 (-dbalt2)

Auto Reconnect (-autoReconnect)

Automatic database reconnection with OpenEdge replication on page 38

CONNECT statement

Connection Retry Attempts (-ct)

Database connection logging

Retry Connect Set (-retryConnect)

Retry Connect Set Pause (-retryConnectPause)

## Automatic database reconnect demo and code

In this video, you learn about a feature which allows ABL clients to automatically connect to an alternate database, if the connection to the primary database fails. This mechanism helps ensure the continuous operation of the client application.

### Demo code

The following code is used in the demo:

**`my.pf`**:

```
-db sports2020 -H localhost -S 5550 -ct 1
-dbalt1 "sports2020 -H localhost -S 5551"
-retryConnect 1
-retryConnectPause 2
```

**dbconnect.p**:

```
/* ***************************  Definitions  ************************** */

BLOCK-LEVEL ON ERROR UNDO, THROW.

/* *********************  Preprocessor Definitions  ******************** */


/* ***************************  Main Block  *************************** */
REPEAT:

IF NOT CONNECTED("sports2020") THEN
CONNECT "-pf my.pf".

RUN getcustomers.p.

CATCH e1 AS PROGRESS.lang.stopError:
    MESSAGE "Caught stoperror " e1:getmessage(1)
            "about to run dbconnect.p so we can re-connect"
            VIEW-AS ALERT-BOX.
    IF CONNECTED("sports2020") THEN
    RETURN.
END.

END.
```

**getcustomers.p**:

```
/* ***************************  Definitions  ************************** */

BLOCK-LEVEL ON ERROR UNDO, THROW.

/* *********************  Preprocessor Definitions  ******************** */


/* ***************************  Main Block  *************************** */
FOR EACH customer.
DISPLAY custnum name.
PAUSE 1.
END.
```

**autoreconnect.pf**:

```
-db sports2020 -H localhost -S 5550 -ct 1
-dbalt1 "sports2020 -H localhost -S 5551"
-retryConnect 1
-retryConnectPause 2
-autoReconnect
```

## Automatic database reconnection with OpenEdge replication

By using the Auto Reconnect (-autoReconnect) client-session startup parameter, remote clients can automatically connect to the primary target of an OpenEdge replication database, if the connection to the source database fails. When an OpenEdge database fails over (planned or unplanned) to a replication primary target database, then remote clients (ABL clients or Progress Application Server for OpenEdge agents) running the application, automatically connect to the replication primary target database.

The AVM handles this automatically, without any administrator intervention. At client session startup, during the connection to the replication source database, the AVM retrieves virtual system table (VST) information about the current replication primary target database, so it knows what to connect to if the replication source database fails. If the information changes, clients are automatically notified of the updated information. In this manner, the client always knows what the current replication target database is.

To use this feature, the OpenEdge database must be configured for, and actively using, OpenEdge replication. For more information on OpenEdge replication, see Use Database Replication.

### Interaction with `-dbalt1` and `-dbalt2` client connection parameters

This feature can be used with, or without, the Alternate Database 1 (-dbalt1) and Alternate Database 2 (-dbalt2) client connection parameters. However, it is a good practice to explicitly configure `-dbalt1` to be the OpenEdge replication primary target database and `-dbalt2` to be the OpenEdge replication secondary target database, in the unlikely event that the replication source database is unavailable during a client's initial connection, and `-dbalt1` is the new replication source. You can set these connection parameters once in a parameter file (`.pf`), to be used at session startup, or with the CONNECT statement, and not have to change them.

The replication source database and replication primary target database are included in the connection set. The order of database reconnection attempts, after a disconnect, is as follows:

1. Replication source database
2. Database specified by `-dbalt1`, if provided
3. Database specified by `-dbalt2`, if provided
4. Primary replication target database

### Frequency of connection set attempts

You can control the number of times to retry connecting to a set of OpenEdge databases, with the Retry Connect Set (-retryConnect) client connection parameter. The default is 0 retries. You can adjust the pause interval between connection set attempts with the Retry Connect Set Pause (-retryConnectPause) client connection parameter. The default value is 5 seconds. You can further control the number of connection attempts for an individual database connection with the Connection Retry Attempts (-ct) client connection parameter. The default is 50 times.

For more information on `-dbalt1`, `-dbalt2`, `-retryConnect`, `-retryConnectPause`, and `-ct`, see "Learn about automatic database reconnect" in *Manage ABL Applications* .

### Logging for connections to OpenEdge replication-enabled databases

Database connection logging can be enabled for clients with the `DB.Connects` log entry type. At logging level 3 or higher, the client logs additional messages for replication-enabled databases.

When the client initially connects to a database, the AVM determines if the database is enabled for replication:

```
CONN           Connected to replication-enabled database db0 (source)
or
CONN           Connected to replication-enabled database db1 (target)
```

When the client receives a database user notification from the replication server, indicating the replication target has changed, a message is logged:

```
CONN           Refresh replication transition information for database db0
```

On session restart, the client attempts to reconnect to the database specified at startup. The message could say `(replication source)` or `(replication target)`.

```
CONN           Attempting to connect to database db0 (replication source)
```

If the replication transition is in process, one of two messages is logged, depending on the replication state:

```
CONN           Replication source database db0 is transitioning, rejecting connection

or

CONN           Database db1 is not a replication source, rejecting connection
```

A message is logged when attempting to connect to the replication target database, after the connection to the replication source either fails or is rejected:

```
CONN           Failover: attempting to connect to database db1 (replication target)
```

A message is logged when the target database has completed the transition and is now the replication source:

```
CONN           Database db1 has transitioned to a replication source
```

A message is logged when the connection to the transitioned database is successful:

```
CONN           Connected to replication-enabled database db1 (source)
CONN           Successful reconnection: -db db0,-H hostname,-S port,-ct 1,-U
username,-P
```

# 3

# Maintain Application Security

OpenEdge applications can use two basic types of user authorization: *application authorization*, which prevents unauthorized ABL application authenticated users from running application procedures and using other types of application resources, and *database authorization*, which prevents unauthorized ABL application authenticated users from modifying database tables and fields. (When a database is initially created, every user is a security administrator.) Application authorization always functions at run time using developer-defined privileges.

OpenEdge provides four types of database authorization: *compile-time authorization* ensures that only authorized users can compile procedures that access protected tables and fields at compile time; *run-time authorization* ensures that only OpenEdge authorized users can access database tables and fields when any ABL session (`.p` or `.r`) runs; *connection authorization* ensures that only OpenEdge authenticated users can connect to an OpenEdge database; and *security authorization* ensures that only authorized security administrators can manage table and field permissions or the records contained in certain security-related meta-schema tables.

OpenEdge also relies on security mechanisms at the operating system level to ensure that only authorized users access r-code, procedure libraries, and database files.

For information about establishing and maintaining connection security, schema security, and database file security, see *Manage the OpenEdge Database*. In addition to the security features described here, OpenEdge supports secure connections between ABL (Advanced Business Language) client and server components on the network using the Transport Layer Security (TLS). For more information, see *Learn about Security and Auditing*.

This set of topics provides details about user authorization, database authorization, and other security features in the following sections:

For details, see the following topics:

- Database table- and field-level security
- Compile-time security
- Run-time security

- Operating system security
- Designate a security administrator

# Database table- and field-level security

OpenEdge allows you to set up table- and field-level security, which OpenEdge uses to authorize access to database tables and fields. This authorization can be specified to apply at:

- **Compile time** — Checks to verify that the user has authorization to compile procedures that access database tables and fields as coded. Database authorization is always applied at compile time. For more information, see Compile-time security on page 48.
- **Run time** — Checks an authenticated user's authorization to access protected databases tables and fields as defined by the database's security settings. You can choose to apply database authorization at run time, but it is not applied by default. For more information, see Specify run-time permissions checking on page 43 and Run-time security on page 49.

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**Caution:** If you plan to use OpenEdge SQL, as your **first task** be sure that you create an SQL DBA account as the **first** user account. Grant the account DBA rights by executing the GRANT statement. For more information, see *Develop SQL for OpenEdge*.

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**Note:** Table- and field-level security for the _Sequence metaschema table applies at both compile time and run time. For more information on this table, see *OpenEdge Programming Interfaces*.

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To set up database table- and field-level security, you and any other trusted users must be set up as security administrators. After you have designated yourself and others as security administrators, be sure that the user ID of each security administrator is included in all the permissions lists for the tables and fields for the database. For example, if you assign user ID sjones as a security administrator, but sjones is not included in the permissions for the customer table, sjones will not be able to modify permissions for the customer table. Any attempt to do so results in the error message, "Invalid access to change security for customer table." Thus, to modify table and field permissions, a user ID must be designated as a security administrator **and** be included in each of the CRUD (Create, Read, Update, and Delete) operations of the individual table and field permissions.

For more information about designating a security administrator, see Designate a security administrator on page 50.

The user ID format you can specify for table- and field-level security differs depending on the tenancy configured for your database. So, if your database is:

- **Non-multi-tenant (the default)** — The user IDs that you specify must be non-qualified, and cannot contain the domain-name delimiter character (@). OpenEdge interprets the user ID as a user name only.
- **Multi-tenant (license required)** — The user IDs that you specify can be fully qualified, containing both a user and domain name separated by the domain-name delimiter character (@). If you specify a non-qualified user ID, OpenEdge interprets it as the specified user name in the blank ("") domain.

Note that to authenticate their identity for any database connection (non-multi-tenant or multi-tenant), users can authenticate to OpenEdge using a fully qualified user ID, which tells OpenEdge the domain in which to authenticate their identity. However, for non-multi-tenant databases, you can specify only a user's non-qualified user ID (user name) in table- and field-level security permissions lists.

For more information about user authentication, domains, and database tenancy, see *Learn about Identity Management*.

## Specify run-time permissions checking

By default, database authorization is always applied at compile time, which does not protect access to the database against ABL `.p` or `.r` code compiled outside of your application. Optionally, you can specify that the table and field security permissions are checked and enforced by the OpenEdge run time for all ABL sessions, regardless of compile time authorization.

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**Note:** Table and field security permissions for the `_Sequence` metaschema table are checked and enforced at both compile time and run time by default.

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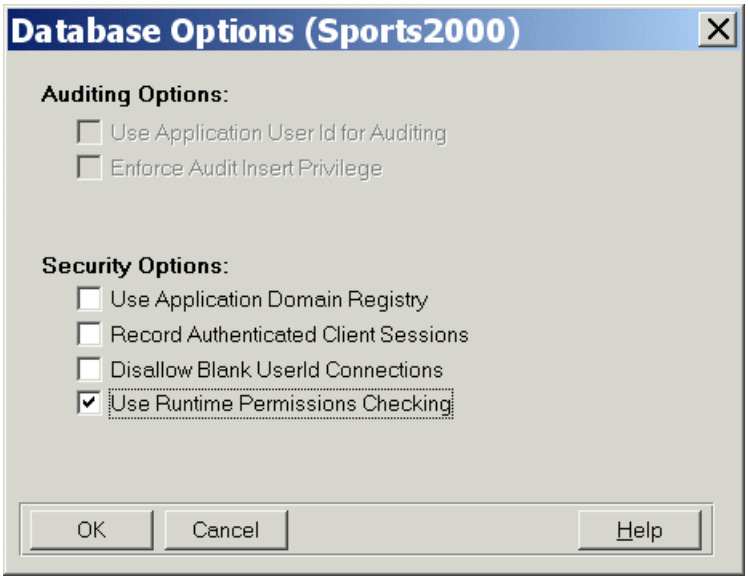
Database permissions are applied to an authenticated user whose identity is set for a database connection through the User ID (`-U`) and Password (`-P`) startup parameters and the following ABL functions and method:

- `SECURITY-POLICY:SET-CLIENT()` method
- `SET-DB-CLIENT()` ABL function
- `SETUSERID()` ABL function

For more information on these security startup parameters, functions, and methods, see *Learn about Identity Management* and *OpenEdge Programming Interfaces*.

To include run-time permissions checking:

1. Connect to the database.
2. Access the **Data Administration** tool if you are using a graphical interface or the Data Dictionary if you are using a character interface.
3. Choose **Database Options** > **Admin**. The **Database Options** dialog box appears.
4. Check the **Use Runtime Permissions Checking** option, as shown:




5. Click **OK**.

   Now when you set database table and field permissions, they will apply at run time in addition to compile time.

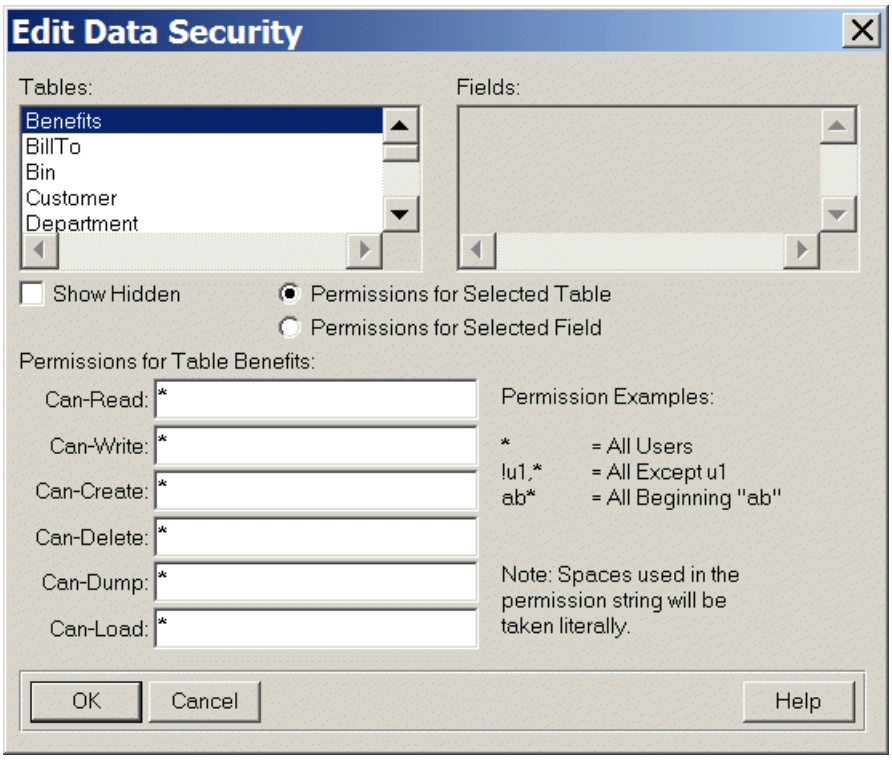
## Set table and field permissions

You can set table and field permissions by using the Change/Display Data Security utility in the Data Dictionary or the Edit Data Security menu option in the Data Administration tool. Note that once security administrators are designated, only they can access this utility. All other users are denied access by the tools with the message, "You must be a Security Administrator to execute this function." For information on designating security administrators, see Designate a security administrator on page 50.

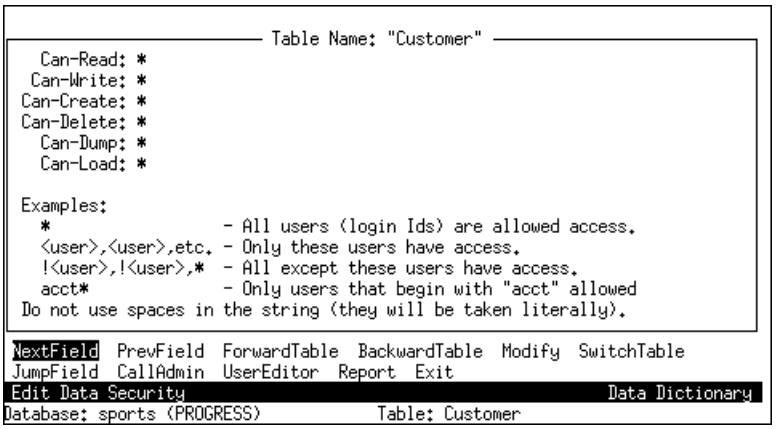
To set table or field permissions:

1. Access the **Data Administration** tool if you are using a graphical interface or the Data Dictionary if you are using a character interface.
2. Choose **Admin** > **Security** > **Edit Data Security**.

   If you are using a graphical interface, the **Edit Data Security** dialog box appears:




   If you are using a character interface, OpenEdge alphabetically lists the tables defined for the working database. Choose the table for which you want to specify permissions. The **Edit Data Security** dialog box appears:




3. Choose the table or field for which you want to specify permissions.

   If you are using a graphical interface, use the **Permissions for Selected Table** and **Permissions for Selected Field** radio buttons, then choose the table or field from the selection lists.

   If you are using a character interface, use the options at the bottom of the dialog box to choose the table or field.

4. Specify the security permissions for the table or field. The following tabel lists the security permissions you can specify for a table or field.

   **Table 2: Table and field security permissions**

| Permission | Description |
|---|---|
| Can-Read | Specifies the users who have permission to read a table or field. |
| Can-Write[1] | Specifies the users who can write to a table or field or update records. |
| Can-Create | Specifies the users who can create new records. The user with Can-Create privileges automatically has Can-Write privileges. |
| Can-Delete | Specifies the users who can delete records from a table. |
| Can-Dump | Specifies the users who can bypass dump trigger security by using DISABLE TRIGGER. |
| Can-Load | Specifies the users who can bypass load trigger security by using DISABLE TRIGGER. |

   Security permissions consist of a list of one or more comma-separated user ID patterns.

   The following table lists basic types of expressions you can use to define the permissions for a table or field. This table shows permissions using non-qualified user IDs, as you specify for a non-multi-tenant database.

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**Note:** An empty permission string denies the table and field permissions to **every** user and is not recoverable.

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[1] Setting this permission requires that the Can-Read permission also be set.

**Table 3: Basic expressions for table and field permissions**

| Expression | Meaning |
|---|---|
| `[,]<blank>,...` | The blank user ID has access. |
| * | All user IDs have access. |
| `mark` | The user ID `"mark"` has access. |
| !mark | The user ID `"mark"` does not have access.<br>**Note:** The `!` permission negation is useful only when the permission list ends with `",*"` |
| ,!mark,* | The blank user ID and the user ID `"mark"` do not have access. |
| `mark*` | All user IDs that begin with `"mark"` have access. |
| `*jones` | All user IDs that end with `"jones"` have access. |
| `db*user` | All user IDs that begin with `"db"` and end with `"user"` have access. |

The following table shows permissions using fully qualified user IDs, as you specify for a multi-tenant database.

**Table 4: Table and field permissions using fully qualified user IDs**

| This expression . . . | Permits access to tables and fields from . . . |
|---|---|
| | The blank user name in the blank domain |
| * | All user ID's |
| `mark@acme.com` | The `"mark"` user name in the `"acme.com"` domain |
| `mark` | The `"mark"` user name in the blank domain |
| `mark*` | All user names that begin with `"mark"` in the blank domain |
| `*jones` | All user names that end with `"jones"` in the blank domain |
| `db*user` | All user names that begin with `"db"` and end with `"user"` in the blank domain |
| `@acme` | The blank user name in the `"acme"` domain |
| `*@acme` | All user names in the `"acme"` domain |
| @ | The blank user name in the blank domain |
| `mark@*` | The `"mark"` user name in any domain |

| This expression . . . | Permits access to tables and fields from . . . |
|---|---|
| *@* | Any user name in any domain |
| mark*@acme.* | Any user name that begins with "mark" in any domain that begins with "acme." |
| *@*.admins | Any user name in any domain that ends with ".admins" |

For a more detailed description of the options available for specifying these permissions, see the sections on configuring and implementing authorization in *Learn about Identity Management*.

Any changes you make to the table permissions do not affect your current session or any other current sessions. This means that if other users are working while you change table permissions, they are not affected. To use the new permissions, you must exit and restart the OpenEdge ABL session.

**Note:** Do not try to bypass the Data Dictionary or Data Administration tools to modify the permissions for the tables and fields in the database. You might lock yourself out of the database.

### Example of personnel security

This example shows how to define permissions for a sample multi-tenant database. Suppose the user IDs are joesmith@acme, jenjones@acme, joesmith@gentac, and tracyblack@gentac.

Suppose you want all users to have Can-Read permission for a table, but only certain users to have Can-Write, Can-Create, and Can-Delete privileges. The following example shows how to specify this information, in which all users have Can-Read permission; Joe Smith at Acme and Tracy Black at Gentac have Can-Write permission; all users at Acme and at Gentac have Can-Create permission; and both Joe Smiths, one at Acme and the other at Gentac, have Can-Delete permission:

```
Can-Read:    *
Can-Write:   joesmith@acme,tracyblack@gentac
Can-Create:  *@acme,*@gentac
Can-Delete:  joesmith@*
```

In the next example, the blank user ID does not have Can-Read permission, whereas all other users have the permission. All users, except Joe Smith at Acme and Joe Smith at Gentac, have Can-Write permission:

```
Can-Read:   !,*
Can-Write:  !joesmith@acme,!joesmith@gentac,*
```

## Determine the privileges of the blank user ID

By not specifying the User ID (-U) and Password (-P) connection parameters when connecting to a database (at startup or in the CONNECT statement), the user can access the database with a default user identity that has the blank user ID or the OS process user ID.

You can also authenticate a blank ("") user ID for a database connection by connecting to a database (at startup or in the CONNECT statement) with the User ID (-U) and Password (-P) connection parameters with no value specified for -U, or by using an ABL function or method like SET-DB-CLIENT ( ) to explicitly set a blank user identity for an existing database connection.

For more information on these connection parameters and ABL functions and methods for setting database connection identity, see *Learn about Identity Management* and *OpenEdge Programming Interfaces*.

**Any** user can use OpenEdge or an OpenEdge application with a blank user ID and access tables and fields in the database as long as the following conditions are all met:

- The database is configured to allow blank user ID connections (the default)
- The table- and field-level permissions permit it (blank user ID) (the default)
- The procedures being run are precompiled with table/field access authorized

As the security administrator, you can deny privileges to the blank user ID to ensure that users with blank user ID do not gain access to the data by following these steps.

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**Note:** These steps must be performed **every time** a new table is added to the database.

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To restrict blank user ID access privileges:

1. Access the **Data Administration** tool if you are using a graphical interface or the **Data Dictionary** if you are using a character interface.
2. Choose **AdminSecurityDisallow Blank Userid Access**. OpenEdge prompts you to verify that you want to prevent users with blank user IDs from accessing the working database.
3. Choose **Yes**. OpenEdge denies the user all security permissions and inserts an exclamation point (!) at the beginning of all the table and field permissions for the database. You can restore a blank user ID's access to selected tables and fields by modifying the permissions.

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   **Note:** You can also restrict a blank user ID from connecting to a database by setting the **Disallow Blank UserId Connections** option in the **Database Options** dialog box. For more information, see the online help for the Data Administration tool and *OpenEdge Database Tools*.

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# Compile-time security

Compile-time security checking is built into OpenEdge. You define compile-time security for an application database at the table and field levels to prevent the user from writing their own procedures to access data in the database.

OpenEdge lets you define the type of access rights or permissions different users can have to the tables and fields in your database applications. OpenEdge checks these permissions when the user runs and compiles a procedure for the first time during an OpenEdge session. The default compile-time checking is useful for applications that are compiled each time a different user runs the application.

However, the default compile-time permissions apply to application code that is compiled each time a different user executes it and are not sufficient for precompiled applications. If you use CRC-based r-code (the default), the user can compile a procedure against a database that has the same schema as the database (a counterfeit database) and then run the procedure against the database. Since the default for OpenEdge is to do compile-time permission checking only, your database is unprotected at run time unless you do one of the following:

- Turn on run-time permission checking as described in Specify run-time permissions checking on page 43.
- Use the PROUTIL utility's DBAUTHKEY qualifier to set an authorization key for the database. The authorization key prevents unwanted r-code that has been compile-time checked only from running against the database.

For more information about CRC-based object code, see R-code Features and Functions on page 191 For more information about the PROUTIL utility, see *Manage the OpenEdge Database*.

# Run-time security

Run-time security can be supported both in an ABL application and in OpenEdge database table and field permissions settings.

## Application support

A developer can write custom run-time authorization to prevent unauthorized users or precompiled procedures from accessing restricted database tables and fields. To establish run-time security for precompiled procedures, you must set up a permissions table within the database and ensure that only your application's precompiled procedures are allowed to run against the database.

The permissions table contains records that specify users who are authorized to run specific procedures or classes. Each record in the permissions table must contain at least two fields: an Activity field and a Can-Run field. The Activity field contains the name of the procedure and the Can-Run field contains the user IDs of those who have permission to run the procedure. Within the application, you can use the ABL `CAN-DO` function to test whether the current application user can run a specific procedure.

As security administrator, you must maintain the permissions table. It is also your responsibility as the developer to provide the tools to maintain this table. For more information about setting up run-time security with a permissions table, see the information on run-time security in *OpenEdge Programming Interfaces*.

## OpenEdge support

To establish run-time security for tables and fields, you must set the table and field permissions using the Data Administration tool or character Data Dictionary.

As security administrator, you can also specify the run-time security permissions for database tables and fields. For more information, see Set table and field permissions on page 44.

# Operating system security

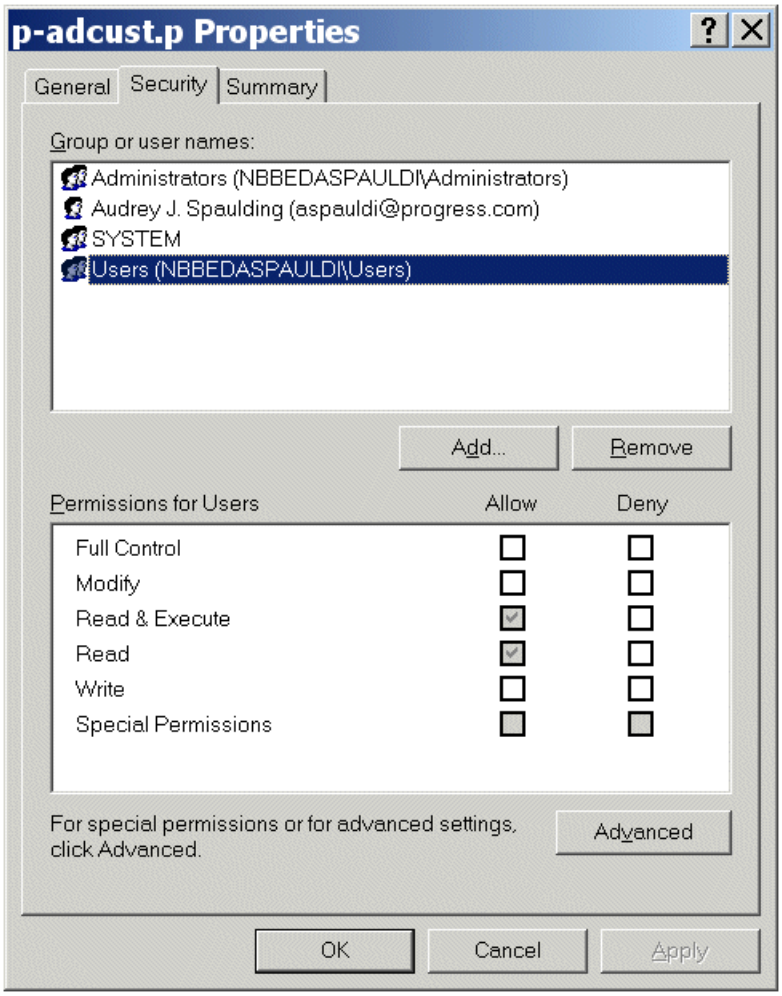
Each operating system provides security measures that you can use to protect r-code, procedure libraries, and database files for access by other OS user accounts and OS administrators.

On UNIX, you can use operating system file security to protect your procedure files in addition to, or instead of, including security checking in the application procedures. If you, as the application administrator, want to be the only user allowed Write access to `p-adcust.p` when everyone else has only Read access, you should create the source and r-code files with your user ID, then change the permissions for the files accordingly. To change the permissions for `p-adcust.p`, enter one of the following UNIX commands:

```
chmod 640 p-adcust.p
chmod 640 p-adcust.r
```

These permissions indicate that you are the only user allowed to read from (R) and write to (W) `p-adcust.p`. No other users are allowed any kind of access to that procedure.

In Windows, you can set authorization on a specific file or directory through the file or directory's properties. For example, if you want to set permissions for `p-adcust.p`, in Windows Explorer right-click on the file and select **Properties** from the pop-up menu. The **Properties** dialog box appears:




After you click the **Security** tab, you can specify various levels of authorization to the file. You can also click the **Advanced** button to set additional security options.

For more information about using the operating system to protect database files, see *Manage the OpenEdge Database*. For more information about setting operating system permissions, see your operating system documentation.

## Designate a security administrator

Each level of security uses an authenticated user ID to determine the user's authority to access data and files. Associating a user ID with a password provides even more protection against unauthorized access.

The implementation of security for the main features of OpenEdge is the responsibility of administrators in the following areas:

- ABL security administration
- Auditing administration
- Transparent Data Encryption administration

## ABL security administration

The ABL security administrator is responsible for maintaining the ABL security information in the database. When a database is first created, everyone is a default security administrator. However, you should assign user IDs as the security administrator. If you plan to define user IDs in the database _User table accounts, you must also designate at least one user from these accounts as a security administrator. Note that once you add at least one individual user ID as a security administrator, no other user ID can function as a security administrator for a future connection to this database.

**Caution:** Make sure you can log into the database with a user ID **before** you assign it as a security administrator.

Typically, the database administrator also serves as security administrator. The security administrator uses:

- The Data Dictionary, the Data Administration tool, or the Database Administration Console of OpenEdge Management or OpenEdge Explorer to establish connection, schema, and database access security at compile time or run time
- An activity table provided by you (the developer) to establish run-time authorization for accessing specified precompiled procedures or classes

**Note:** SQL has its own administrator (DBA) to grant access privileges. The SQL DBA cannot set ABL permissions, just as an ABL security administrator cannot grant SQL privileges. For more information, see OpenEdge Data Management: SQL Development.

For more information about designating a security administrator or establishing and maintaining user IDs, passwords, and data access privileges, see *Manage the OpenEdge Database* and *Learn about Identity Management*.

## Auditing administration

By default, OpenEdge applies a grant authorization model to all audit-related database tables. This means that in order for an individual to be able to create audit policies and manage audit data, the individual must be granted the appropriate privileges to do so.

Because you might not want only one individual to have responsibility for all audit-related activities, you can assign to certain users one or more auditing privileges. When you assign privileges to a user, you also decide whether that user can then grant the same privileges to other users. Only users who have been granted the appropriate privileges can perform the corresponding auditing functions.

There are four audit security privileges, one of which is known as the audit administrator. The audit administrator is an authenticated user who has been granted privileges to create, update, and delete audit policies. The audit administrator also has unrestricted read access to all the audit tables and is the only user authorized to configure audit policy.

For more information about audit security privileges, see *Learn about Security and Auditing*.

## Transparent data encryption administration

You must be connected to the database locally and have ABL security administrator and key store administrator privileges to create encryption policies with the Data Administration tool. For more information, see *Learn about Security and Auditing*.

# 4

# Maintain User Environments

This set of topics explains how to maintain user interface environments in Windows and on UNIX, as described in the following sections:

For details, see the following topics:

- Maintain the Windows user environment
- Maintain the UNIX user environment

## Maintain the Windows user environment

In the Windows software environment, OpenEdge uses the `progress.ini` file as well as the Registry to maintain environment variables.

When you install OpenEdge, the installation program automatically updates the Registry with the information in the `progress.ini` file that is shipped to you. Progress Software Corporation recommends that you maintain environment variables in both the `progress.ini` file and the Registry. If you modify environment variables in the `progress.ini` file, you must update the information in the Registry.

Although there are several methods for adding and deleting information from the Registry directly, Progress Software Corporation recommends that you do not use these direct update methods. Instead, maintain the Registry information by editing the `progress.ini` file and using the INI2REG utility to update the Registry. This approach synchronizes the information in the `progress.ini` file and the Registry without causing unintended edits to the Registry.

For more information about modifying the `progress.ini` file, see the Maintain the progress.ini file on page 58.

In addition to the `progress.ini` file, the OpenEdge installation includes a Windows manifest file which provides your ABL (Advanced Business Language) application with the Windows XP look. For more information on this file, see Windows manifest file on page 82.

The OpenEdge GUI for .NET enables you to expose your ABL applications through a .NET interface. GUI for .NET applications have extra requirements of which you need to aware. For more information on maintaining an environment for GUI for .NET applications, see Environments with OpenEdge GUI for .NET applications on page 82.

## Use the INI2REG utility

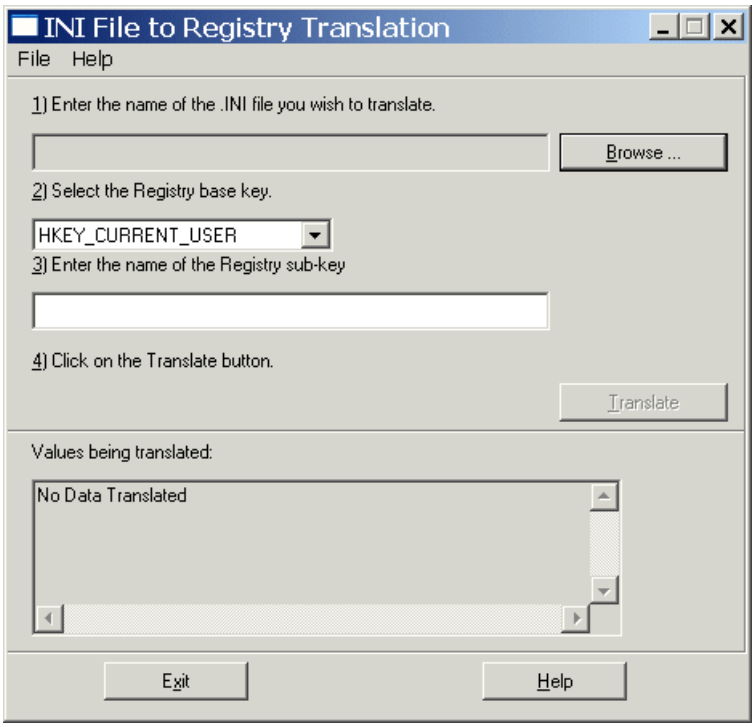
The INI2REG utility lets you translate the contents of an initialization (`.ini`) file into comparable Registry key entries. You can access the INI2REG utility through a graphical user interface or from the command line.

To access the INI2REG utility and translate an initialization file:

1. From the Windows **Start** menu, choose **OpenEdge** > **Proenv**.
2. Enter the INI2REG command as follows:

```
ini2reg
```

The **INI File to Registry Translation** dialog box appears:




3. From the **INI File to Registry Translation** dialog box, choose the **Browse** button or **File** > **Open**. The **Open** dialog box appears.
4. Type in or browse for the initialization file you want to translate, and choose **OK**. The name of the selected file appears in the `.INI` file to translate field.
5. From the **Registry base key** drop-down list, select the base key under which you want to create the subkey entries. The default subkey that corresponds to the selected initialization file and base key appears in the **Registry subkey** field.

If you want to use a subkey other than the default, type the subkey name in the **Registry subkey** field.

6. To begin the translation, choose the **Translate** button or **FileTranslate**. For each entry in the initialization file, INI2REG creates a Registry key entry with the same value. As each entry is translated, it appears in the **Values** being translated display area. If a Registry key entry already exists, INI2REG prompts you to overwrite it.
7. To exit, choose the **Exit** button or **FileExit**.

## Use the command line interface

To access the INI2REG utility and translate an initialization file from the command line, specify the INI2REG command using the following syntax:

## Syntax

```
ini2reg { -a | -ao }[ -i ini-file-name][ -b base-key][ -s subkey][ -d
default-subkey]
```

`-a`

Automates the translation. That is, it processes the translation automatically without presenting the graphical user interface.

`-ao`

Automates the translation and automatically overwrites existing Registry entries.

`-i` *`ini-file-name`*

The pathname of the initialization file to translate.

`-b` *`base-key`*

The base key under which the subkey is created. The value of `base-key` must be one of following:

- `HKEY_CURRENT_USER` (default).
- `HKEY_USERS`
- `HKEY_LOCAL_MACHINE`
- `HKEY_CLASSES_ROOT`
- `HKEY_CURRENT_CONFIG`
- `HKEY_DYN_DATA`

`-s` *`subkey`*

The subkey under which entries are created. The subkey is created under the base key specified in the -b parameter.

Use -d to specify a default subkey for the translation destination.

`-d` *`default-subkey`*

The default subkey under which entries are created. The default subkey is created under the base key specified in the -b parameter.

If the base key is HKEY_LOCAL_MACHINE or HKEY_CURRENT_USER, INI2REG prepends SOFTWARE to the specified default subkey. If the initialization file name is not `progress.ini`, INI2REG appends the root name of the initialization file to the specified default subkey. If this parameter is not specified, INI2REG uses a default subkey of PSC\PROGRESS*`version`*.

You can generalize this as follows:

```
base-key\[SOFTWARE]\default-subkey\[rootname]
```

Use -s to specify a complete subkey for the translation destination.

By default, the INI2REG utility creates Registry key entries for 32-bit OpenEdge at the following location:

```
HKEY_CURRENT_USER\SOFTWARE\PSC\PROGRESS\version
```

By default, the INI2REG utility creates Registry key entries for 64-bit OpenEdge at the following location:

```
HKEY_CURRENT_USER\SOFTWARE\PSC\PROGRESS\x64\version
```

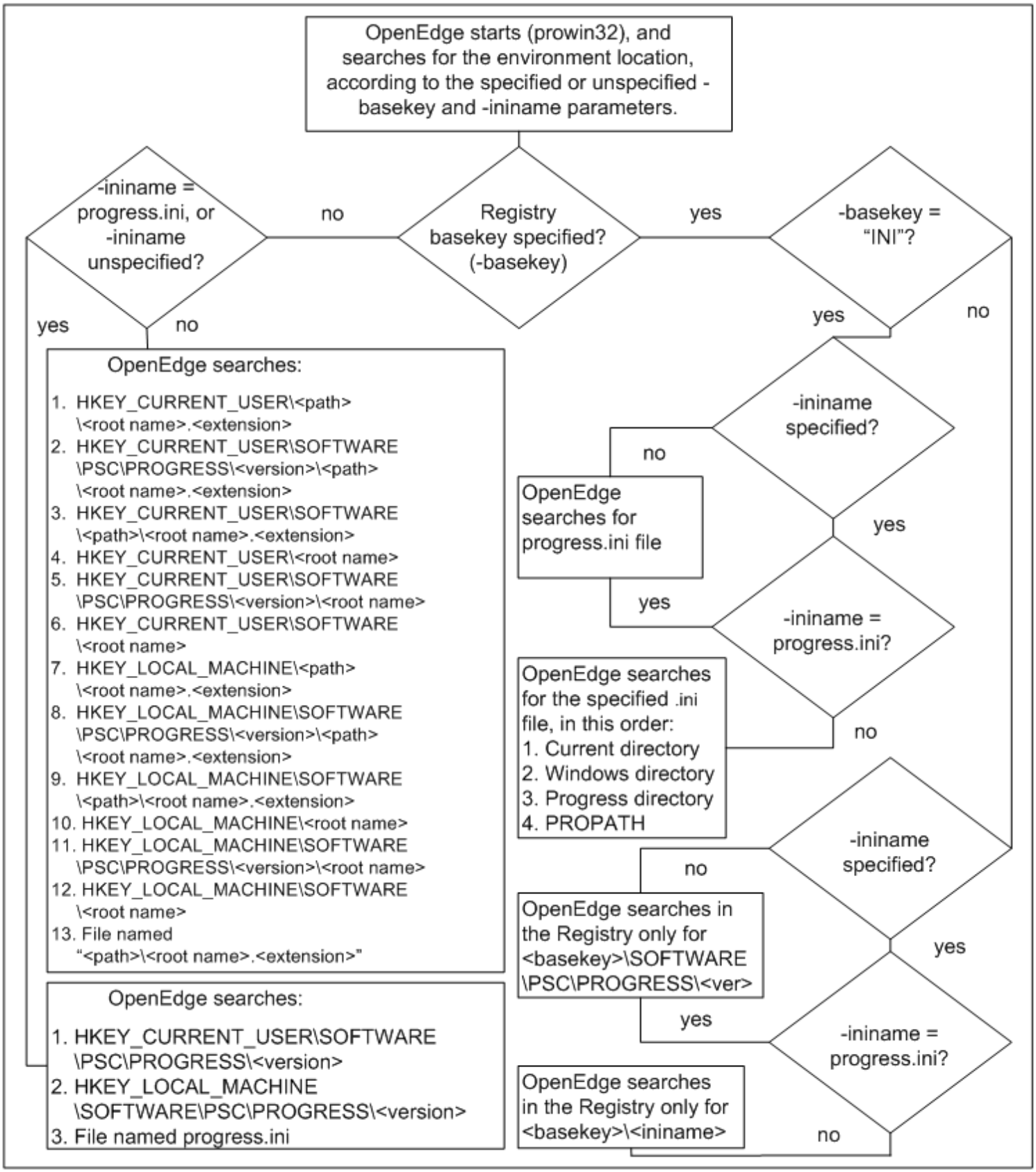
## Search progress.ini and the Registry at startup

At startup, OpenEdge searches for a Registry location, a `progress.ini` file, or both. The particular search path depends upon the parameters you specify with the `prowin32` command, particularly the Registry Base Key (`-basekey`) and Initialization File (`-ininame`) parameters. You can use these parameters to create a more efficient search at startup.

**Note:** The `-basekey` and `-ininame` parameters can only be used on the command line. You cannot use them within a parameter file.

The following illustrates the path that OpenEdge follows when searching for environment information in Windows.

**Figure 2: Windows environment information search path**



**Note:** OpenEdge searches for environment information in the HKEY_CURRENT_USER\SOFTWARE\PSC\PROGRESS\x64\<version> location if you have installed 64-bit OpenEdge.

When OpenEdge does not find environment information in the Registry, or when it was started with the -basekey INI startup parameter, it searches through directories for a progress.ini file in the following order:

1. The current working directory (as defined in the Working Directory field in the Program Item properties sheet for Windows)
2. The WINDOWS directory
3. The directory that contains the OpenEdge executable
4. The user's PROPATH

   This search order fosters deployment flexibility because you can:

   - Create a customized progress.ini file
   - Place the file in a consistent place on every machine
   - Allow all users to share the same file on a network

   After OpenEdge locates the environment information, OpenEdge reads the values for DLC, PROMSGS, and other environment variables. For each variable, OpenEdge first searches the location where it found the environment information. If OpenEdge does not find the variable, it searches for an operating system environment variable.

OpenEdge expects to find all environment settings in the same location it finds the environment variables. There is one exception: OpenEdge searches HKEY_CURRENT_USER and HKEY_LOCAL_MACHINE first when it starts without the -basekey parameter and finds the environment information in the Registry. If OpenEdge writes a value to the Registry, however, it will always write it to HKEY_CURRENT_USER. This allows multiple users of a single machine to customize settings individually. The environment setting location could be either a Registry key or an initialization file, but not both.

The ABL GET-KEY-VALUE statement also searches for user environment information. The GET-KEY-VALUE statement searches either the Registry or a progress.ini file, but not both. When GET-KEY-VALUE searches the Registry, it searches both of the HKEY_CURRENT_USER and HKEY_LOCAL_MACHINE keys if the following conditions are true:

- The OpenEdge startup command (prowin32) used for the current session did not include the -basekey parameter.
- OpenEdge found the environment information in the Registry at startup or at the last LOAD statement.

The ABL PUT-KEY-VALUE statement writes to the location where the environment information was found at startup. If that location is the Registry, and if the prowin32 command did not include the -basekey parameter at startup, the PUT-KEY-VALUE statement writes to the HKEY_CURRENT_USER key and not to the HKEY_LOCAL_MACHINE key.

## Maintain the progress.ini file

The progress.ini file specifies environment variable settings for the Windows environment. It contains sections and settings for the following types of options:

- Options required by OpenEdge
- Options required by OpenEdge tools (such as the Procedure Editor and the Report Builder)
- User-defined options

- Environment variables

The following shows excerpts from a sample `progress.ini` file.

**Sample OpenEdge initialization file in Windows**

```
[Startup]
V6Display=no
;ImmediateDisplay=yes
;MultitaskingInterval=100
DefaultFont=MS Sans Serif, size=8
DefaultFixedFont=Courier New, size=8
DLC=C:\Progress\OpenEdge
Use-3D-Size=Yes
PROPATH=.,C:\Progress\OpenEdge\C:\Progress\OpenEdge\bin
UseSourceEditor=yes
EditorConfigPath=C:\OpenEdge\WRK\proedit
...[WinChar Startup]
DLC=C:\Progress\OpenEdge
PROCFG=C:\DLC\PROGRESS.CFG
PROMSGS=C:\DLC\PROLANG\PROMSGS.GER
PROPATH=.,C:\DLC
V6Keys=No
V6FKeys=No
...
```

When installed, the `progress.ini` file contains the following sections:

- Startup section on page 60
- Colors section on page 68
- Default Window section on page 70
- Fonts section on page 70
- WinChar Startup section on page 71
- WinChar Colors section on page 74
- WinChar Default Window section on page 74
- WinChar Keys section on page 74

The `progress.ini` file can also contain the following optional sections:

- Debug-Init section on page 76
- Debug-Macros section on page 76
- Debug-Buttons section on page 76
- Debug-Buttons section on page 76
- Keys section on page 76
- Keymap section on page 78

You can edit the `progress.ini` file to customize environments at different sites. The `progress.ini` file is located in the *`install-dir`*`\bin` directory, by default.

The following sections describe each of these `progress.ini` file sections.

## Startup section

The Startup section of the `progress.ini` file contains options that specify the following environment characteristics for graphical user interface clients:

- Display attributes and multi-tasking capabilities
- Default fonts used for displaying and printing alphanumeric data

The Startup section also contains OpenEdge environment variables that you can set for use with graphical user interface clients. See Specify environment variables on page 79 for a list of environment variables you can set in the Startup section.

The Startup section contains the following options:

`AlignFrameTitles`

```
AlignFrameTitles=n
```

Lets you specify the alignment of frame titles in a graphical user interface. Valid settings include the following: 0 (left justified), 1 (centered), and 2 (right justified). The default is centered.

`ButtonImageBorderMode`

```
ButtonImageBorderMode=n
```

Use this setting if you want to change the default behavior of how OpenEdge draws borders on buttons with images. The border drawing behavior for image buttons depends on two factors:

- The type of image button—single-image or dual-image. *Dual-image buttons* use two images (an "up" image and a "down" image). *Single-image buttons* use one image (an "up" image which is shifted slightly to mimic a "down" appearance for the button).
- The presence of a manifest file. For more details on manifest files, see Windows manifest file on page 82.

The default behavior is:

- For single-image buttons, OpenEdge creates a Windows XP-style border (rounded corners, no 3D shadow) when using the manifest file. It draws a Windows classic-style border (angular corners with 3D shadow) when not using the manifest file.
- For dual-image buttons, OpenEdge does **not** draw a border for the button, regardless of whether there is a manifest file. (Note that this is the default behavior. You can change the value of `ButtonImageBorderMode` to **2** if you want OpenEdge to draw a border for dual-image buttons.)

The following table describes OpenEdge's border drawing behavior, based on the value of the `ButtonImageBorderMode` setting. If you want to keep the default behavior, you do not need to add this setting to your `progress.ini` file.

**Table 5: Image button border drawing behavior**

| Type of image button | ButtonImageBorderMode value of *n* | | |
|---|---|---|---|
| | **1 (default)** | **2** | **3** |
| Single-image button with manifest file | Adds an XP-style border to the button | Adds an XP-style border to the button | Adds a classic-style border to the button |
| Single-image button without manifest file | Adds a classic-style border to the button | Adds a classic-style border to the button | Adds a classic-style border to the button |
| Dual-image button with manifest file | No border added | Adds an XP-style border to the button | No border added |
| Dual-image button without manifest file | No border added | Adds a classic-style border to the button | No border added |

Note that `ButtonImageBorderMode` affects clients running on XP with a manifest file and clients running on non-XP systems (or XP without a manifest file). The same setting is required for all clients.

`CarefulPaint`

```
CarefulPaint={ YES | NO }
```

Lets you set the accuracy with which OpenEdge repaints overlapping 3D widgets and frames. Set to `YES` for OpenEdge to repaint overlapping 3D widgets and frames slowly and carefully. Set to `NO` for OpenEdge to repaint overlapping 3D widgets and frames quickly (which might reduce the quality of the graphic). The default value is `YES`.

This option applies only when `UseNative3D=NO`.

`ClientTimeOut`

```
ClientTimeOut=n
```

Lets you specify the number of minutes a client session can remain inactive before the server disconnects the session.

The server process determines whether a client has been inactive for a specified period of time, and if so, the server disconnects the client and backs out any related active transactions.

`DefaultFixedFont`

```
DefaultFixedFont=typeface, [ size point-size, keyword, ... ],
   [ script=scriptname ]
```

Lets you specify the default fixed display font.

*typeface*

A valid typeface name, such as Times or Courier.

*point-size*

The size of the font, in points. If you omit the point size, OpenEdge uses the default point size as defined by the typeface.

*keyword*

You can specify the following keywords: bold, italic, underline, or strikeout.

*scriptname*

By default, OpenEdge uses the script (character set) of the Windows FixedSys font for all fonts specified in the environment. If you select a different script when editing a font using the font common dialog, OpenEdge writes the specified script name to the font entry.

DefaultFont

```
DefaultFont=typeface, [ size point-size, keyword, ...],
   [ script=scriptname]
```

Lets you specify the default display font.

*typeface*

A valid typeface name, such as Times or Courier.

*point-size*

The size of the font, in points. If you omit the point size, OpenEdge uses the default point size as defined by the typeface.

*keyword*

You can specify the following keywords: bold, italic, underline, or strikeout.

*scriptname*

By default, OpenEdge uses the script (character set) of the Windows FixedSys font for all fonts specified in the environment. If you select a different script when editing a font using the font common dialog, OpenEdge writes the specified script name to the font entry.

DefaultV6UpdateFont

```
DefaultV6UpdateFont=typeface, [ size point-size, keyword, ...],
   [ script=scriptname]
```

Lets you specify the Version 6 update font.

*typeface*

A valid typeface name, such as Times or Courier.

*point-size*

The size of the font, in points. If you omit the point size, OpenEdge uses the default point size as defined by the typeface.

*keyword*

You can specify the following keywords: bold, italic, underline, or strikeout.

*scriptname*

By default, OpenEdge uses the script (character set) of the Windows FixedSys font for all fonts specified in the environment. If you select a different script when editing a font using the font common dialog, OpenEdge writes the specified script name to the font entry.

When V6Display=YES, the font specified by the DefaultV6UpdateFont setting is used when a fill-in is in update mode. The default value for DefaultV6UpdateFont is a version of the system default fixed font with underlines (`fixedsys`, `underline`).

The DefaultFixedFont and the DefaultV6UpdateFont should be the same base font. If you change them, make sure that the font is fixed and that the DefaultV6UpdateFont has the underline attribute. OpenEdge does not automatically add the underline attribute to the DefaultV6UpdateFont setting.

`EndMsgTitle EndMsgText`

```
EndMsgTitle=title-text
EndMsgText=message-text
```

Lets you specify the title and text for the Windows shutdown message box.

When Windows shuts down, a dialog box prompts the user to verify the shutdown. If the user answers `YES`, OpenEdge closes and the Windows Exit procedure continues. If the user answers `NO`, the Windows Exit procedure terminates and Windows remains active.

EndMsgTitle can be up to 80 characters long. Its default value is "OpenEdge." EndMsgText can be up to 80 characters long. Its default value is "Windows is exiting. Is this OK?".

`FrameSpacing`

```
FrameSpacing=n
```

Lets you specify how the OpenEdge layout processor spaces frames.

Setting the value to -1 places the frame at the next character unit boundary. Setting the value to 0 places frames one half of a character unit apart. Setting the value greater than 0 spaces the frames by the specified number of pixels.

`ImmediateDisplay`

```
ImmediateDisplay={ YES | NO }
```

Lets you redisplay the screen at predefined intervals.

If you do not set this option, some Version 6 applications will not draw the screen correctly. Set this option for applications with existing code that you do not want to modify. The default setting is `NO`.

You can also use the `IMMEDIATE-DISPLAY` attribute with the `SESSION` system handle to surround the offending code. This is the preferred technique.

For more information about the `IMMEDIATE-DISPLAY` attribute and the `SESSION` system handle, see *ABL Reference*.

`Keep3DfillinBorder`

```
Keep3DfillinBorder={ YES | NO }
```

Set to `YES` to display a disabled fill-in field with a border. Set to `NO` to display a disabled fill-in field without a border. The default value is `NO`.

`MultitaskingInterval`

```
MultitaskingInterval=n
```

Lets you specify how the OpenEdge session interacts with a Windows cooperative multi-tasking environment. Its value determines how often OpenEdge filters events or messages between itself and other Windows applications. As OpenEdge filters these events more often, it executes procedures less efficiently but allows other Windows applications more opportunity to execute. Adjusting the internal event filter is particularly useful during background processing, such as report generation.

To maximize performance during batch-mode processing, set the value to 9999 (the maximum value allowed). If you want to run another application while you run OpenEdge in batch mode, set the value to 1000. If you set the value to 0 (the default), the internal loop never executes. Although this results in high performance, interoperability with other Windows applications is poor. The lower the number, the more often the loop executes, resulting in better interoperability. Set this option for applications with existing code that you do not want to modify.

You can also use the `MULTITASKING-INTERVAL` attribute with the `SESSION` system handle to control how OpenEdge interacts with Windows cooperative multi-tasking by surrounding long ABL processing loops with this attribute.

See *ABL Reference* for more information about the `MULTITASKING-INTERVAL` attribute and the `SESSION` system handle.

`NoSplash`

```
NoSplash={ YES | NO }
```

Set to YES to turn off display of the splash screen. By default, the OpenEdge GUI client and the WebClient display a splash screen during startup. The screen, which is a blue rectangle with the words "Powered by Progress Software," disappears when the OpenEdge application starts.

`NoZGrouping`

```
NoZGrouping={ YES | NO }
```

Set to YES to disable the grouping of ABL windows at startup. By default, the AVM groups all ABL windows created in a session such that when an ABL window is brought to the foreground all other ABL windows move to the foreground with it. Grouping is automatically disabled when an application displays a .NET form.

`Opsys`

```
Opsys=character-string
```

Lets you specify the value used by the OPSYS preprocessor directive or the value returned by the OPSYS function. Valid settings include any character string.

`PopupAppOverridesSys`

```
PopupAppOverridesSys={ YES | NO }
```

Set to YES to display the system-default pop-up menu only if a user-defined pop-up menu is not available. Set to NO to display the system-default pop-up menu regardless of a user-defined pop-up menu. If a user-defined pop-up menu is available, it is displayed after the system pop-up menu is closed. The default value is YES.

---

**Note:** The system-default pop-up menu is displayed when you click the right mouse button on a fill-in field or an editor widget and a user-defined pop-up menu is not available.

---

`PopupNoSysDefault`

```
PopupNoSysDefault={ YES | NO }
```

Set to YES to suppress the system-default pop-up menu. Only the user-defined pop-up menu is displayed. The default value is NO.

---

**Note:** The system-default pop-up menu is displayed when you click the right mouse button on a fill-in field or an editor widget and a user-defined pop-up menu is not available.

---

PopupOnMouseDown

```
PopupOnMouseDown={ YES | NO }
```

Set to YES to display a pop-up menu when the right mouse button is depressed. Set to NO to display a pop-up menu when the right mouse button is released. The default value is NO.

**Note:** This option applies only to pop-up menus that are displayed with the right mouse button (that is, MENU-MOUSE = 3). Menus that are displayed with the left or middle mouse button are always displayed when the buttons are depressed.

PrinterFont

```
PrinterFont=typeface, [ size=screen-point-size]
```

Lets you specify the printer fonts OpenEdge uses with the OUTPUT TO PRINTER statement.

PrinterFont*n*

```
PrinterFontn=typeface, [ size=screen-point-size]
```

Lets you specify the printer font OpenEdge uses with the OUTPUT TO LPT*n* statement.

UseClipChildren

```
UseClipChildren={ YES | NO }
```

This option is set to YES by default and works with the Windows manifest file in drawing buttons. For more information on the manifest file, see Windows manifest file on page 82.

Do **not** change the default setting of the UseClipChildren option until you first talk with a Progress Software Technical Support representative.

UseNative3D

```
UseNative3D={ YES | NO }
```

This option is set to YES by default. It specifies to use Windows 3D drawing capabilities.

Set this option to NO to use OpenEdge's 3D drawing capabilities instead. If you set the UseNative3D option to NO, you **must** also remove the prowin32.exe.manifest file from your *installation-path*\bin\ directory. If you set this option to NO and you do **not** remove the manifest file, you will see inconsistencies in the appearance of your user interface.

**Note:** The 64-bit client ignores the `UseNative3D=NO` setting and continues to use Windows 3D drawing capabilities.

`UseSourceEditor`

```
UseSourceEditor={ YES | NO }
```

Set to `YES` if you want to use the Source Editor with advanced editing features. Set to `NO` if you want to use Rich Edit editor. Both editors are Unicode-enabled.

`Use-3D-Size`

```
Use-3D-Size={ YES | NO }
```

Lets you specify how OpenEdge calculates the height of a character unit.

If you set the value to `YES`, OpenEdge uses the height of a three-dimensional fill-in. If you set the value to `NO`, OpenEdge uses the height of a non-three-dimensional fill-in. The default setting is `YES`.

`V6Display`

```
V6Display={ YES | NO }
```

Lets you specify Progress Version 6 behavior.

When you compile a procedure in Windows, OpenEdge compiles the borders and fonts associated with user interface widgets into the screen layout by default. As a result, you might encounter compilation problems when you try to run a Version 6 application in a later version of OpenEdge on Windows. There might not be enough space on the display to accommodate the borders and default fonts that are automatically associated with user interface widgets of the Version 6 application.

To avoid this problem, set V6Display to `YES` to specify that you are running Version 6 code.

You can also set a session attribute to control the run-time setting of the V6Display state. The attribute is `V6DISPLAY` and has a Boolean value. Setting this attribute has the same effect as specifying the setting at startup; however, you must hide all existing windows.

When you set the V6Display option or session attribute:

- The character unit height is recalculated to the height of the font specified by the DefaultV6UpdateFont option.
- The character unit width is recalculated to the width of an average character in the font specified by the DefaultV6UpdateFont option.
- The default font is automatically changed to use the font specified by the DefaultFixedFont option.
- All OpenEdge fill-ins are created without a border.
- OpenEdge fill-ins keep any trailing spaces.

- All OpenEdge fill-ins that are enabled for update use the font specified by the DefaultV6UpdateFont option (by default, the default fixed font with underlines). This means that updateable fill-ins are drawn with underlines.
- Frame titles are drawn so that the frame title height measures exactly one character unit.

The V6Display option or attribute does not enable support for `PUT SCREEN`. In addition, if you set the V6Display option, OpenEdge applications that have not been compiled with the V6Display option set to `YES` will draw screens incorrectly.

---

**Note:** The V6Display option is intended only for use with applications, not with the OpenEdge ADE. The ADE is not supported when V6Display is set to `YES`.

---

If you plan to use Version 6 user interface code with tools based on later OpenEdge releases, Progress Software Corporation recommends that you use the V6Frame option instead of V6Display.

`V6FontNumber`

```
V6FontNumber=n
```

Lets you specify the font for Version 6 frames.

By default, this option points to the font defined as font3 in the [Fonts] section. Font3 is the ADE character-mode font. If you change the V6FontNumber value, make sure you define the new font number in the [Fonts] section.

---

**Note:** Do not change the definition of font3 in the [Fonts] section. OpenEdge relies on that font definition for other purposes.

---

`V6FrameBGC`

```
V6FrameBGC=n
```

Lets you specify the default background color for all frames that use the `V6FRAME` option. Valid settings include any number that corresponds to a color in the OpenEdge color table.

`WindowSystem`

```
WindowSystem=character-string
```

Lets you specify the value used by the `WINDOW-SYSTEM` preprocessor directive. Valid settings include any character string.

## Colors section

The Colors section of the `progress.ini` file contains options that specify the colors that make up the color table for use with graphical user interface clients. Although there are 16 preset colors available to an application for use as either foreground or background colors, you can specify up to 256 colors.

**Note:** Do not change the first 16 colors. These colors are reserved for the Application Development Environment (ADE) tools. Changing them could cause the OpenEdge ADE tools to malfunction.

Each entry in the Colors section performs two semantic functions: it defines a color, and it maps that color to an integer in the range 0 to 255. An application specifies this integer when making a color assignment to a widget.

Specify a color entry using the following syntax:

## Syntax

```
colorn = { R , G , B , | colorname}
```

*n*

An integer from 0 to 255 that specifies the color table entry.

R

An integer that specifies the amount of red present in the color.

G

An integer that specifies the amount of green present in the color.

B

An integer that specifies the amount of blue present in the color.

*colorname*

Any of the following color names, mapped to the colors defined in the Windows Control Panel. For example:

```
COLOR-SCROLLBAR
COLOR-BACKGROUND
COLOR-ACTIVECAPTION
COLOR-INACTIVECAPTION
COLOR-INACTIVECAPTIONTEXT
COLOR-MENU
COLOR-WINDOW
COLOR-WINDOWFRAME
COLOR-MENUTEXT
COLOR-WINDOWTEXT
COLOR-CAPTIONTEXT
COLOR-ACTIVEBORDER
COLOR-INACTIVEBORDER
COLOR-APPWORKSPACE
COLOR-HIGHLIGHT
COLOR-HIGHLIGHTTEXT
COLOR-BTNFACE
COLOR-BTNHIGHLIGHT
COLOR-BTNSHADOW
COLOR-GRAYTEXT
COLOR-BTNTEXT
```

Any entries you add to the color table must be sequential. For example, since the installed `progress.ini` file defines color0 to color15, the next color you add must be color16. If you add an entry for color17, OpenEdge ignores it if color16 is undefined.

For backward compatibility, color0 to color15, as installed, are the same as the colors supported in Version 6. See the topics about colors and fonts in *OpenEdge Programming Interfaces* for a listing of these colors.

For backward compatibility, the `progress.ini` file specifies the following color pairs for Version 6 applications:

- `NORMAL` specifies the colors for fill-ins that do not have input focus.
- `INPUT` specifies the colors for fill-ins that have input focus.
- `MESSAGES` specifies the colors for the message area.

`NORMAL`, `INPUT`, and `MESSAGES` each take a pair of integer values from 0 to 255. The integers represent color table entries. For example, in the default `progress.ini` file, `NORMAL` is defined as foreground equal to color table entry 0 (RGB value 0,0,0) and background equal to color table entry 15 (RGB value 255,255,255).

The following example shows how to redefine `NORMAL` as foreground equal to color table entry 3 and background equal to color table entry 12:

```
NORMAL=3,12
```

## Default Window section

The Default Window section of the `progress.ini` file allows you to specify:

- The location of the default window as an x,y pixel value.
- The size of the default window as a number of rows and columns. The default size is 25 by 80.

The following is a sample Default Window section:

```
[Default Window]
x=
y=
rows=
columns=
```

## Fonts section

The `progress.ini` file as installed contains font table entries for the OpenEdge ADE tools. OpenEdge uses the default system fonts defined in the Startup section, unless you add additional fonts to the existing font table in the Fonts section.

---

**Note:** You can add site-specific fonts to the file, but do not change the first 8 fonts. These fonts are reserved for the Application Development Environment (ADE) tools. Changing them could cause the OpenEdge ADE tools to malfunction.

---

Determine which display fonts exist in your environment. The fonts you choose should be graphically compatible. One way to choose fonts is to use the font common dialog box.

The font table can contain up to 256 entries. Each entry in the table performs two semantic functions: it names a font that exists in your environment and it maps that font to an integer from 0 to 255. An application specifies this integer when making a font assignment to a widget.

**Note:** You cannot enter extra spaces in the font definition section. Extra spaces will cause the error 4499.

Specify a font entry using the following syntax:

### Syntax

```
fontn=typeface, [ size point-size, keyword, ...],
   [ script=scriptname]
```

*n*

An integer that specifies the font table entry.

*typeface*

A valid typeface name, such as Times or Courier.

*point-size*

The size of the font, in points. If you omit the point size, OpenEdge uses the default point size as defined by the typeface.

*keyword*

You can specify the following keywords: bold, italic, underline, or strikeout.

*scriptname*

By default, OpenEdge uses the script (character set) of the Windows FixedSys font for all fonts specified in the environment. If you select a different script when editing a font using the font common dialog, OpenEdge writes the specified script name to the font entry.

## WinChar Startup section

The WinChar Startup section of the `progress.ini` file contains options that specify the following environment characteristics for character clients:

- Default interface attributes
- Default key bindings

The WinChar Startup section also contains OpenEdge environment variables that you can set for use with character clients. See Specify environment variables on page 79 for a list of environment variables you can set in the WinChar Startup section.

The WinChar Startup section contains the following options:

BrowseRowMarker

```
BrowseRowMarker=n
```

Lets you specify a character to represent a browse row marker. Valid settings include any number that corresponds to a character in the CPSTREAM character set.

CursorHeight

```
CursorHeight=n
```

Lets you specify the height of a cursor as a percentage. Valid settings include any number between 0 and 100. This option overrides the UseDosCursor setting.

EnableMouse

```
EnableMouse={ YES | NO }
```

Set to YES to enable mouse input. Set to NO to disable mouse input. The default value is YES.

FastCursorMode

```
FastCursorMode={ YES | NO }
```

For WebSpeed agents, this option is set to YES by default so that the ABL client does **not** process the normal hiding and showing of the cursor during display. This is the default behavior for WebSpeed agents since WebSpeed applications do not have cursors (they do not have a console). This option setting improves the performance of WebSpeed applications.

For character clients, this option is set to NO by default. Using FastCursorMode=YES with the character client on Windows can cause incorrect cursor behavior so make sure you leave this option set to NO if you are **not** using WebSpeed.

---

**Note:** To avoid possible performance issues and incorrect cursor behavior, do **not** change the default setting of this option until you first talk with a Progress Software Technical Support representative.

---

MenuMnemonicColor

```
MenuMnemonicColor=n
```

Lets you specify the color of mnemonic characters in menu items. Valid settings include any number that corresponds to a color in the OpenEdge color table.

SingleLineBorder

```
SingleLineBorder=n,n,n,n,n,n,n,n
```

Lets you specify the characters used to draw borders and lines (such as frame borders, rectangles, submenu and pop-up menu borders, and horizontal and vertical lines). Valid settings include any eight numbers that correspond to characters in the CPSTREAM character set, separated by commas.

These eight numbers represent the corners and sides of a rectangle and must be specified in the following order: top, bottom, left, right, top-left corner, top-right corner, bottom-right corner, and bottom-left corner.

SysCheckmark

```
SysCheckmark=n
```

Lets you specify a character to represent a selection marker in widgets (such as a selection list, menu, or browser). Valid settings include any number that corresponds to a character in the CPSTREAM character set.

UseDosCursor

```
UseDosCursor={ YES | NO }
```

Set to YES to change the cursor from an underscore to a solid block when switching from insert mode to over-strike mode in a fill-in field or editor widget. Set to NO to use an underscore as the cursor in either mode. The default value is NO.

V6Keys

```
V6Keys={ YES | NO }
```

Set to YES to use a set of key bindings that are Version 6 compatible by default. The default value is NO.

V6FKeys

```
V6FKeys={ YES | NO }
```

Set to YES to use the bindings for the **CTRL**, **ALT**, **SHIFT**, and **F13** to **F39** keys that are Version 6 compatible by default. The default value is NO.

## WinChar Colors section

The WinChar Colors section of the `progress.ini` file contains options that specify the colors that make up the color table for use with character clients.

Each entry in the WinChar Colors section performs two semantic functions: it defines a color, and it maps that color to an entry in the color table by specifying an integer from 0 to 255. An application specifies this integer when making a color assignment to a widget.

Specify a color entry using the following syntax:

```
keyword
                | colorn = {[ BLINK- ][ BRIGHT- ]fgnd-color|bgndcolor}
```

*keyword* | color*n*

You can also specify color0, color1, and color2 using the `NORMAL`, `INPUT`, and `MESSAGES` keywords, respectively. The keyword overrides the color*n* specification. That is, if you specify both color*n* and its corresponding keyword, OpenEdge displays the colors you specified with the keyword.

*fgnd-color*

The color to use for the screen foreground.

*bgnd-color*

The color to use for the screen background.

For information about color definitions for the WinChar Colors section, see the Color Phrase reference entry in the *ABL Reference*.

## WinChar Default Window section

The WinChar Default Window section of the `progress.ini` file specifies the line mode for a character client. You can specify 50 rows if your hardware supports 50-line mode. Specify 25 rows if you want the application to be compatible with Progress Version 6 or if you want to port the application to a character terminal.

The following is an example of a WinChar Default Window section:

```
[WinChar Default Window]
rows=25
```

## WinChar Keys section

The WinChar Keys section of the `progress.ini` file defines the customized key bindings for use with character clients. The following table lists the user-definable key bindings in the Windows environment. For a complete listing of the Windows key function and key label mappings for handling user input, see *OpenEdge Programming Interfaces*.

**Table 6: User-definable key bindings in Windows**

| Key function | Key label |
|---|---|
| APPEND-LINE | CTRL+A |
| BLOCK | CTRL+V |
| BREAK-LINE | CTRL+ALT+B |
| CLEAR | F8 |
| COPY | F11 |
| CUT | F10 |
| DEFAULT-POP-UP | SHIFT+F4 |
| DELETE-LINE | CTRL+D |
| END-ERROR | ESC |
| ENTER-MENUBAR | F3 |
| FIND | CTRL+F |
| GET | F5 |
| GO | F1 |
| HELP | F2 |
| INSERT-MODE | INS |
| NEW-LINE | CTRL+N |
| NEXT-FRAME | CTRL+TAB |
| PASTE | F12 |
| PREV-FRAME | CTRL+SHIFT+TAB |
| PUT | F6 |
| RECALL | F7 |

Specify a key-binding entry using the following syntax:

## Syntax

```
keyfunction=keylabel[ , keylabel]
```

Use a single entry to specify a key binding; additional entries for the same key function are ignored.

If you specify more than one key label, OpenEdge uses the first when it needs to display a key label given a key function, as in "Enter data or press Escape to end."

For example, the following entry maps the Help key function to the **F2** key label, and the Go key function to the **F1** key label:

```
HELP=F2
GO=F1
```

You can use any combination of **CTRL**, **SHIFT**, and **ALT** keys. However, **SHIFT** only has an effect when used with ASCII keys. If an entry contains nonexistent key labels, the entry is ignored.

**Note:** Set the V6Keys option in the [WinChar Startup] section to enable OpenEdge to use a set of key bindings that are Version 6 compatible by default.

## Debug-Init section

Do not modify information in the Debug-Init section.

## Debug-Macros section

The Debug-Macros section of the `progress.ini` file contains a list of parameters that define initial macros used by the Debugger. You can also define your own macros. For more information, see *Troubleshoot ABL Applications*.

## Debug-Buttons section

The Debug-Buttons section of the `progress.ini` file contains a list of parameters that define initial buttons used by the Debugger. You can also define your own buttons. For more information, see *Troubleshoot ABL Applications*.

## Keys section

The Keys section is an optional section you can create in the `progress.ini` file to customize key bindings for the Windows environment.

The following table lists the static key bindings in the Windows environment.

**Table 7: Static key bindings in Windows**

| Key function | Key label |
|---|---|
| BACKSPACE | BACKSPACE |
| BACK-TAB | SHIFT+TAB |
| CURSOR-DOWN | CURSOR+DOWN |
| CURSOR-LEFT | CURSOR+LEFT |
| CURSOR-RIGHT | CURSOR+RIGHT |

| Key function | Key label |
|---|---|
| CURSOR-UP | CURSOR+UP |
| DELETE-CHARACTER | DEL |
| END | END |
| HOME | HOME |
| PAGE-DOWN | PAGE-DOWN |
| PAGE-UP | PAGE-UP |
| RETURN | ENTER |
| TAB | TAB |

The following table lists the user-definable key bindings in the Windows environment.

**Table 8: User-definable key bindings in Windows**

| Key function | Key label |
|---|---|
| APPEND-LINE | No default |
| BLOCK | No default |
| BREAK-LINE | No default |
| CLEAR | No default |
| DEFAULT-POP-UP | F4 |
| DELETE-LINE | No default |
| END-ERROR | ESC |
| FIND | No default |
| GET | No default |
| GO | F2 |
| HELP | F1 |
| INSERT-MODE | INS |
| NEW-LINE | No default |
| NEXT-FRAME | F6 |
| PREV-FRAME | SHIFT+F6 |

| Key function | Key label |
|---|---|
| PUT | No default |
| RECALL | No default |

## Keymap section

The Keymap section is an optional section you can create in the `progress.ini` file to define mappings between standard ASCII (7-bit) characters and extended (8-bit) characters. Extended characters are typically non-English alphabetical characters. OpenEdge uses these keymap entries to build a translation table for processing characters in the input and output streams.

**Note:** Using the Keymap section is the Version 6 technique for mapping characters. Using conversion tables is a better technique for processing characters. For information about defining conversion tables, see *Internationalize ABL Applications*.

Use the `IN` statement, in a keymap entry, to map an ASCII character to an extended character using the following syntax:

## Syntax

```
[ MAP-language ]
:IN(\ascii-char)=\extended-char:
```

*language*

An identifier that appears with the `MAP` option.

*ascii-char*

The 7-bit character, in octal (*nnn*) format. You must specify all three digits.

*extended-char*

The 8-bit character, in octal (*nnn*) format. You must specify all three digits.

Use the `OUT` statement, in a keymap entry, to map an extended character to an ASCII character using the following syntax:

```
[ MAP-language ]
:OUT(\extended-char)=\ascii-char:
```

You can use multiple `IN` and `OUT` statements in a single keymap entry.

If you use extended character sets, you must specify character mappings for each character set on a per-terminal basis. For example, the following code fragment demonstrates how to map characters to German language characters:

```
[MAP-german]
  :IN(\102)=\341:
  :IN(\101)=\216:
  :IN(\141)=\204:
  :IN(\117)=\231:
  :IN(\157)=\224:
  :IN(\125)=\232:
  :IN(\165)=\201:
```

The `IN` statements in the preceding example map ASCII characters (B, A, a, O, o, U, and u) to German characters (ß, Ä, ä, Ö, ö, Ü, and ü). When OpenEdge sees the character A (\101) on input, it converts the character to Ä (\216). Likewise, when OpenEdge needs to send an Ä to the terminal, it sends (\101). The terminal sees A and displays Ä.

Suppose the terminal cannot display an Ä. You can use the OUT statement to specify an appropriate character to display for Ä, such as capital A. For example:

```
[MAP-german]
  :OUT(\216)=\101:
```

You can also specify keymap entries for the input and output streams using the `MAP` option with each of the following ABL language elements:

- `INPUT FROM` statement
- `INPUT THROUGH` statement
- `INPUT-OUTPUT THROUGH` statement
- `OUTPUT THROUGH` statement
- `OUTPUT TO` statement

For more information about these language elements, see *Internationalize ABL Applications*.

## Specify environment variables

The following table lists the environment variables you can set in either the Startup section or the WinChar Startup section of the `progress.ini` file.

**Table 9: Environment variables**

| Variable | Description | Code example |
|---|---|---|
| PROPATH | A list of directory paths separated by commas. When you run a procedure from within an OpenEdge session with the RUN statement, OpenEdge searches for it in the directory paths defined in PROPATH in the order listed.<br><br>**Note:** When OpenEdge encounters a period in PROPATH (".,C . . ."), it substitutes the pathname of the current directory. | `PROPATH=.,C:\Progress\OpenEdge` |
| PROMSGS | The full pathname of the OpenEdge error messages file. The default value is install-dir\PROMSGS. You only have to set the PROMSGS environment variable if you want to use an error messages file different from the default PROMSGS file in the installation directory. | `PROMSGS=C:\Progress\OpenEdge\PROLANG\GER\PROMSGS.GER` |
| PROCFG | The path name of your product's configuration file. The configuration file is a data file that identifies the OpenEdge product and components that you are licensed to use. Reset PROCFG if you have moved the configuration file from the directory in which you installed OpenEdge. | `PROCFG=C:\Progress\OpenEdge\PROGRESS.CFG` |
| PROSTARTUP | The name of the OpenEdge startup parameter file. The default is `startup.pf`. | `PROSTARTUP=C:\Progress\OpenEdge\startup.pf` |
| DLC | The pathname of the directory in which you installed the OpenEdge system software. | `DLC=C:\Progress\OpenEdge` |

## Windows icons for running OpenEdge

The install process places icons in the OpenEdge group on the Windows Explorer desktop and in the Windows Start menu. The default group name is OpenEdge; however, you can choose another group name. The icons vary depending on the products installed. Modify client icons on page 81 describes the icons.

**Table 10: Windows-installed icons**

| Icon title | Icon command line |
|---|---|
| OpenEdge Client | *install-dir*\bin\prowin32.exe |
| OpenEdge Run-time Client | *install-dir*\bin\prowin32.exe -rr |
| OpenEdge Help | *install-dir*\prohelp*filename* |
| OpenEdge Desktop | *install-dir*\bin\prowin32.exe -p _desk.p |
| OpenEdge AppBuilder | *install-dir*\bin\prowin32.exe -p _ab.p |

On the icon command line, `install-dir` is the directory where you have installed the products.

See the Windows user documentation for more information about creating additional icons, copying and modifying existing icons, and general information about the Windows Explorer.

## Start the OpenEdge client

You can start the OpenEdge client using any of the following techniques:

- Choose the icon on the desktop.
- Choose **StartRun** from the task bar and enter startup parameters on the command line.
- Click on **prowin32** from the Explorer.

Starting the OpenEdge ABL client places you in the Procedure Editor with no databases attached.

## Modify client icons

You can edit the startup command options, including the environment variables, for the default OpenEdge clients.

To modify startup parameters for a client icon:

1. Select the **client** icon from the OpenEdge program group and choose **FileProperties** from the Windows Explorer, or right-click on the icon and choose **Properties** from the pop-up menu. The **Properties** dialog box appears.
2. From the **Shortcut** tab, modify the command-line in the **Target** field. You can supply up to 259 characters in this field. The command-line limit of 259 characters is still valid for the expanded version of the command-line text.
3. Choose **OK**.

**Note:** You can specify environment variables in the command-line. For example, specifying the following command runs the PROWIN32 executable located in the path where the %DLC% environment variable points:

```
%DLC%\BIN\PROWIN32.EXE
```

## Windows manifest file

The OpenEdge installation includes a *manifest file*—a text file that contains XML code. The manifest file provides your ABL application with the look of the Windows XP user interface. For OpenEdge, the manifest file is named `prowin32.exe.manifest` and it is located in the *`install-dir`*`/bin` directory by default. For Web Client, the manifest file is `prowc.exe.manifest`. (Each executable needs its own manifest file and the manifest file must be in the same directory as the executable for which it is intended.)

**Note:** This Windows XP feature also applies to Windows Vista and Windows 7.

Only Windows XP recognizes manifest files; all other versions of Windows (including Windows XP with the screen display set to the Windows Classic style), ignore the manifest file. If you do not want to use the manifest file on XP, you must move, rename, or delete it.

The following settings in the `[Startup]` section of your `progress.ini` file work in conjunction with the manifest file:

- **`UseNative3D`** — When you set this option to `NO`, you specify to use OpenEdge's 3D drawing capabilities insteadof Windows 3D drawing functionality. If you set the UseNative3D option to `NO`, you **must** also remove the `prowin32.exe.manifest` file from your *`installation-path`*`\bin\` directory. If you set this option to `NO` and you do **not** remove the manifest file, you will see inconsistencies in the appearance of your user interface.

**Note:** The 64-bit client ignores the `UseNative3D=NO` setting and continues to use Windows 3D drawing capabilities.

- **`UseClipChilden`** — This option works with the Windows manifest file in drawing buttons. The default setting for this option is YES. Do **not** change the default setting of the UseClipChildren option until you first talk with a Progress Software Technical Support representative.
- **`ButtonImageBorderMode`** — This setting lets you change the default behavior of how OpenEdge draws borders on buttons with images. One of the factors that determines the effect of this option is the presence of a manifest file.

See Startup section on page 60 for more information on these settings.

## Environments with OpenEdge GUI for .NET applications

OpenEdge GUI for .NET supports the ability to access Microsoft .NET objects from ABL much as if they were native ABL classes. The GUI for .NET provides an alternative user interface for ABL applications based on .NET forms and controls. GUI for .NET applications have extra considerations, including the following:

- Microsoft .NET Framework 3.0 or later
- .NET assemblies

- Code Access Security (CAS) for network installs

## .NET Framework

Any client machine running the GUI for .NET requires .NET Framework 3.0 or later. The OpenEdge installer includes the option to install .NET Framework 3.0 if it is missing. Choose this option if you are going to develop or deploy GUI for .NET applications on a client machine. The installer determines if there is already an appropriate version of the framework installed before installing the version included in OpenEdge.

---

**Note:** Microsoft requires users to accept an EULA before installing the .NET Framework. The Microsoft EULA appears during the OpenEdge installation if the framework is installed. This prevents silent installs on client machines that do not already have an appropriate version of the framework.

---

By default, the AVM only loads the .NET Common Language Runtime (CLR) or .NET assemblies as the OpenEdge tools or a running GUI for .NET application require them. This behavior avoids wasting resources running unnecessary code. If your session definitely requires .NET, consider using the Preload CLR (`-preloadCLR`) startup parameter to force the CLR and any specified assemblies to load at startup. For more information on `-preloadCLR`, see *Startup Command and Parameter Reference*.

Running a GUI for .NET application on a client machine without the .NET Framework produces the following error:

```
The OpenEdge GUI for .NET is disabled for this session; the required .NET Framework
version is not installed (14798).
```

## .NET assemblies

An *assembly* is a .NET library or collection of classes. A GUI for .NET application uses several assemblies to connect the ABL and .NET sides of the application. The application might also use assemblies for the following:

- Optional OpenEdge Ultra Controls for .NET
- Classes used by the application that reference .NET objects
- Third-party .NET controls

The AVM internally knows how to locate some assemblies that the GUI for .NET requires. By default, the AVM looks for any other assemblies in the session's working directory. The working directory must contain an Assembly References File (`assemblies.xml`). This file lists all the assemblies used by the application. Progress Developer Studio for OpenEdge includes a mechanism for creating an `assemblies.xml` file for any project that uses the GUI for .NET. Progress Developer Studio for OpenEdge automatically adds assembly references to the `assemblies.xml` file, but it also allows you to manage those references more directly. You can use the Assembly References Tool (`proasmref`) for modifying the `assemblies.xml` file outside of Progress Developer Studio for OpenEdge. You can add any additional assemblies that your application uses to that file or create your own.

---

**Note:** Even if you install assemblies in .NET's Global Assembly Cache (GAC), you must list all assemblies used by your application in `assemblies.xml`.

---

If you do not put your assemblies and `assemblies.xml` file in the session's working directory, you must use the Assemblies (`-assemblies`) startup parameter. The Assemblies (`-assemblies`) startup parameter enables you to specify the absolute or relative path to the directory containing `assemblies.xml` and any third-party assemblies that are not installed in the GAC. A relative path is relative to the working directory for the OpenEdge session. For more information on `-assemblies`, see *Startup Command and Parameter Reference*.

In exceptional circumstances, you might need to include an `assemblies.config` file in your assemblies directory. The `assemblies.config` file is a customized type of .NET application configuration file. It applies only to assemblies that your application expects to find in the assemblies directory. It cannot affect assemblies installed in the GAC or the internal assemblies in *`OpenEdge-install-dir`*`/bin`.

The `assemblies.config` file enables the CLR to find assemblies by providing assembly-specific information. When a GUI for .NET application loads a .NET assembly, OpenEdge checks this configuration file for any changes for that assembly. For example, the file can point to an updated version of an assembly, an alternate path to load an assembly, or provide localization support by pointing to alternate assemblies. For more information on application configuration files, see the "Configuring Apps by using Configuration Files" topic in the *.NET Framework development guide*, currently at the following address:

```
https://docs.microsoft.com/en-us/dotnet/framework/configure-apps/
```

### Code Access Security for network installs

The .NET Framework includes a system of Code Access Security (CAS) that tries to prevent untrusted code from performing privileged operations. When the CLR loads an assembly at runtime, it uses CAS to determine whether the assembly has permission to perform the requested operations. By default, the framework gives assemblies installed on a network share limited permissions. These limited permissions would prevent the GUI for .NET from running.

OpenEdge's Shared Network Installation Utility provides an option to adjust these permissions to allow the GUI for .NET to run. You should consult with your IT administrator about any security issues before using this option. For more information, see the section on shared network installations in *Install OpenEdge*.

## Maintain the UNIX user environment

Typically, you create a user-defined startup script to specify environment variable settings in the UNIX software environment. You can also use the `buildenv` script. OpenEdge uses the `buildenv` script to maintain environment variables that define objects, libraries, and options required for building executables on UNIX.

You must also maintain the `PROTERMCAP` file. `PROTERMCAP` is a terminal definition file that contains the terminal description for your monitor's terminal type. OpenEdge uses this file to determine how to interact with your terminal, console, or terminal emulator.

### Maintain the buildenv script

The `buildenv` script contains settings for the following types of options:

- Options required by OpenEdge
- Options required by OpenEdge tools
- User-defined options
- Environment variables

The following shows an excerpt from a sample `buildenv` script.

**Table 11: Sample buildenv script on UNIX**

```
#!/bin/sh
MACHINE="aix"
export MACHINE
UDORA="User Defined"
export UDORA
if [ x$RDL = x -a -f `pwd`/buildenv.log ] ; then
    rm -f `pwd`/buildenv.log
fi
ORA_MK=$DLC/oebuild/make/ORA.mk
if [ x$RDL != x ]; then
    ORA_MK=$PRGSSRC/project/ORA.mk
fi
# If ORALIB is not set already, attempt to set it
# ORACLE_HOME must be set for the following to work.  Error if unset.
if [ "x$ORALIB" = x -a "x$ORACLE_HOME" != x ] ; then
    # Execute ('source' into current environment) oralib.sh if it exists.
    # (it is assumed to be a Bourne-shell compatible script which, when
    # finished, has defined an appropriate value for $ORALIB.
    if [ -x $DLC/oebuild/build/oralib.sh ] ; then
        . $DLC/oebuild/build/oralib.sh
    else . . .
```

You can edit this script to customize environments at different sites. The `buildenv` script is located in the `$DLC/oebuild/make` directory. OpenEdge uses the `buildenv` script to maintain environment variables that define objects, libraries, and options required for building executables on UNIX. For more information about building OpenEdge executables, see Build OpenEdge Executables on page 183

## Maintain the PROTERMCAP file

The terminal definition file for most character interfaces is called the PROTERMCAP file. This file is a flat file database that contains the terminal description for your monitor's terminal type to inform OpenEdge on how to interact with your terminal, console, or terminal emulator. It specifies which characters to use to draw boxes, how to write in various video modes (such as inverse or blinking), how many lines are on the screen, and what actions to perform for each key on the keyboard.

---

**Note:** Make a backup copy of the PROTERMCAP file before making modifications.

---

Each terminal entry contains the commands and terminal descriptions that OpenEdge uses to communicate with and control the terminal. Each entry is divided into these logical sections:

- Terminal name
- Terminal capabilities
- OpenEdge terminal-specific key functions
- OpenEdge color table
- Vermont Views key functions
- Pointer to key functions

The PROTERMCAP environment variable (*install-dir*`/protermcap`): points to the PROTERMCAP file.

The PROTERMCAP file contains a lengthy entry for each terminal type supported by OpenEdge. Each entry has six parts. The following shows a partial example of each part of a PROTERMCAP entry.

**Parts of a PROTERMCAP entry**

```
wy370|wyse370|wyse 370 running in native mode:\        Terminal name
  :  :\
  :ct:\
  :cm=\E[%i%d;%dH:\              Terminal capabilities
  :co#80:\
  :li#24:\
  :G1=k:
  :  :\
  :GO(F1)=\EOP:\                OpenEdge terminal-specific
  :HELP(F2)=\EOQ:\              key functions
  :  :\
  :COLOR 5 RED/BLACK=\E[31;40m:\E[m:\            OpenEdge
  :COLOR 6 GREEN/BLACK=\E[32;40m:\E[m:           color table
  :  :\
  :ku=\E[A:  :L_ku=<Up>:\
  :kd=\E[B:  :L_kd=<Down>:\         Vermont Views
  :kr=\E[C:  :L_kr=<Right>:\        key functions
  :kl=\E[D:  :L_kl=<Left>:\
  :kh=\E[E:  L_kh=<Home>:\
  :tc=v7kf:                     Pointer to Version 7 key functions
```

**Note:** There is a 8,192-byte limit on the size of each PROTERMCAP entry.

The following sections describe PROTERMCAP syntax and each part of a PROTERMCAP entry.

## PROTERMCAP syntax

This section explains the following:

- The general syntax rules that apply when specifying fields in any of the six PROTERMCAP sections.
- The syntax rules that apply when specifying string values within a field. String values can occur in the terminal capabilities section, the key bindings section, and the color table section.

Syntax rules that apply only to specific sections of the PROTERMCAP file are explained in context.

### General syntax

A PROTERMCAP entry is a single logical line that contains many fields. The syntax for an entry is as follows:

- Each field is terminated by a colon (:). (Use the octal equivalent \072 to specify a colon that is not a terminator.)
- Unless stated otherwise, a field cannot contain embedded separators. Spaces and tabs improve readability, but they are considered empty fields and must be terminated by a colon.
- Comment lines begin with a pound sign (#), and can only occur at the beginning and end of each PROTERMCAP terminal entry (that is, before the terminal name line and after the pointer to key functions line).
- To enhance readability, the PROTERMCAP file, as installed, contains as many physical lines as there are fields. Each physical line in the entry contains the following, in the order listed:
  - An empty field consisting of a tab character
  - A field definition
  - A backslash (\)

- A return

The backslash indicates that the terminal entry continues on the next physical line of the file. If you need to include a literal backslash in a field, use two backslashes.

The following code fragment from the entry for the Wyse 370 shows the use of the colon, tab, space, backslash, and return characters:

```
wy370|wyse370|wyse_370|wyse 370 running in native mode:\
  :  :\
  :ct:\
  :cm=\E[%i%d;%dH:\
  :co#80:\
  :li#24:\
  :G1=k:
  :  :\
  :GO(F1)=\EOP:\
  :HELP(F2)=\EOQ:\
  :  :\
  :COLOR 5 RED/BLACK=\E[31;40m:\E[m:\
  :COLOR 6 GREEN/BLACK=\E[32;40m:\E[m:
```

## String syntax

Certain fields in the capabilities, key bindings, and color sections are specified using strings. Strings are typically a combination of command sequences, literal values, and encoded arguments that tell OpenEdge how to control some aspect of the display.

The following table show the symbols that are common to all strings. Symbols that are unique to strings specified in the capabilities, key bindings, or color sections are explained in context.

**Table 12: Syntax for specifying string values**

| Mnemonic | Description |
|---|---|
| \E | ESC (ASCII 27) |
| \n | New line |
| \r | Return |
| \t | Tab |
| \b | Backspace |
| \f | Form feed |
| *999* | Octal representation of a character. A colon (:) within a string must be represented as \072 and a null character as \200. |
| ^*x* | **CTRL+x**, where *x* represents an appropriate character. For example, ^N represents **CTRL+N**. |
| \^ | ^ |
| \\ | \ |

Some terminal types require you to specify a delay period, also called a padding constant, with certain string capabilities. The delay, in milliseconds, gives the terminal adequate time to execute the command. Specify this delay as an integer value after the equals sign (=) in a string, as shown in the following example:

```
:cm=20\E[%i%d;%dH:\
```

This tells OpenEdge to wait 20 milliseconds after sending the cursor motion (cm) command sequence.

You can optionally follow an integer delay value with an asterisk (*) for commands that affect more than one line of the display. In this case, OpenEdge delays the specified time for each line affected by the command. However, this significantly degrades performance and usually is not required.

When you specify proportional delay, you must specify an integer as the delay in a string field. It cannot have a fractional part; for example, a delay of 1.5* is not valid.

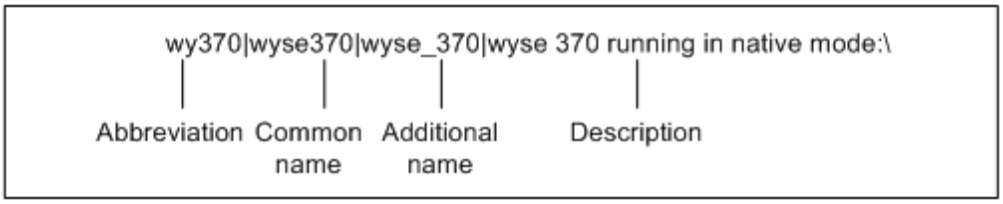
**Note:** Do not specify a padding constant with the GS, GH, GV, GE, G1, G2, G3, and G4 capabilities.

## Terminal name entries

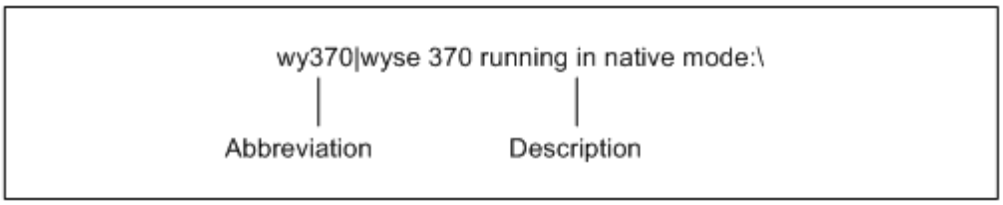
The first field in each PROTERMCAP terminal entry is the Name field. This field provides the names known for the terminal. The Name field contains one or more of the following components, separated by the pipe symbol ( | ):

- An abbreviation of the terminal's name
- The common name of the terminal
- Additional names for the terminal, if any
- A description of the terminal in which only the last name can contain blanks for readability (optional)

PROTERMCAP requires at least one of the name entries (1, 2, or 3, above) to be entered without spaces; the other two, and the description, are optional. See the following example:




Another example of a terminal name entry is:



## Terminal capabilities entries

The terminal capabilities section of a terminal entry contains fields that tell OpenEdge features of the terminal being used. These entries are indented from the name line to distinguish them from the terminal name.

Terminal capabilities entries control visual attributes of the terminal: how big the terminal screen is, how to move to any point on the screen, how to refresh the screen, how to enter/exit special display modes (reverse, blinking, underline), etc. They also control specific terminal functions to set up and clean up the terminal properly, so as not to leave a terminal in an unexpected state (which might leave the terminal unusable).

These entries are the core sequences that OpenEdge uses to communicate with the terminal. Changing them can cause very unpredictable results and might even cause OpenEdge to put the terminal in an unusable state. The entries can be changed, but exercise great care in doing so.

Terminal capability entries consist of:

- A two-character mnemonic that identifies a generic terminal capability
- An assignment operator equal sign (=), or a pound sign (#)
- For certain capability types, a value that allows OpenEdge to understand and interact with the capability on a specific terminal

For example:

```
:ct:\
:cm=\E[%i%d;%dH:\
:co#80:\
:li#24:\
:G1=k:\
```

### Functional listing of terminal capabilities

These are the cursor terminal capabilities that OpenEdge supports:

bc, CF, CN, cm, kd, kl, kr, ku, ke, ks

These are the color/video terminal capabilities that OpenEdge supports:

BB, BR, ct, HS, HR, se, so, ue, us

The following are the graphics character terminal capabilities that OpenEdge supports:

G1, G2, G3, G4, GH, GV, GE, GS

**Note:** Do not use a padding constant with any of the above graphic strings.

The following are miscellaneous terminal capabilities that OpenEdge supports:

co, li, CA, ce, cl, is, Se, Si, te, ti, pc, xi

The following are the key translation capabilities that OpenEdge supports:

k0, k1, k2, k3, k4, k5, k6, k7, k8, k9, k0, k. (period), k, (comma), k- (hyphen)

The following are the scroll region capabilities that OpenEdge supports:

al, sf, sr, dl, cs

**Note:** The ce, cl, and cm capabilities are required for OpenEdge to start up. Vermont Views supports all the capabilities listed here, except ce, te, and ti, and the key translation capabilities.

The following table describes the mnemonics that OpenEdge supports.

**Table 13: Alphabetical listing of capability mnemonics**

| Mnemonic | Data type | Description |
|---|---|---|
| al | STRING | Add line. |
| bc | STRING | Backspace character. |
| BB | STRING | Enter COLOR 4 mode (usually blink mode). |
| BR | STRING | Exit COLOR 4 mode (usually blink mode). |
| CA | BOOLEAN | Terminal clears screen with current attribute. If you do not specify and this capability is available, full-screen clears with attributes other than NORMAL will be slow. |
| ce | STRING | Clear to end of line. |
| CF | STRING | Cursor off. |
| cl | STRING | Clear screen. This improves speed. On some terminals, you must define cl as home cursor followed by clear to end of screen. |
| cm | STRING | Cursor motion. |
| CN | STRING | Cursor on. |
| co | INTEGER | Columns on screen (usually 80). |
| cs | STRING | Change scroll region. Uses cm syntax. |
| ct | BOOLEAN | Terminal supports color. |
| dl | STRING | Delete line. |
| G1 | STRING | Single-line upper-right corner character. |
| G2 | STRING | Single-line upper-left corner character. |
| G3 | STRING | Single-line lower-left corner character. |
| G4 | STRING | Single-line lower-right corner character. |
| GE | STRING | graphics end. Sent when finished drawing box or underline. |
| GH | STRING | Single-line horizontal character. |
| GS | STRING | graphics start. Sent to begin drawing box or underline. |

| Mnemonic | Data type | Description |
|---|---|---|
| GV | STRING | Vertical-line graphic character. |
| HR | STRING | Exit COLOR 3 mode (usually highlight mode). |
| HS | STRING | Enter COLOR 3 mode (usually highlight mode). This is usually set to high intensity, if available. |
| is | STRING | Terminal initialization string. Sent when OpenEdge starts. |
| k0-9 k. k, k- | STRING | Define the codes sent by the numeric keypad keys if these are different from the codes sent by the standard 0-9, period, comma, and hyphen keys. These are only used by OpenEdge. |
| kd | STRING | Down arrow. |
| ke | STRING | Exit keypad mode. |
| kl | STRING | Left arrow. |
| kr | STRING | Right arrow. |
| ks | STRING | Set keypad mode. |
| ku | STRING | Up arrow. |
| li | INTEGER | Lines on screen (usually 24). |
| pc | CHARACTER | Pad character (defaults to null). |
| Se | STRING | String to send when OpenEdge terminates (after te). |
| se | STRING | Exits COLOR 2 mode, or MESSAGE color (usually reverse video). |
| sf | STRING | Scroll forward. You can use this on terminals that have scrolling regions (for example, terminals with cs and sr defined). |
| Si | STRING | String to send when OpenEdge starts (after is). |
| so | STRING | Enter COLOR 2 mode, or MESSAGE color (usually reverse video). OpenEdge uses this attribute by default for the two-line message area at the bottom of the screen. It is also the default for the PROMPT-FOR color of selectable widgets (that is, buttons, sliders, toggle-boxes, etc.). If not set and the PROMPT-FOR color of a widget is not explicitly set in ABL, a widget might not be visible. |
| sr | STRING | Scroll reverse. |
| te | STRING | Cursor movement string to send when OpenEdge terminates. |
| ti | STRING | Cursor movement string to send when OpenEdge starts. |

| Mnemonic | Data type | Description |
|---|---|---|
| ue | STRING | Exit COLOR 1 mode, or INPUT color. |
| us | STRING | Enter COLOR 1 mode, or INPUT color (usually the underline attribute). OpenEdge uses COLOR 1 as the default PROMPT-FOR color for fill-ins and editors. If COLOR 1 is not defined by the us and ue capabilities, and the PROMPT-FOR color for fill-ins and editor widgets is not explicitly set in ABL, these widgets might not be visible, and there might be no indication they are enabled. |
| ws | BOOLEAN | Uses the device /dev /tty for the current port to determine the number of columns and rows for the terminal. Meaningful primarily for emulated terminals in a windowing system (that is, xterm). If successful, overrides co and li; otherwise, defaults to co and li. OpenEdge will not automatically resize if the size of the terminal changes after initialization. |
| xi | BOOLEAN | Terminal will not automatically do a hardware scroll when the last position (last row and last column) on the screen is written to. Specify whether available, otherwise OpenEdge will not write to the last position in order to avoid the automatic scrolling. |

There are four types of terminal capability fields: BOOLEAN, NUMERIC, CHARACTER, and STRING. The following table summarizes the four data types and the operators used in conjunction with each. Boolean fields are specified by a mnemonic abbreviation only. The mnemonic indicates that the feature is present and its absence indicates that the feature is not present. All other capabilities take a value, which can be a string, a character, or a numeric value.

**Table 14: Data types and operators**

| Data type | Operator |
|---|---|
| BOOLEAN | none |
| NUMERIC | # and value |
| CHARACTER | = and character |
| STRING | = and string |

The following code fragment from the terminal entry for the Wyse 370 terminal shows how to specify BOOLEAN, NUMERIC, CHARACTER, and STRING capabilities:

```
:ct:\
:cm=\E[%i%d;%dH:\
:co#80:\
:li#24:\
:G1=k:\
```

In this example, the mnemonic ct is a Boolean switch that indicates that the terminal supports color. The mnemonic cm specifies cursor motion and takes a string. The assignment operator for string values is an equals sign (=). The mnemonics co and li specify the number of columns and lines on the display and each takes an integer. The assignment operator for integer values is a pound sign (#). The mnemonic G1 specifies the upper-right corner line-graphic character and takes a character. The assignment operator for character values is an equals sign (=).

## Vermont Views key function capabilities

Certain programs, such as the install program, use a character interface library called Vermont Views for character input. Vermont Views does not use the OpenEdge Key Function syntax of `keyfunction(label)=sequence`. Instead, it uses key function and key label capabilities. Except for bc, ku, kd, kl, and kr, these key function capabilities are unique to Vermont Views. The key label capabilities mnemonics are created from the key function capabilities mnemonics by prepending "L_". Because both OpenEdge and Vermont Views use only the first instance of a capability, each key function capability can represent only one key label.

For readability, the Vermont Views section of an entry has two distinct columns containing a list of the:

1. Key function capabilities.
2. Matching key label capabilities. The label in this column always starts with "L_".

   Here is an example:

```
:ku=\E[A:          :L_ku=<Up>:\
:kd=\E[B:          :L_kd=<Down>:\
:kr=\E[C:          :L_kr=<Right>:\
:kl=\E[D:          :L_kl=<Left>:\
:kh=\E[E:          :L_kh=<Home>:\
Vermont Views                Labels
mnemonics
```

**Note:** For readability in the PROTERMCAP file, the bc, ku, kd, kl, and kr capabilities are usually repeated in the Vermont Views part of the file, even though both OpenEdge and Vermont Views use these capabilities as they appear earlier in the OpenEdge capabilities part. To avoid confusion, the key sequences for the Vermont Views capabilities should be the same as the OpenEdge capabilities.

The following table summarizes the Vermont Views key function capabilities mnemonics.

**Table 15: Vermont Views key function mnemonics**

| Mnemonic | Description |
|---|---|
| kh | Home (beginning of line, then beginning of page) |
| EN | End (end of line, then end of page) |
| PU | Page up |
| PD | Page down |
| ki | Insert toggle |
| DL | Delete character |

| Mnemonic | Description |
|---|---|
| ESC | Exit current form |
| bt | Back tab |
| fk0 | Function Key 1 |
| fk1 | Function Key 2 (contents) |
| fk2 | Function Key 3 (enter the menu bar, then exit the menu bar) |
| fk3 | Function Key 4 (exit current form) |
| fk4 | Function Key 5 (browse backward) |
| fk5 | Function Key 6 (browse forward) |
| fk6 | Function Key 7 (go back through hypertext links) |
| fk7 | Function Key 8 (bring up search dialog box) |
| fk8 | Function Key 9 |
| fk9 | Function Key 10 |
| Aka | Browse backward |
| Akd | Browse forward |
| Aki | Exit current form |
| Akp | Go back through hypertext links |
| Aks | Bring up search dialog box |
| Aku | Menu bar |
| Akw | Contents |

## Pointer to key functions

The last line of every terminal entry is a pointer to the OpenEdge key functions. These key functions are common to all terminal types and are used by OpenEdge to map certain key functions with certain control sequences, for example, **`:FIND (CTRL-F) = ^F:`**. This pointer always appears as follows:

```
tc=v7kf:
```

If you modify or create new PROTERMCAP entries, be sure to include this line as the last line in the entry. This line ensures that the terminal entry can support current OpenEdge releases.

If you want to use Version 6 mappings with later OpenEdge releases, change the pointer as follows:

```
tc=v6kf:
```

## Specify colors

You specify colors in the OpenEdge terminal-specific key functions and capabilities section of PROTERMCAP. You can specify up to 123 color fields in a terminal entry. This guide refers to the color specifications as the color table.

Each line in the table performs two semantic functions: it defines a foreground/background color pair and it maps that color pair to an integer from 5 to 127. The integer is how an application references the color pair when making color assignments to a widget. (An application typically assigns two color pairs to a widget: one for display mode and another for prompt mode.)

Use the following syntax to specify a color field in a PROTERMCAP terminal entry:

### Syntax

```
COLOR color-number [color-name]=start-sequence:stop-sequence:
```

*color-number*

An integer from 5 to 127 that specifies the location of the color in the color table. The color number is the mechanism used to assign a color pair in an application.

*color-name*

The name of the color. You can use any color value except an ABL keyword. Although this is optional, including a name makes the color section of the terminal entry self-documenting (you cannot embed comments) and also makes the color specifications backwardly compatible.

*start-sequence*

The character sequence that starts the color attribute.

*stop-sequence*

The character sequence that stops the color attribute.

For example, the following fields from the Wyse 370 terminal define color table locations 5 and 6:

```
COLOR 5 RED/BLACK=\E[31;40m:\E[m:\
COLOR 6 GREEN/BLACK=\E[32;40m:\E[m:\
```

OpenEdge reserves color table locations 0 to 4 as follows:

- Color 0 holds the Version 6 color NORMAL, which is set by the terminal initialization (is) field.
- Color 1 holds the Version 6 color INPUT and is set and cleared by us and ue. As installed, this is underline mode.

- Color 2 holds the Version 6 color MESSAGE and is set and cleared by so and se. As installed, this is reverse-video.
- Color 3 holds the colors used for high intensity and is set and cleared by HS and HR.
- Color 4 holds the colors used for blink and is set and cleared by BB and BR.

**Note:** As installed, the PROTERMCAP file does not support spacetaking (embedded attribute) terminals. These are terminals that use characters on the display to hold control codes for video and color capabilities. If you add support for such terminals, OpenEdge ignores the capability when displaying the interface.

## Specify the cursor motion capability

The absolute cursor-motion (cm) capability allows OpenEdge to move to any row and column on the display. The capability takes a string that is composed of two parts:

- Control characters
- Two conversion specifications

The conversion specifications allow OpenEdge to convert an integer row value and an integer column value into the arguments the terminal expects.

The cm string syntax is exactly the same as that used in the standard UNIX `termcap` file, in which the conversion specifications follow the pattern of the UNIX `printf( )` command. The following table lists the supported conversion specifications, each of which begins with a percent sign (%).

**Table 16: Syntax for specifying cursor motion string value (*value*)**

| Mnemonic | Description |
|---|---|
| %d | Send the integer to the terminal in ASCII format. |
| %2 | Pads the value with a leading blank if it is only one digit. |
| %3 | Pads the value with up to two leading blanks. |
| %. | Treats the value as an ASCII character value. |
| %+x | Sets value += x, then does a % |
| %>xy | If value **> x**, then value +=y; no output |
| %r | Reverses the order of row and column; no output |
| %i | Allows row and column values based on a zero origin to be incremented by one to make them appropriate for terminals whose origin is at (1,1) |
| %% | Gives a single **%** |
| %n | Exclusive OR row and column with 0140 |
| %B | BCD (16*(value/10)) + (value%10); no output |

| Mnemonic | Description |
|---|---|
| %D | Reverses coding (value - 2*(value%16)); no output |
| %x | Gives a two-byte, zero-padded, hex value as in the "%0.2x" format for the UNIX printf() function |
| %M | Not similar to any UNIX printf( ) format, and given the row (row) and column (col), %Mx%Mx translates to:**p1 = row / x + x p2 = row mod x + x p3 = col / x + x p4 = col mod x + 2x**Where p1 through p4 are sent to the terminal as characters |

The following example is the cursor motion field for the wyse 370 terminal:

```
:cm=\E[%i%d;%dH:\
```

Where the following symbols indicate the specified action:

- **\E[** — The standard ANSI console lead-in sequence (Escape, followed by a left square bracket). OpenEdge transmits this literally.
- **%i** — Instructs OpenEdge to add one to the row and column values to compensate for a terminal whose origin is 1,1.
- **%d** — Instructs OpenEdge to send the row and column values to the terminal in ASCII format.
- **;** — Separates the row value from the column value.
- **H** — A terminating character.

To create a cm string for a new terminal type, find the description of this capability in your terminal's documentation to determine the control characters and the arguments it expects to move the cursor to a random spot on the display. The documentation specifies an algorithm for converting a row/column integer pair to the arguments it needs. The documentation also specifies the order in which the row and column values are expected (typically row first), and the character to use to separate the two values. For example, to move to column 65, row 66, a terminal might expect the characters A and B, which have ASCII values of 65 and 66, respectively.

## Specify keyboard mappings

The PROTERMCAP file maps key functions to key labels. The following table shows the mappings as installed. Many of the mappings shown are terminal specific, and certain terminals might not support the function for a particular sequence given in the table.

**Table 17: OpenEdge PROTERMCAP key functions**

| Key function | UNIX key label |
|---|---|
| ABORT | CTRL-\ CTRL-ALT-DEL |
| APPEND-LINE | CTRL-A |
| BACKSPACE | BACKSPACE CTRL-H DEL-CHAR |
| BACK-TAB | BACK-TAB CTRL-U SHIFT-TAB |

| Key function | UNIX key label |
|---|---|
| BELL | BELL CTRL-G |
| BLOCK | SELECT CTRL-V |
| BOTTOM-COLUMN | ESC-CTRL-B |
| BREAK-LINE | ESC-B |
| CANCEL-PICK | ESC-CTRL-X |
| CHOICES | ESC-CTRL-H |
| CLEAR | F8 CTRL-Z |
| CLOSE | ESC-Z |
| COMPILE | ESC-P |
| COPY | F11 ESC-C |
| CURSOR-DOWN | CURSOR-DOWN CTRL-J |
| CURSOR-LEFT | CURSOR-LEFT CTRL-O |
| CURSOR-RIGHT | CURSOR-RIGHT CTRL-L |
| CURSOR-UP | CURSOR-UP CTRL-K |
| CUT | F10 ESC-X |
| DEFAULT-POP-UP | ESC-U |
| DELETE-CHARACTER | DEL |
| DELETE-COLUMN | ESC-CTRL-Z |
| DELETE-END-LINE | ESC-K |
| DELETE-FIELD | ESC-CTRL-D |
| DELETE-LINE | REMOVE CTRL-D |
| DELETE-WORD | ESC-D |
| EDITOR-BACKTAB | CTRL-B |
| EDITOR-TAB | CTRL-G |
| END | END ESC -> ESC-. |
| END-ERROR | F4 PF4 ESC CTRL-E |

| Key function | UNIX key label |
|---|---|
| ENTER-MENUBAR | F3 PF3 ESC-M |
| EXIT | ESC-Q |
| FIND | CTRL-F FIND |
| FIND-NEXT | ESC-F |
| FIND-PREVIOUS | ESC-I |
| GET | F5 ESC-O |
| GO | F1 PF1 CTRL-X DO |
| GOTO | ESC-G |
| HELP | HELP F2 ESC-? PF2 |
| HOME | HOME ESC-H ESC-h ESC-< ESC-, |
| INSERT-COLUMN | ESC-CTRL-N |
| INSERT-FIELD | ESC-CTRL-G |
| INSERT-FIELD-DATA | ESC-CTRL-F |
| INSERT-FIELD-LABEL | ESC-CTRL-E |
| INSERT-MODE | INS F9 CTRL-T CTRL-@ |
| LEFT-END | ESC-LEFT-ARROW ALT-LEFT-ARROW |
| MAIN-MENU | ESC-CTRL-M |
| MOVE | ESC-CTRL-V |
| NEW | ESC-N |
| NEW-LINE | INSERT-HERE CTRL-N |
| NEXT-ERROR | ESC-E |
| NEXT-FRAME | ESC-CTRL-I |
| NEXT-WORD | CTRL-W |
| OPEN-LINE-ABOVE | ESC-L |
| OPTIONS | ESC-CTRL-O |

| Key function | UNIX key label |
|---|---|
| PAGE-DOWN | PAGE-DOWN ESC-CURSOR-DOWN ESC-DOWN-ARROW NEXT-PAGE NEXT-SCRN |
| PAGE-LEFT | ESC-W |
| PAGE-RIGHT | ESC-Y ESC-CTRL-J |
| PAGE-RIGHT-TEXT | ESC-CTRL-J |
| PAGE-UP | PAGE-UP ESC-CURSOR-UP ESC-UP-ARROW PREV-PAGE PREV-SCRN |
| PASTE | F12 ESC-V |
| PICK | ESC-CTRL-P |
| PICK-AREA | ESC-CTRL-W |
| PICK-BOTH | ESC-CTRL-Q |
| PREV-FRAME | ESC-CTRL-U |
| PREV-WORD | CTRL-P |
| PUT | F6 ESC-S |
| RECALL | F7 CTRL-R |
| REPLACE | ESC-R |
| REPORTS | ESC-CTRL-A |
| RESUME-DISPLAY | CTRL-Q |
| RETURN | RETURN CTRL-M |
| RIGHT-END | ESC-CURSOR-RIGHT ESC-RIGHT-ARROW ALT-RIGHT-ARROW |
| SAVE-AS | ESC-A |
| SCROLL-LEFT | ESC-CTRL-L |
| SCROLL-MODE | ESC-T |
| SCROLL-RIGHT | ESC-CTRL-R |
| SETTINGS | ESC-CTRL-@ |
| STOP | CTRL-C CTRL-BREAK |

| Key function | UNIX key label |
|---|---|
| STOP-DISPLAY | CTRL-S |
| TAB | TAB CTRL-I |
| TOP-COLUMN | ESC-CTRL-T |

## Use key function syntax

To change any of these mappings or create new ones, use the following syntax:

## Syntax

```
keyfunction(key-label) = sequence:
```

*keyfunction*

The name of a key function.

*key-label*

The key label as it appears on the keyboard.

*sequence*

The characters transmitted when the key is pressed.

As in other sections of the PROTERMCAP file, string values are assigned using an equal sign (=) and the field is terminated with a colon (:). For example:

```
RECALL(F7)=^AF\r:
```

This field in a PROTERMCAP terminal entry defines the **F7** key as transmitting a **CTRL+A** followed by a capital **F** followed by a carriage return, and associates use of **F7** with the RECALL function.

The following field defines **SCROLL-DOWN** to act like **PAGE-DOWN**:

```
PAGE-DOWN(SCROLL-DOWN)=\021:
```

If you assign the same key label to two or more different key functions, you get a warning message when you start OpenEdge. For example, "You cannot use DELETE for both DELETE-CHARACTER and BACKSPACE."

If you use a key in the ABL ON statement or GO-ON option only, and do not have to assign it to a standard action, then use the following syntax in the PROTERMCAP entry:

```
(key-label)=sequence:
```

For example, the following entry indicates that pressing **F16** sends a capital O followed by a carriage return:

```
(F16)=O\r:
```

If any of the control code sequences sent when you press a key on the keyboard begin with a control key, you cannot use that control key on your keyboard and the key does not have its normal OpenEdge meaning. For example, if you specify **CTRL+F** in a control code sequence when creating a key mapping, you can no longer use **CTRL+F** for **FIND**. You have to map another key to the **FIND** action.

The key labels that the UNIX `stty` command specifies for **FLUSH** and **SUSPEND** override the PROTERMCAP file's use of the same key labels. For example, if the `stty` settings for **FLUSH** and **SUSPEND** are **CTRL+Q** and **CTRL+S**, you cannot map these key labels to key functions in the PROTERMCAP file. If you do, you receive no warning; the labels assume their `stty` meanings at run time and OpenEdge ignores them.

### UNIX stty control functions

The installed PROTERMCAP file does not map the ABL functions ABORT, STOP, and UNIX-END to key labels. OpenEdge instead uses the key labels that the UNIX `stty` command specifies for **QUIT**, **INTR** and **EOF** respectively.

For example, the following `stty` command specifies that OpenEdge should use **CTRL+** for ABORT, **CTRL+C** for STOP, and **CTRL+D** for UNIX-END:

```
stty quit ^\ intr ^C eof ^D
```

The labels specified by the `stty` command are of two forms: either **CTRL+X** or **DEL** if the **DELETE** key (octal 177, decimal 127) is used. When entering the `stty` command, indicate the control character by holding down the **CTRL** key and pressing the specified key; you do not type a caret (^) followed by the key.

If an entry in the PROTERMCAP file uses one of the key labels specified in the `stty` command, you get a warning message when you start OpenEdge. For example, if the `stty` command specifies the **DELETE** key for the STOP function and the PROTERMCAP file specifies the **DELETE** key for the DELETE-CHARACTER function, you receive a warning message.

In UNIX environments that do not use the Bourne shell (for example, the Korn shell or C shell), job control allows you to end a job currently executing on a terminal. In most environments this is initiated using **CTRL+Z**; however, OpenEdge uses this character sequence to clear the editor.

## Extended character support entries

You can define mappings between standard ASCII (7-bit) characters and extended (8-bit) characters in the PROTERMCAP file. Extended characters are typically non-English alphabetical characters. OpenEdge uses these mappings to build a translation table for processing characters in the input and output streams.

If you use extended character sets, you must specify character mappings for each character set on a per-terminal basis. For example, the following code fragment from the PROTERMCAP file demonstrates how to map characters on the Wyse 60 keyboard to German language characters:

```
ger|german|wy60 in german mode:\
  :IN(\102)=\341:\
  :IN(\101)=\216:\
  :IN(\141)=\204:\
  :IN(\117)=\231:\
  :IN(\157)=\224:\
  :IN(\125)=\232:\
  :IN(\165)=\201:
```

The IN statements in the preceding example map ASCII characters (B, A, a, O, o, U, and u) to German characters (ß, Ä, ä, Ö, ö, Ü, and ü). When OpenEdge sees the character A (\101) on input, it converts the character to Ä (\216). Likewise, when OpenEdge needs to send an Ä to the terminal, it sends (\101). The terminal sees A and displays Ä.

Suppose the terminal cannot display an Ä. You can use the OUT statement to specify an appropriate character to display for Ä, such as capital A. For example:

```
:OUT(\216)=\101:
```

The IN and OUT statements express both the ASCII character and the extended character in octal (*nnn*) format.

Given the appropriate PROTERMCAP file entries for a language and terminal, set the TERM environment variable to *terminal/language* (for example, TERM=wy60/german).

You can also specify character mappings for the input and output streams using the MAP option with each of the following ABL language elements:

- INPUT FROM statement
- INPUT THROUGH statement
- INPUT-OUTPUT THROUGH statement
- OUTPUT THROUGH statement
- OUTPUT TO statement

For more information about these language elements, see *ABL Reference*.

## Create a PROTERMCAP entry

On UNIX, if OpenEdge does not support your terminal or you need to modify the PROTERMCAP entry for your terminal, refer to the programming documentation from your terminal's manufacturer. It should specify the appropriate commands, values, and key sequences that OpenEdge needs to interact with your terminal.

If you need to create a new PROTERMCAP entry, first check the /etc/termcap file for an entry for your terminal. The /etc/termcap file is the standard terminal definition file used by several UNIX system programs, such as the vi editor. This file is usually provided with UNIX.

If this file contains an entry for your terminal, copy this entry to the PROTERMCAP file. Use this file as a starting point to build an entry for your terminal in the PROTERMCAP file.

If your version of UNIX uses a personal `termcap` called `terminfo`, you must modify the `terminfo` keywords to match the PROTERMCAP capability mnemonics described in the preceding sections.

## Test terminal entries

If you left any required specifications out of the PROTERMCAP file, you will receive an error message when you run OpenEdge. Once in the Procedure Editor, try some operations, such as insert line, delete line, insert character, delete character, and scroll up/down. Also, you should run procedures that require data entry and display messages in the message area.

To fully test the terminal:

1. Open the Procedure Editor.
2. Test to see that the key-functions and key-labels work.
3. Test to see that colors are working correctly on widgets and frames.
4. Test the output to terminal paged to test scrolling capabilities.

## Set up the terminal

Use your terminal's setup mode to synchronize the terminal with the color and key code definitions in its PROTERMCAP entry.

OpenEdge supports terminals based on definitions of their characteristics stored in a file called the PROTERMCAP file. The PROTERMCAP file supplied with OpenEdge has built-in definitions for many terminals. If your terminal is not included in the PROTERMCAP file supplied with OpenEdge, you must make modifications to that file. OpenEdge uses the shell variable or logical PROTERMCAP to find the PROTERMCAP file. By default, OpenEdge looks for this file whenever you start the software in a character environment.

## Set the terminal type

Use the appropriate command to make a new terminal type the current terminal type. The commands assume that the name of the new terminal type is my_term_type.

**Table 18: Setting the terminal type**

| Operating system | Command | Environment |
|---|---|---|
| UNIX (Bourne shell) | `TERM="my_term_type"; export TERM` | In `.profile` or at the shell prompt |
| UNIX (C shell) | `setenv TERM "my_term_type"` | In `.profile` or at the shell prompt |

Alternately, you can change the terminal type from within an OpenEdge program with the following ABL statement:

```
TERMINAL = termid
```

See the TERMINAL function reference entry in *ABL Reference* for more information.

**Note:** Terminal names are case sensitive.

## Set the PROTERMCAP environment variable

If you create a new PROTERMCAP file, store it in the current working directory. Then set the PROTERMCAP environment variable, using the appropriate command from the following table, to allow OpenEdge to use the new file.

**Table 19: Setting the PROTERMCAP environment variable**

| Operating system | Command |
|---|---|
| UNIX (Bourne shell) | `PROTERMCAP=protermcap; export PROTERMCAP` |
| UNIX (C shell) | `setenv PROTERMCAP protermcap` |

## Revert to the default PROTERMCAP file

Use the appropriate command in the following table at the operating system prompt to go back to using the default PROTERMCAP file.

**Table 20: Reverting to the default PROTERMCAP file**

| Operating system | Command |
|---|---|
| UNIX (Bourne shell) | `unset PROTERMCAP` |
| UNIX (C shell) | `unsetenv PROTERMCAP` |

## Copy an existing terminal entry

Use the `tc` (terminal copy) command when you are defining a new terminal entry that is similar to an existing entry. The command appends the specifications for the similar terminal to the new entry, so you do not have to retype the similar information.

The `tc` command takes a string, as shown in the following example:

```
:tc=terminal-name
```

Follow these guidelines when using the `tc` command:

- To override a capability in the copied entry, specify the capability in the new terminal's entry. Commands specified first always override those specified later.
- To suppress the inclusion of a capability that you do not want to specify in the new terminal's entry, specify only the mnemonic, followed by an at symbol (@) in the new terminal's entry. This tells OpenEdge to ignore the capability when it reads it from the similar terminal.
- You cannot use the Version 6 PROTERMCAP in later OpenEdge releases. You can edit the PROTERMCAP to use the Version 6 key bindings by editing the following line at the end of the file:

```
:tc=v7kf {change to} :tc=v6kf
```

- Make `tc` the last field in the terminal entry.
- Place the similar terminal entry in the `PROTERMCAP` file before entries that reference it.
- The combined length of all the definitions must be less than 8,192 bytes.

For example, the following code fragment is a terminal entry for a Wyse 370 in 132 column mode. The entry specifies the name of the terminal, a terminal initialization sequence, the number of columns, and then uses `tc` to append the specifications for the Wyse 370 terminal, as shown:

```
wy370-132:Wyse 370 in 132 column mode:\
  :is=\E[?3h\E[90;1"p\E(B\E)0\E[63;0w:\
  :co#132:
  :tc=wy370:
```

# 5

# Manage Client Performance

On client systems, OpenEdge consumes system resources to execute ABL (Advanced Business Language) procedures, store variables and record buffers, sort records, and store temporary files. When managing client performance, be aware of key performance factors such as procedure loading and execution, temporary file I/O, and sorting I/O. In addition to these factors, application design and coding can significantly affect client performance. For information about this topic, see *OpenEdge Programming Interfaces*.

For information about database performance, see *Manage the OpenEdge Database* and *Startup Command and Parameter Reference*.

For details, see the following topics:

- Procedure loading and execution
- Temporary file I/O
- Sorting I/O

## Procedure loading and execution

*R-code* is the intermediate binary code that ABL generates when it compiles ABL source files. This is the code that OpenEdge actually runs when it executes a procedure or class, whether from session compiles or from permanently generated r-code (`.r`) files. This section describes r-code and the performance options related to it. For information about r-code features and functions, see R-code Features and Functions on page 191.

### Use procedure libraries to improve r-code performance

You can organize and store r-code in an ABL procedure library. The r-code files in a procedure library are known as *members*. Procedure libraries allow you to manage and execute r-code more efficiently.

OpenEdge provides two types of procedure libraries: standard and memory-mapped. A standard library contains r-code that executes in local memory. A memory-mapped library contains r-code that executes in shared memory. You create procedure libraries by using the PROLIB utility. For information about using the PROLIB utility to create and manage procedure libraries, see Manage Procedure Libraries on page 117.

When loading and executing r-code from operating system files in a directory, OpenEdge must open and close each file individually. When loading and executing r-code from standard or memory-mapped libraries, OpenEdge opens only one file—the library itself—to access all of the members in the library.

When you execute members from either a standard library in local memory or a memory-mapped library in shared memory, you gain the following advantages:

- Faster access to r-code
- Fewer file open and close operations
- Less I/O to temporary files

When you execute members from a memory-mapped library in shared memory, you gain the following additional advantages:

- Even faster access to r-code
- Requires less memory because multiple clients access the same r-code segments in shared memory

## R-code execution environment

OpenEdge provides a dynamic environment for loading and executing r-code from operating system files, standard procedure libraries, and memory-mapped procedure libraries. This execution environment consists of the following components:

- **Execution buffer** — The portion of local memory that OpenEdge allocates and uses to store the chain of loaded r-code segments for all standard r-code executing in local memory.
- **R-code swap file ( `.rcd` )** — A file that OpenEdge uses to dynamically swap standard r-code segments in and out of the execution buffer.
- **Shared memory buffer** — The portion of shared memory that the operating system allocates and uses to store and execute the r-code segments for all memory-mapped members.
- **Segment descriptor table** — An in-memory table that references the r-code segments required by all executing r-code, including the location of each r-code segment in local or shared memory and usage count information.
- **R-code directory** — An in-memory table that contains information about all r-code executing in local or shared memory, including r-code size, usage count, segment descriptions, and a reference to the segment descriptor table for each segment.

For more information about the r-code execution environment, see R-code Features and Functions on page 191.

OpenEdge loads and executes r-code in different ways, depending on whether you access the r-code file directly or store the r-code in either a standard or memory-mapped procedure library. The following sections provide an overview of how OpenEdge loads and executes r-code from each of these sources.

### Load and execute r-code from a file

When loading r-code from an operating system file in a directory, OpenEdge opens the r-code file, loads the required r-code segments into local memory, and closes the file.

When executing r-code from an operating system file, OpenEdge accesses and executes the r-code segments in the execution buffer in local memory. OpenEdge also swaps segments to and from the r-code swap file, as necessary.

## Load and execute r-code from a standard procedure library

When loading r-code from a standard library, OpenEdge opens the library file and loads the required r-code segments into local memory. The library remains open until the end of your OpenEdge session or until you remove the library from the PROPATH. When OpenEdge needs to load an r-code segment for a member in that library, it accesses the open library in local memory. This process is much faster than loading r-code from an operating system file.

When executing r-code from a standard procedure library, OpenEdge accesses and executes the r-code segments in the execution buffer in local memory. OpenEdge does not swap r-code segments to the r-code swap file unless you specify the PROLIB Swap (-pls) startup parameter. By default, OpenEdge reloads segments from the open library in local memory.

## Load and execute r-code from a memory-mapped procedure library

When loading r-code from a memory-mapped library, OpenEdge opens the library and maps it in shared memory where multiple users can access it. The library remains mapped until the end of your OpenEdge session or until you remove the library from the PROPATH. When OpenEdge needs to execute an r-code segment for a member in that library, it accesses the library in shared memory. This is even faster than loading r-code from a standard procedure library.

## Tune r-code execution

The following table lists the parameters you use to tune the r-code execution environment for a session.

**Table 21: Startup parameters for tuning the execution environment**

| Startup parameter | Suggested use |
|---|---|
| Maximum Memory (-mmax) | Use this parameter to set the initial execution buffer ceiling; the default is 3096K. OpenEdge increases the execution buffer dynamically as required, but only after attempting to swap segments to the r-code swap file. Increase this parameter to minimize swapping I/O. |
| Directory Size (-D) | Use this parameter to set the initial number of r-code directory entries. OpenEdge can reuse directory entries for inactive r-code files. However, reusing an entry requires some overhead. To reduce this overhead, increase the value of the -D parameter. The default is 100 entries, the minimum is 5 entries, and the maximum is 2,147,483,647 entries. |
| Stack size (-s) | When you load data definitions for very large tables or use recursive procedures, you might receive an error message directing you to increase this parameter. This parameter changes the size of the stack (an internal memory area used by OpenEdge program modules). |
| Nested Blocks (-nb) | If memory is severely limited, use this parameter to limit the maximum number of nested procedure blocks allowed. |

For more information about these startup parameters, see *Startup Command and Parameter Reference*.

### Tune standard procedure libraries

The following table lists the startup parameters you use to tune standard procedure libraries for a session.

**Table 22: Startup parameters for tuning procedure libraries**

| Startup parameter | Suggested use |
|---|---|
| PROLIB Memory (-plm) | If you have a large standard library or a memory shortage, use this parameter to allocate a 512-byte cache for the library's directory instead of loading the entire directory into memory. This parameter slows the speed of library access but increases available memory. |
| PROLIB Swap (-pls) | Use this parameter to allow swapping from a standard library to a r-code swap file. OpenEdge typically reads library-stored r-code from the library instead of swapping to a r-code swap file. However, when using a library over a network, swapping to a r-code swap file might be faster than accessing the remote library. |

If you specify the PROLIB Memory (`-plm`) and PROLIB Swap (`-pls`) startup parameters with memory-mapped libraries, OpenEdge ignores them.

For more information about these startup parameters, see *Startup Command and Parameter Reference*.

## Monitor r-code activity

You can monitor execution environment activity by using the startup parameters listed in the following table to collect usage statistics during an OpenEdge client session.

**Table 23: Startup parameters for monitoring r-code activity**

| Startup parameter | Description |
|---|---|
| Statistics (-y) | Collects procedure access and usage statistics throughout the OpenEdge session and writes them to an output file (by default, `client.mon` in your current working directory). Use the SHOW-STATS statement at any time during the session to instruct OpenEdge to write the statistics immediately. |
| Statistics with CTRL+C (-yc) | Collects the same statistics as the -y parameter, but lets you press **CTRL+C** as an alternative to executing the SHOW-STATS statement. Use this parameter if you cannot execute SHOW-STATS. |

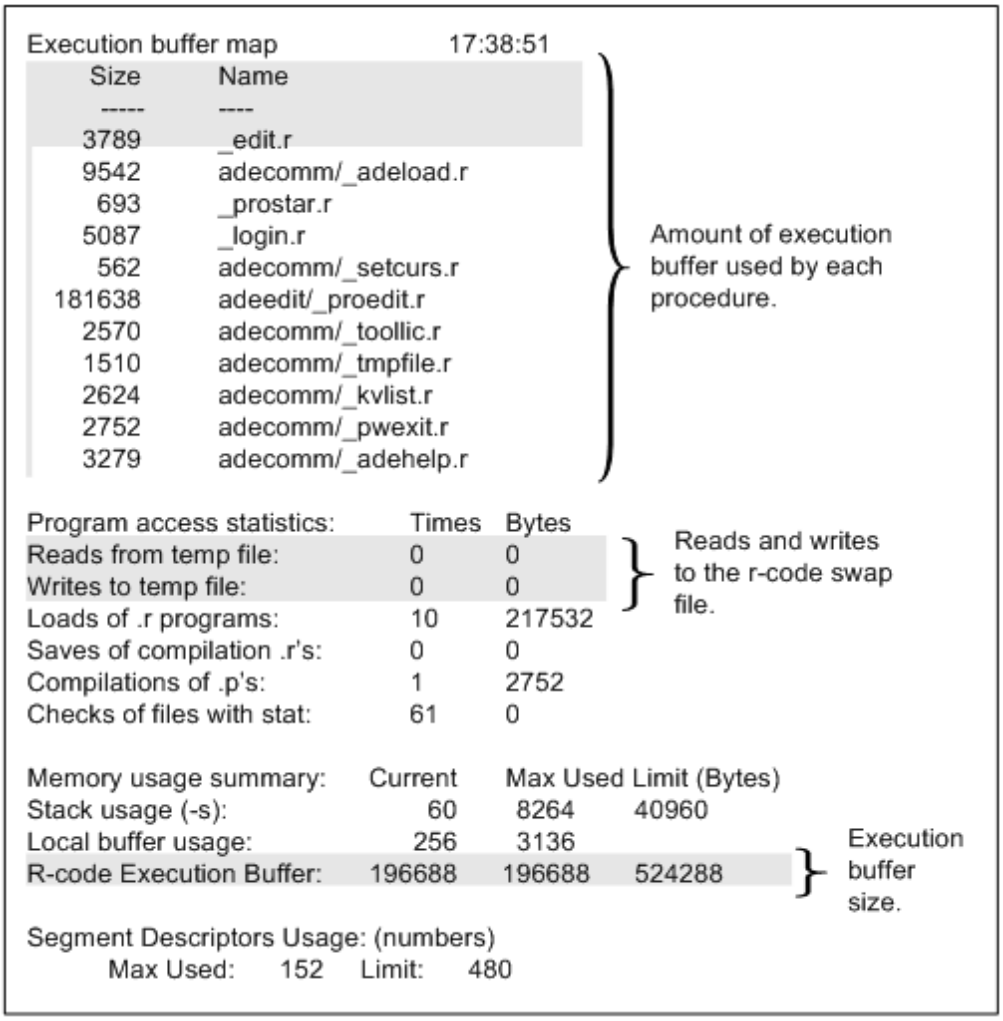
| Startup parameter | Description |
|---|---|
| Segment Statistics (-yd) | Collects r-code segment statistics and writes them to the client monitor file (by default, client.mon in your current working directory). It provides a breakdown of an r-code file by segment type, including the number of segments and its size. It also summarizes read and write access to the r-code swap file by segment type and access type, including the number of times the RCD file was accessed and the number of bytes read from or written to the RCD file. |
| Statistics with Cross-reference (-yx) | Collects procedure call statistics and writes them to an output file (by default, proc.mon in your current working directory). Use this parameter to answer these questions:<br>• How many calls were made in a given period of time?<br>• How long did a procedure spend executing?<br>• How often was a procedure swapped to and from the RCD file? |

For more information about these startup parameters, see *Startup Command and Parameter Reference*.

## Interpret r-code usage statistics

The following image shows a sample excerpt from the output of the Statistics (-y) startup parameter.

**Figure 3: Sample statistics (-y) output**



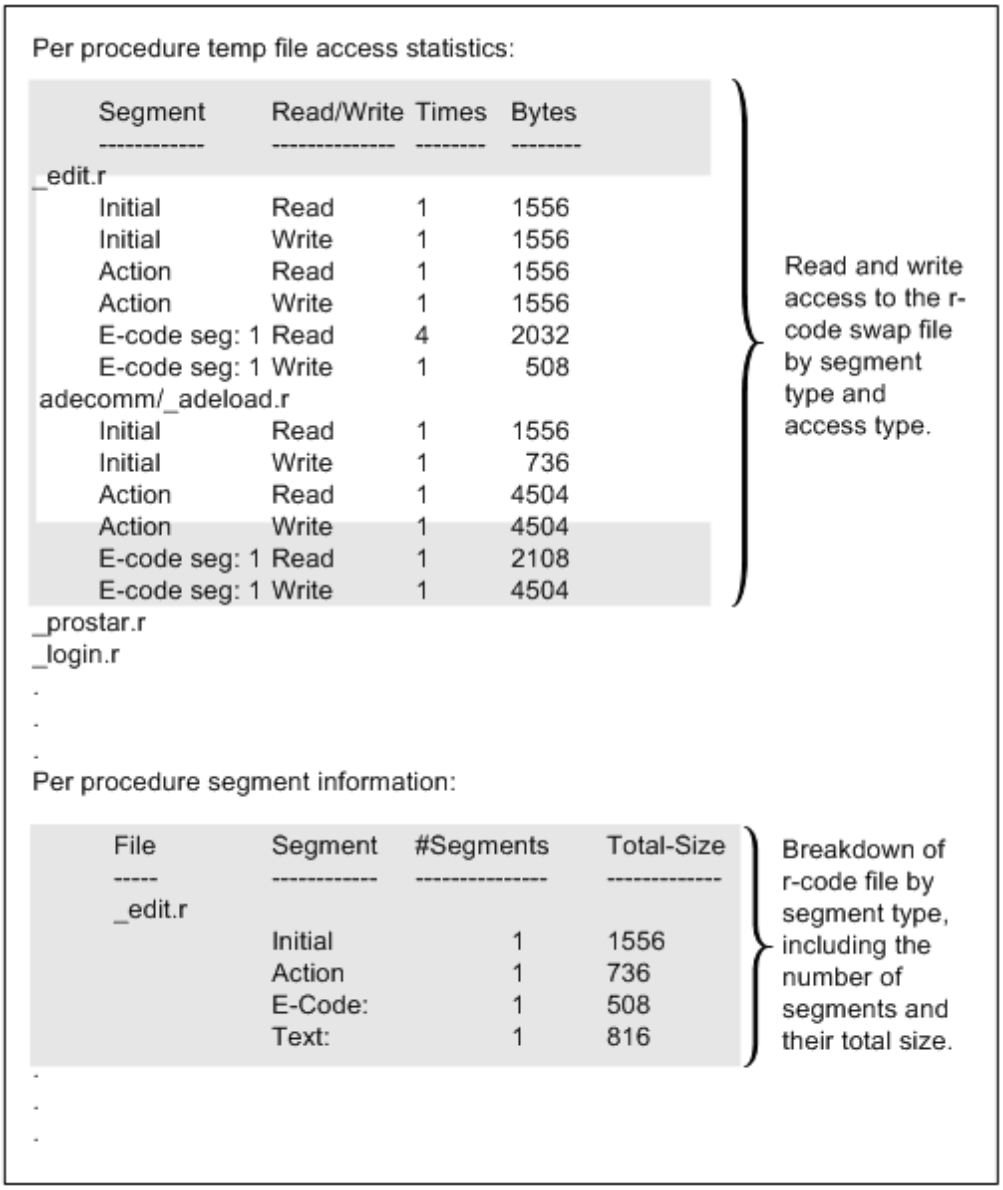

The Reads from temp file and Writes to temp file fields show the amount of swapping to and from the r-code swap file. Segments are written to the swap file only once. Once swapped, they remain in the swap file, even when they are reloaded into memory. For this reason, the number of writes is typically much smaller than the number of reads. If these numbers are relatively high, consider putting the swap file on a dedicated disk. For more information, see Temporary file I/O on page 113.

The R-code Execution Buffer field shows the current size of the execution buffer, the peak usage during the session, and the current ceiling. Use the data in these fields to determine the optimal initial ceiling for the execution buffer (that is, the point at which OpenEdge starts swapping to the r-code swap file). Set this value with the Maximum Memory (-mmax) startup parameter. For more information, see Tune r-code execution on page 109.

### Interpret r-code segment statistics

The following image shows a sample excerpt from the output of the Segment Statistics (-yd) startup parameter.

**Figure 4: Sample segment statistics (-yd) output**




The Per procedure temp file access statistics fields show the swap rates for each segment of each procedure executed during the session. The Per procedure segment information fields show the number and size of r-code segments in each procedure. Use this information to determine how your application design is affecting r-code performance. For more information about application design and r-code performance, see R-code Features and Functions on page 191.

# Temporary file I/O

OpenEdge creates temporary files during each client session. Each operating system has different temporary files. The following table describes the temporary files.

**Table 24: Temporary client session files**

| File | Description |
|---|---|
| `.dbi` | Stores temporary tables |
| `.lbi` | Local before-image file (subtransaction undo) |
| `.ped` | Edit buffer contents |
| `.rcd` | Cache of r-code being run in a session |
| `.srt` | Temporary sort space; session compile storage |
| `.trp` | Stores Data Dictionary changes until they are saved |

By default, OpenEdge stores the temporary files in the user's working directory. Use the Temporary Directory (`-T`) startup parameter to specify an alternate location. When a session ends, OpenEdge deletes these files unless you specify the Save Temp Files (-t) startup parameter. For more information about the Temporary Directory (`-T`) and Save Temp Files (-t) startup parameters, see *Startup Command and Parameter Reference*.

On UNIX, unless you use the Save Temp Files (-t) startup parameter, you do not see the temporary files in the directory because they are created unlinked. However, if your system crashes, the UNIX file system recovery program, `fsck`, finds the files. This program might then prompt you to delete the files. If this occurs, delete them.

On Windows, these temporary files are always visible during an OpenEdge session, but the file sizes are set to zero. Windows does not record file sizes until files are closed.

Writing to these temporary files creates I/O activity that might slow down client performance. The amount of temporary file I/O activity varies among applications.

You might find that running a particular procedure results in OpenEdge abnormally terminating in a way that indicates the hard disk is full. However, when you check the disk immediately afterward, adequate space is available. One possibility is that temporary files created during an OpenEdge session become quite large, taking up disk space as they expand. Since OpenEdge erases temporary files at the end of a session, they do not appear when you check the disk. Of the temporary files, the following files are most likely to cause this problem:

- **Temp table file (.dbi)** — OpenEdge uses this file to store temporary tables. If the application uses a lot of temporary tables, this file can grow quite large.
- **Local before-image file ( `.lbi` )** — OpenEdge uses this file to back out of subtransactions and variable value changes. If the local before-image file becomes too large, the procedures probably use a lot of subtransactions. Examine the transaction structure of the application procedures to understand why OpenEdge starts so many subtransactions. For more information about transaction processing, see *Develop ABL Applications*.
- **R-code swap file ( `.rcd` )** — OpenEdge uses this file to dynamically swap r-code segments in and out of the execution buffer. Use the r-code usage statistics startup parameters to collect information about I/O to the swap file, as explained in Monitor r-code activity on page 110. Using procedure libraries helps reduce the amount of I/O required to load r-code files. For more information, see Use procedure libraries to improve r-code performance on page 107.

---

**Note:** The AVM swaps codepage-converted text segments for procedure libraries from the execution buffer to the r-code swap file and reloads the converted text segments from the swap file instead of the library when necessary.

---

If temporary files grow to exceed disk space, change the application to reduce the size of temporary files, or use the Temporary Directory (-T) parameter to store the temporary files on a disk with sufficient space to hold the files. To optimize performance, place the temporary files on a dedicated disk.

## Sorting I/O

The following table lists the startup parameters you use to improve performance when sorting records for reports and during index rebuild operations.

**Table 25: Startup parameters for tuning sort performance**

| Startup parameter | Description |
|---|---|
| Speed Sort (-TB) | Increase this parameter to 8K, 16K, or even 31K, particularly for index rebuild operations. Increasing this parameter increases memory usage during sorting and index rebuilds. It also slightly increases disk space usage. |
| Merge Number (-TM) | Increase this parameter to 32 to speed the merge phase of the sort process (at the cost of increased temporary memory usage). |

For more information about these startup parameters, see *Startup Command and Parameter Reference*.

# 6

# Manage Procedure Libraries

An ABL (Advanced Business Language) procedure library is a collection of r-code combined in a single file. The r-code files in a procedure library are known as *members*. It is similar to an object library in Windows or an archive file on UNIX. However, object libraries and archive files are used solely for efficient storage. Procedure libraries allow you to manage and execute r-code more efficiently.

**Note:** OpenEdge can only make use of r-code and images within a procedure library. It is technically possible to include other types of files in a procedure library. However, the user would need to extract them from the library before making use of them.

For details, see the following topics:

- Library overview
- Set up a library
- Run members from a library
- Libraries and PROPATH
- Memory and network considerations
- Use the PROLIB utility
- Generate a memory-mapped library
- Code page compatibility

# Library overview

OpenEdge provides two types of procedure libraries: standard and memory-mapped. A standard library contains r-code that executes in local memory. A memory-mapped library contains r-code that executes in shared memory. The r-code files that you place in a library are called *members*.

---

**Note:** Whether the source code is an ABL procedure or ABL class, it compiles into r-code. For the purposes of this topic, procedure and class files are equivalent.

---

When you execute a member from either a standard library in local memory or a memory-mapped library in shared memory, you gain the following advantages:

- Faster access to r-code
- Fewer file open and close operations
- Less I/O to temporary files

When you execute a member from a memory-mapped library in shared memory, you gain the following additional advantages:

- Even faster access to r-code
- Requires less memory because multiple users access the same r-code segments in shared memory

When loading and executing r-code from operating system files in a directory, OpenEdge must open and close each file individually. When loading and executing r-code from standard or memory-mapped libraries, OpenEdge opens only one file—the library itself—to access all of the members in the library.

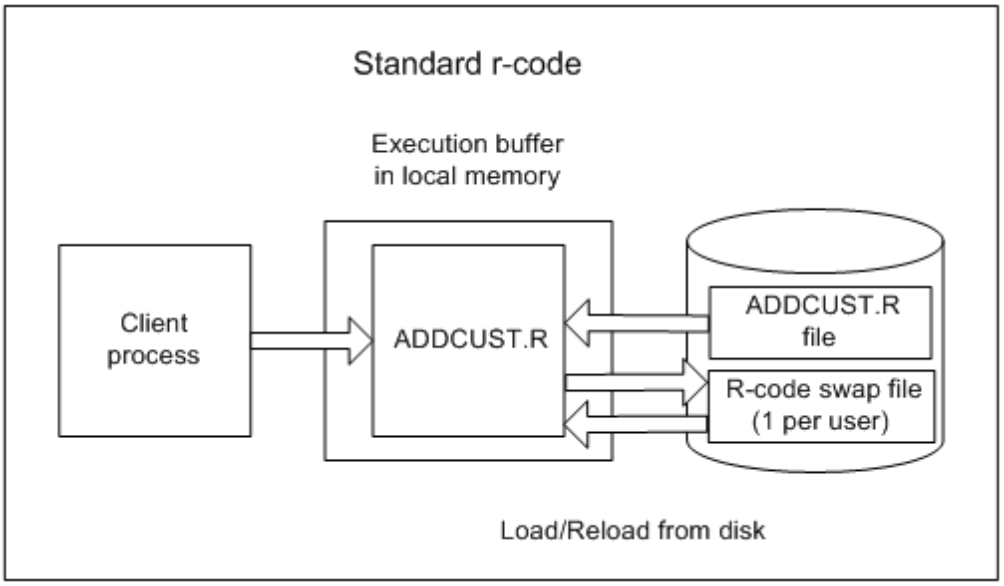
OpenEdge opens a library the first time you run a member from the library. The library stays open until the end of your OpenEdge session or until you remove the library from the PROPATH. For more information about how standard and memory-mapped libraries interact with PROPATH during an OpenEdge session, see Libraries and PROPATH on page 122.

For information about monitoring and optimizing r-code execution during a client session, see ABL Client Deployment Overview on page 17. For more information about r-code structure and execution, see R-code Features and Functions on page 191.

## Load r-code from a file

The following image shows the load operation when executing r-code from an operating system file.

**Figure 5: Loading r-code from a file**



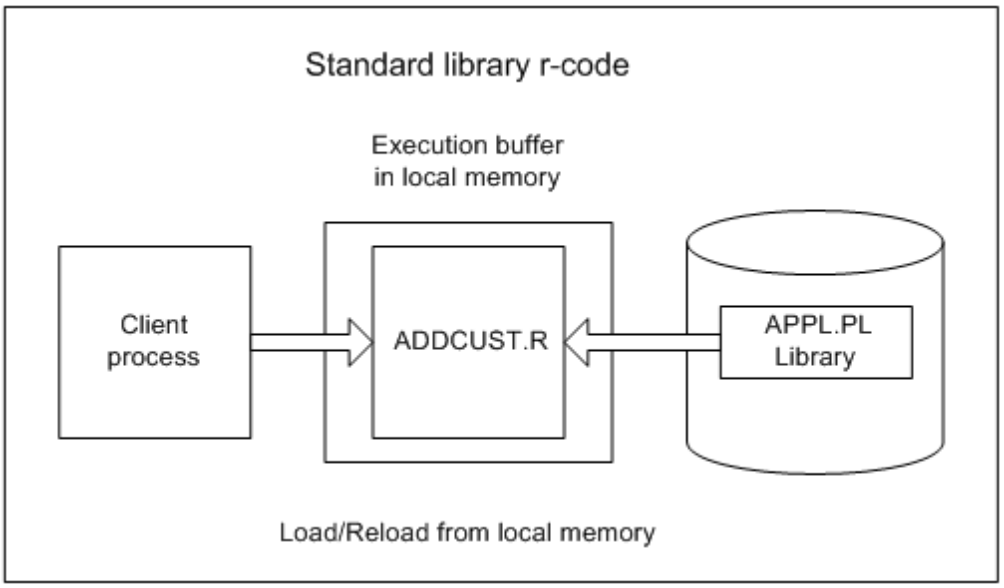

As shown in the above figure, when a client process accesses r-code from an operating system file, OpenEdge loads the r-code into local memory for that individual client and executes the segments from local memory. OpenEdge swaps segments to the r-code swap file, and reloads segments from the r-code swap file, as necessary.

## Load r-code from a standard library

After locating r-code in a standard library, OpenEdge loads the member into local memory.

The following figure shows the load operation when executing r-code from a standard library.

**Figure 6: Loading r-code from a standard library**



As shown in the above figure, when a client process accesses a member from a standard library, OpenEdge loads the member into local memory for that individual client and executes the segments from local memory. OpenEdge does not swap segments to and from the r-code swap file unless you specify the PROLIB Swap (`-pls`) startup parameter. By default, OpenEdge reloads segments from the open library in local memory.

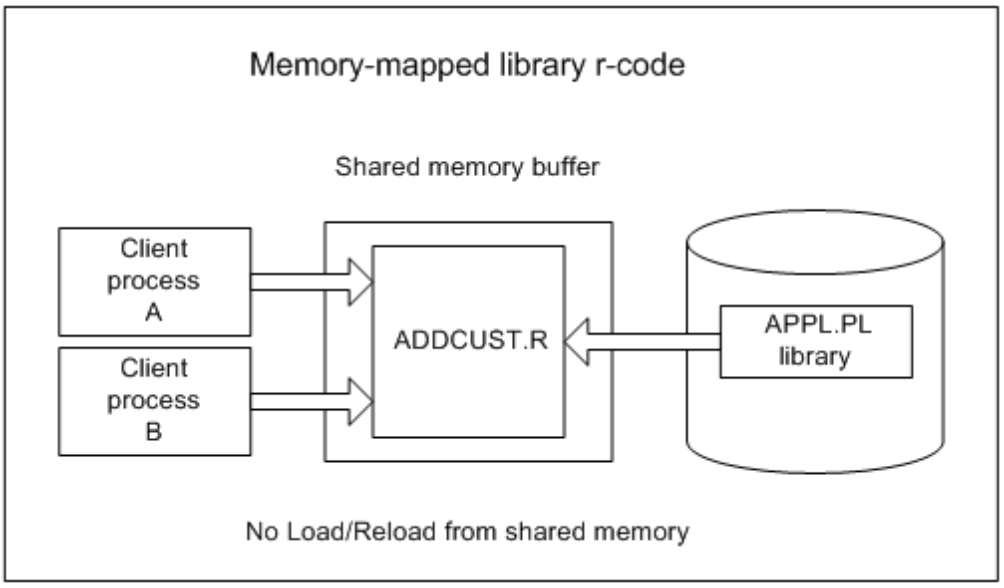
**Note:** The AVM swaps codepage-converted text segments for procedure libraries from the execution buffer to the r-code swap file and reloads the converted text segments from the swap file instead of the library when necessary.

## Load r-code from a memory-mapped library

After locating a member in a memory-mapped library, OpenEdge loads the member by mapping the library in shared memory where one or more clients can access it.

The following image shows the load operation when executing a member from a memory-mapped library.

**Figure 7: Loading r-code from a memory-mapped library**




As shown in the above image, when one or more client processes access a member in a memory-mapped library, they access the same segments in shared memory. Because OpenEdge executes the segments from the mapped library in shared memory (not local memory), no reloading is necessary. If you specify the PROLIB Swap (`-pls`) startup parameter with memory-mapped libraries, OpenEdge ignores it.

**Note:** The AVM swaps codepage-converted text segments for procedure libraries from the execution buffer to the r-code swap file and reloads the converted text segments from the swap file instead of the library when necessary.

# Set up a library

This section provides step-by-step instructions for setting up a library using the PROLIB utility.

To set up a library:

1. Create the standard library with the PROLIB utility. (All libraries must have a `.pl` extension.)
2. Add the r-code files to the library with the PROLIB utility.

3. If you are setting up a memory-mapped library, use the PROLIB utility to generate the memory-mapped library from the standard library.
4. Place the library in the PROPATH.

   For more information about the PROLIB utility, see Use the PROLIB utility on page 124. For more information about placing libraries in the PROPATH, see Libraries and PROPATH on page 122.

# Run members from a library

The difference between running a procedure from an operating system file and running a member from a library is in how you reference it. You can reference both using either absolute or relative pathnames.

## Use an absolute pathname

The most efficient but least flexible way to reference r-code in a library is by using an absolute pathname. When you reference a member using an absolute pathname, OpenEdge does not search the PROPATH. It looks for the member in the specified directory.

To run a procedure from an operating system file in a specific directory, reference the procedure using an absolute pathname. For example:

```
RUN /usr/appl/addcust.r
```

However, to run a member from a library in a specific directory, you must reference both the library and the member with an absolute pathname. For example:

```
RUN /usr/appl.pl<<addcust.r>>
```

When you reference a member in a specific library, you must enclose the member name in double angle brackets as shown.

## Use a relative pathname

The most flexible but least efficient way to reference r-code in a library is by using a pathname relative to a location on the PROPATH. When you reference a member using a relative pathname, OpenEdge searches the PROPATH.

When you reference a member in an unspecified library using a relative pathname, OpenEdge searches each directory and library defined in the PROPATH until it finds the first occurrence of the procedure. For example:

```
RUN mydir/appl/addcust.r
```

When you reference a member in a specific library using a relative pathname, OpenEdge searches the PROPATH until it finds the first occurrence of the library. For example:

```
RUN mydir/appl.pl<<addcust.r>>
```

When you reference a member in a specific library, you must enclose the member name in double angle brackets as shown.

The most flexible way to find r-code is to specify relative pathnames for all procedures run in your application. This enables you to include a procedure in a library at deployment, but maintain separate procedure and r-code files during development. In a development environment, either place the library in the PROPATH after your development directories or omit it from the PROPATH entirely. In a production environment, place the library at or near the beginning of the PROPATH to avoid long searches.

---

**Note:** OpenEdge can only find r-code members in a procedure library. While it is technically possible to include other types of files in a procedure library, OpenEdge cannot find them while searching the PROPATH.

---

For more information about how libraries interact with PROPATH, see Libraries and PROPATH on page 122. For more information about the RUN statement, see *ABL Reference*.

## Related functions

If a file is in a library, the SEARCH function returns the file's pathname using the following syntax:

### Syntax

```
library-pathname<<member-name>>
```

For example:

```
/usr/dictionary/dictionary.pl<<dict.r>>
```

Other ABL functions make use of this syntax. The LIBRARY function parses the pathname and returns the name of the library (in this example, /usr/dictionary/dictionary.pl). If the argument to LIBRARY is not in the form *library-pathname*<<*member-name*>>, the LIBRARY function returns the Unknown value (?). This is also true of the MEMBER function, which parses the pathname and returns the name of the member file (in this example, dict.r).

For more information about the SEARCH, LIBRARY, and MEMBER functions, see *ABL Reference*.

# Libraries and PROPATH

The following rules govern how standard and memory-mapped libraries interact with PROPATH during an OpenEdge session:

- The first time you run a member from a standard or memory-mapped library that is specified in the PROPATH, OpenEdge locates the member by searching through each directory and library in the PROPATH until it finds the member. To search a library for a member, OpenEdge must open the library. When OpenEdge opens a standard library, it loads the procedure into local memory. When OpenEdge opens a memory-mapped library, it maps the library in shared memory.
- When searching through directories and libraries in the PROPATH, OpenEdge starts at the beginning of the PROPATH and searches each directory and library, in defined order, until it finds the member. Thus, placing the library at the beginning of the PROPATH improves performance.

- A library remains open until the end of your OpenEdge session or until you remove the library from the PROPATH. If you remove a library from the PROPATH while a member is still active (either running, or waiting for a subprocedure to return), OpenEdge displays an error message and the library remains open until you end your OpenEdge session. Otherwise, OpenEdge closes a standard library or unmaps a memory-mapped library.
- If you use a SEARCH or RUN statement to open a library that is not in the PROPATH, the library remains open until you end your OpenEdge session.
- If you use libraries, OpenEdge accesses r-code as if you had specified the Quick Request (-q) startup parameter. That is, OpenEdge searches the PROPATH only on the first reference to a member. Thereafter, if the member still resides in memory, in the local session compile file, or in an procedure library, OpenEdge reuses the member instead of searching the PROPATH again. For more information about the Quick Request (-q) startup parameter, see *Startup Command and Parameter Reference*.

---

**Note:** To ensure that all users access the same memory-mapped library in shared memory, each user must place the library in their PROPATH using the same library pathname.

---

For more information about running members from a library, see Run members from a library on page 121.

## Memory and network considerations

Each library has an internal directory that OpenEdge uses to access members. OpenEdge loads this directory into memory when it opens the library. The directory stays in memory until the library is closed.

By default, OpenEdge tries to load the entire directory of each library into memory. In some cases, you might not have enough available memory to store a library's entire internal directory. Use the PROLIB Memory (-plm) startup parameter to limit the size of a standard library's internal directory in memory. This parameter allocates a 512-byte cache for a standard library's directory. This parameter is especially useful when running in limited memory with several libraries opened simultaneously. If you specify the PROLIB Memory (-plm) startup parameter with memory-mapped libraries, OpenEdge ignores it.

If you run OpenEdge over a network and place a standard library on a file server, remote reads from the library might take longer than reading a r-code file and storing it locally in the r-code swap file. Use the PROLIB Swap (-pls) startup parameter to store standard library members locally in the r-code swap file. If you specify the PROLIB Swap (-pls) startup parameter with memory-mapped libraries, OpenEdge ignores it.

For more information about the PROLIB Memory (-plm) and PROLIB Swap (-pls) startup parameters, see *Startup Command and Parameter Reference*.

# Use the PROLIB utility

The PROLIB utility allows you to create and maintain standard libraries and generate memory-mapped libraries. This is the syntax to start the PROLIB utility:

| Operating system | Syntax |
|---|---|
| UNIX Windows | `prolib library-name parameter [ file-name . . . ]`<br>`[ parameter [ file-name . . . ] . . . ]` |

*library-name*

Specifies the name of a procedure library. The library name must have a `.pl` extension.

*parameter*

Specifies what action to take on the library. The following table lists the parameters and their descriptions.

**Table 26: PROLIB utility parameters**

| Parameters | Description |
|---|---|
| `-create` | Creates a new standard library. |
| `-makeshared` | Generates a memory-mapped library from a standard library. |
| `-add` | Adds files to a standard library. |
| `-replace` | Replaces files in a standard library. |
| `-delete` | Deletes files from a standard library. |
| `-list` | Lists library information such as library name, format, code page, and file contents. |
| `-extract` | Extracts files from a standard library. This parameter creates a copy of a file from the library outside of the library. |
| `-yank` | Extracts files from a standard library and places them in the current working directory. |
| `-compress` | Compresses a standard library by making a copy of it. |
| `-nowarn` | Suppresses any warning message that might occur during the operation of the primary parameters. If you add a file to a standard library with the -add and -nowarn parameters, and the file already exists in the library, PROLIB replaces the file. |
| `-pf` | Allows you to supply command-line arguments in a parameter file. You cannot use -pf in a parameter file. |

| Parameters | Description |
|---|---|
| `-verbose` | Directs PROLIB to display processing information that is ordinarily suppressed. |
| `-date` | Specifies the format of the date as it appears when you use the -list parameter. |

When specifying a parameter, you do not have to type the complete parameter name. You can type the minimally unique string for each parameter (for example, `-l` for `-list` and `-e` for `-extract`).

The `-nowarn` and `-verbose` parameters modify the behavior of the `-create`, `-makeshared`, `-add`, `-replace`, `-delete`, `-list`, `-extract`, and `-yank` parameters.

You can place the `-nowarn`, `-pf`, and `-verbose` parameters anywhere on the command line. They affect the processing of all other specified parameters.

You must place the `-create` parameter before all other parameters. PROLIB processes parameters in left-to-right order as they appear on the command line. If an error occurs during the PROLIB command, PROLIB terminates. This behavior occurs so that options specified later in the command line, which might depend on the failed option, do not execute.

You cannot use the `-add`, `-replace`, `-delete`, `-extract`, `-yank`, or `-compress` parameters with a memory-mapped library (that is, when you specify a memory-mapped library in *`library-name`*).

*`file-name`*

Specifies the name of an r-code file, or a memory-mapped library file when using the `-makeshared` parameter.

## Use wild cards

The `-add`, `-replace`, `-extract`, `-list`, `-delete`, and `-yank` parameters accept wild card arguments. Wild card arguments can contain only the ? or * wild card characters. Depending on the parameter you want to use, you must specify these arguments in one of two ways:

- Using your operating system's regular wild card conventions
- Escaping the wild cards

The `-add` and `-replace` parameters act on operating system files. PROLIB uses system calls to copy the files. Thus, when you use these parameters, use your operating system's standard conventions to specify wild cards.

The `-extract`, `-list`, `-delete`, and `-yank` parameters act on members that are already in a library. PROLIB does not use system calls to act on the files, but instead uses its own internal code. On UNIX, you must escape your wild card arguments by either enclosing them in quotes (for example, `prolib app.pl -delete "sys*.r"`) or escaping the wild card characters individually (for example, `prolib app.pl -delete sys\*.r`). Your operating system might use different techniques to escape wild cards. In Windows, you do not need to escape wild card arguments because the operating system does not expand them before passing them to PROLIB.

## Create a standard library

This is the syntax for the PROLIB command to create a standard library:

| Operating system | Syntax |
|---|---|
| UNIX Windows | `prolib` *`library-name`*<br>`-create [ -codepage` *`codepage-name`* `]` |

`library-name`

Specifies the name of the library you want to create.

All libraries must have a `.pl` extension. You can add a library to the PROPATH environment variable by specifying the file's absolute pathname or its pathname relative to the current working directory.

`codepage-name`

Specifies the name of the code page for the library you want to create.

A library can contain members with different code pages. All members retain their respective code pages.

If you do not specify the `-codepage` parameter at creation time, OpenEdge marks the procedure library with the code page specified in the Internal Code Page (-cpinternal) startup parameter.

For information about code page compatibility, see Code page compatibility on page 133.

# Generate a memory-mapped library

This is the syntax for the PROLIB command to generate a memory-mapped library from a standard library:

| Operating system | Syntax |
|---|---|
| UNIX Windows | `prolib` *`standard-library-name`*<br>`-makeshared` *`mapped-library-name`* |

*`standard-library-name`*

Specifies the name of the standard library from which to generate the memory-mapped library. The library name must have a `.pl` extension. You can add a library to the PROPATH environment variable by specifying the file's absolute pathname or its pathname relative to the current working directory.

Save the standard library; it is the source of modification for the memory-mapped library. Each time you modify the standard library, you must regenerate the memory-mapped library.

*`mapped-library-name`*

Specifies the name of the memory-mapped library you are generating. The library name must have a `.pl` extension.

**Note:** You cannot modify a memory-mapped library directly. To modify a memory-mapped library, you must modify its source standard library and regenerate the memory-mapped library.

PROLIB generates a memory-mapped library with the standard library's code page. All text segments in all members retain their respective code pages.

For information about code page compatibility, see Code page compatibility on page 133.

## Add files to a standard library

This is the syntax for the PROLIB command to add files to a standard library:

| Operating system | Syntax |
|---|---|
| UNIX Windows | `prolib` *`library-name`*<br>`-add` *`file-name`* **[** *`file-name`* **]** **. . .** |

*`library-name`*

Specifies the name of the library where you want to add the file.

*`file-name`*

Specifies the pathname of the file. You can add a file to a library by specifying the file's absolute or relative pathname. You can add a file to the PROPATH environment variable by specifying the file's absolute pathname or its pathname relative to the current working directory.

When you add a file to a library, the library entry for that file retains the entire pathname. For example:

```
prolib newlib.pl -add /usr/apps/proc1.r
```

The pathname `/usr/apps/proc1.r` appears in the library's table of contents. You can display the library's table of contents with the `-list` parameter.

When you extract a file from a library, PROLIB copies the file into the directory specified by the pathname (in this example, `/usr/apps`). See Extract files from a standard library on page 130 for more information.

If you try to add a file that already exists, PROLIB displays an error message. However, if you specify the `-nowarn` parameter, PROLIB replaces the existing file. See Replace files in a standard library on page 128 for more information.

## Replace files in a standard library

This is the syntax for the PROLIB command to replace one or more files in a standard library:

| Operating system | Syntax |
|---|---|
| UNIX Windows | `prolib library-name -replace file-name [ file-name ] . . .` |

*library-name*

Specifies the name of the library with the file you want to replace.

*file-name*

Specifies the name of the file.

When you replace a file, the system overwrites the old file with a file of the same name. Therefore, the pathname you supply for the file has to be the same as the pathname you used originally to add the file to the library. If you try to replace a file that does not exist, PROLIB displays an error message. However, if you specify the `-nowarn` parameter, PROLIB adds the existing file to the library. See Add files to a standard library on page 127 for more information.

## Delete files from a standard library

This is the syntax for the PROLIB command to delete files from a standard library:

| Operating system | Syntax |
|---|---|
| UNIX Windows | `prolib library-name -delete file-name [ file-name ] . . .` |

*library-name*

Specifies the name of the library with the file you want to delete.

*file-name*

Specifies the name of the file. You can specify more than one file at a time.

## List the contents of a library

This is the syntax for the PROLIB command to list the contents of a library:

| Operating system | Syntax |
|---|---|
| UNIX Windows | `prolib` *`library-name`*<br>`-list` **[** *`file-name`* **] . . .** |

*`library-name`*

Specifies the name of the library with the contents you want to list.

*`file-name`*

Specifies that PROLIB should list information about that file only; *`file-name`* has to be the same absolute or relative pathname as when you originally added the file. You can specify more than one file at a time.

The following table lists the information that appears in the header section of the output.

**Table 27: List (-list) parameter library information**

| Information | Description |
|---|---|
| Library Name | The name of the library. |
| Code Page | The code page in which the library was created. |
| Format | The format of the library. The valid library formats are STANDARD and MAPPED. |

The following table lists the information that appears in the output for each file in the library.

**Table 28: List (-list) parameter file information**

| Information | Description |
|---|---|
| Name | The name of the file. |
| Size | The size of the file in the library, in bytes. |
| Type | The file type. PROLIB recognizes two file types: R (r-code file type) and O (any other file type). Although libraries are specifically designed to hold r-code files, you can place any type of file in them. |
| Offset | The distance, in bytes, of the start of the file from the beginning of the library. |

| Information | Description |
|---|---|
| Modified | The date and time the file was last modified. |
| Added To Lib | The date and time the file was entered into the library. You can also change the format of the dates as they appear in the **Modified** and **Added To Lib** fields with the -date parameter, where *date-format* is three letters: m (month), d (day), and y (year). To specify a format, place the letters in the order you want the months, days, and years to appear on screen. The default is mdy. |

## Extract files from a standard library

This is the syntax for the PROLIB command to extract files from a standard library:

| Operating system | Syntax |
|---|---|
| UNIX Windows | `prolib` *library-name*<br>`-extract` *file-name* **[** *file-name* **] . . .** |

*library-name*

Specifies the name of the library with the file you want to extract.

*file-name*

Specifies the name of the file. You can specify more than one file at a time.

---

**Note:** You **must** create all subdirectories required by a library **before** trying to extract files from the library. You can see what directories and subdirectories a library needs by using the PROLIB `-list` parameter to view the contents of the library.

---

When you extract a file from a library, PROLIB copies the file and places it in its original directory. Depending on how you add a file to a library, PROLIB extracts it differently. For example:

- If you added the file by specifying a relative pathname, PROLIB searches your current working directory for the subdirectory indicated in the pathname. For example, if you added a file by using the relative pathname `apps/proc1.r`, PROLIB searches your current working directory for the subdirectory `apps`. If the directory does not exist, PROLIB displays an error message.
- If you added the file by specifying its absolute pathname, PROLIB searches for the original directory. If the directory does not exist, PROLIB displays an error message.

---

**Note:** If you specify the `-yank` parameter instead of `-extract`, OpenEdge strips everything but the filename from the pathname and places the file in your current directory.

---

If the file you are extracting (or yanking) already exists in the directory outside of the library, PROLIB displays the following message (where *file-name* is the pathname of the file you are extracting or yanking):

```
File file-name already exists. Do you want to replace it?
Please answer 'yes' or 'no' or 'rename' to assign new name:
```

If you answer yes, PROLIB overwrites the file. If you answer no, PROLIB does not overwrite the file. If you answer rename, PROLIB displays the following message (where *file-name* is the pathname of the file you are extracting or yanking):

```
Enter new name to use for extracted file file-name -->
```

After you enter the pathname, PROLIB gives the file the new pathname and places it in the appropriate directory.

## Extract files to your current directory

When extracting a file with the `-yank` parameter, PROLIB discards everything but the filename from the file's pathname. For example, if you added a file using the pathname `/usr/apps/proc1.r`, PROLIB discards `/usr/apps` from the pathname and places `proc1.r` in your current working directory.

This is the syntax for the PROLIB command to extract files from a library using the `-yank` parameter:

| Operating system | Syntax |
|---|---|
| UNIX Windows | `prolib` *library-name*<br>`-yank` *file-name* **[** *file-name* **] . . .** |

*library-name*

Specifies the name of the library with the file you want to extract.

*file-name*

Specifies the name of the file. You can specify more than one file at a time.

## Compress a standard library

This is the syntax for the PROLIB command to compress a standard library:

| Operating system | Syntax |
|---|---|
| UNIX Windows | `prolib` *`library-name`* `-compress` |

*`library-name`*

Specifies the name of the library you are compressing. The `-compress` parameter removes extra spaces that occur in the library as a result of repeated adds or deletes.

To compress a library, PROLIB creates a temporary file that requires an area of disk space equal to the size of the compressed library. Before compressing a library, make sure you have enough disk space for the temporary file. Temporary files have names that begin with the letters `PLB`, followed by numbers and possibly letters.

If your system goes down during a compress operation, the temporary file might remain on your disk. Delete this file to free up disk space. The original library will not be damaged.

Repeated adds create empty spaces in the library over time. To minimize the rate at which these empty spaces are created, you can use one command instead of many. For example, instead of entering the following commands:

```
prolib test.pl -add test.r
prolib test.pl -add test2.r
prolib test.pl -add test3.r
```

Enter this command:

```
prolib test.pl -add test*.r
```

You can use the `-list` parameter to determine how much space in your library is unused.

## PROLIB command examples

This section provides several PROLIB command examples.

The following example creates a standard library called `app.pl` in your current directory:

```
prolib app.pl -create
```

The following example adds all the r-code files in the current directory that begin with the letters "sys" to the standard library `app.pl`. In this example, the r-code files are in a directory, so the operating system processes the wild card argument, as shown:

```
prolib app.pl -add sys*.r
```

The following example deletes all members ending with the letters "dev.r" from the standard library `app.pl` and lists all of the members in the library. In this example, the members are in the `app.pl` library, so PROLIB processes the wild card argument. This requires escaping the `*dev.r` argument. Your operating system might use different techniques to escape wild cards. On UNIX, this means placing quotes around it, as shown:

```
prolib app.pl -delete "*dev.r" -list
```

The following example replaces the members `appmenu.r` and `apprept.r` in the standard library app.pl, then compresses the library to free up unused disk space:

```
prolib app.pl -replace appmenu.r apprept.r -compress
```

The following example creates a standard library called `app.pl` in your current directory, adds all the r-code files in the current directory that begin with the letters "sys" to the library `app.pl`, and generates a memory-mapped library called `app_map.pl`:

```
prolib app.pl -create -add sys*.r -makeshared app_map.pl
```

## Code page compatibility

The Internal Code Page (`-cpinternal`) startup parameter determines the internal code page that OpenEdge uses in memory. The code page in which r-code is compiled and the internal code page of the session in which the r-code runs must be compatible. That is, the r-code code page must be either the internal code page, undefined, or convertible to the internal code page.

If the code page of the r-code, from either an operating system file, a memory-mapped procedure library, or a standard procedure library, is not the same as the session's internal code page, OpenEdge performs an in-memory conversion of the r-code text segments to the session's internal code page.

---

**Note:** If you use the R-code In Code Page (`-cprcodein`) startup parameter to specify a code page for reading r-code text segments, OpenEdge reads the text segments as if they were written in that code page, even if the text segments were written in a different code page.

---

For more information about the Internal Code Page (`-cpinternal`) and R-code In Code Page (`-cprcodein`) startup parameters, see *Startup Command and Parameter Reference*.

# 7

# Manage Print Devices

System administrators are responsible for setting up and maintaining the output devices required by an application. Most OpenEdge applications access printers to print reports or other output. This set of topics provides an overview of how to set up print devices on OpenEdge-supported operating systems. It also describes how to use OpenEdge to set up and control output routing and printing characteristics.

For details, see the following topics:

- Print in OpenEdge
- Print in Windows
- Set up output-routing
- Print on UNIX
- Configure a printer

## Print in OpenEdge

Most operating systems support two general printing techniques: direct printing and spooled printing. *Direct printing* sends application output directly to a printer set up on the operating system. This technique of printing is frequently found on single-user systems. However, you can use direct printing in other situations (for example, printing tickets and special forms).

*Spooled printing* sends application output to a temporary file and places a print request in a print queue set up on the operating system. Spooling permits you to queue a print request and continue processing; the system executes the print request when a printer becomes available. A spooled device can help balance the demand on line printers if you are running applications on a time-shared system.

OpenEdge runs with most printers and, depending on the operating system in use, makes default assumptions about printer setup. OpenEdge uses the printer port or spooler named at execution time, not at compile time. Thus, precompiled OpenEdge applications work regardless of the printer port or spooler in effect.

This section provides an overview of the ABL (Advanced Business Language) language elements you can use to direct application output, which includes the:

- `OUTPUT TO` statement
- `OUTPUT THROUGH` statement

## OUTPUT TO statement

By default, all OpenEdge output is directed to the terminal. The `OUTPUT TO` statement allows an application to redirect output to other output devices. The following is a partial syntax example of the `OUTPUT TO` statement:

**Syntax**

```
OUTPUT [ STREAM stream | STREAM-HANDLE handle ] TO
  {     PRINTER [ printer-name ] |  opsys-file
      | opsys-device
      | TERMINAL
      | VALUE ( expression )
      | "CLIPBOARD"
  }
        .
        .
        .
  [ PAGED ] [ PAGE-SIZE { constant | VALUE ( expression ) } ]
        .
        .
        .
```

Use the `OUTPUT TO` statement with the `PRINTER` option to send output to the default print device on the current operating system. For example:

```
OUTPUT TO PRINTER.
```

On UNIX, the `OUTPUT TO PRINTER` statement sends output to the default spooler. To use a spooler other than the default, start OpenEdge using the Printer (`-o`) startup parameter.

In Windows, the `OUTPUT TO PRINTER` statement sends output to the printer defined in default print context. The default print context is the set of values that defines the default printer and setup for that printer in Windows. If there is no default print context, OpenEdge uses the printer control settings from the current environment.

Use the `SYSTEM-DIALOG PRINTER-SETUP` statement to display the Windows Print dialog box and let the user change the default print context at runtime. Use the `PRINTER-NAME` attribute of the `SESSION` system handle to change the printer name in the default print context without user intervention. You can change the system default printer from the Windows Control Panel.

Use the OUTPUT TO PRINTER statement with its various options to override the default print context for a specific print job. For example, send output to a printer other than the default printer by using the following syntax:

```
OUTPUT [ STREAM stream | STREAM-HANDLE handle ] TO PRINTER printer-name
```

OpenEdge assumes that all printers can handle hard-coded form feed characters (**CTRL+L** or 0C Hex). The OUTPUT TO PRINTER statement automatically paginates OpenEdge output on the default printer. To paginate output on a printer, other than the default printer, use the OUTPUT TO PRINTER statement with the PAGED or PAGE-SIZE option.

Use the Printer (-o) startup parameter to specify a default printer to use when processing the OUTPUT TO PRINTER statement in procedures. The specified printer must be set up on the current operating system.

For a complete description of the OUTPUT TO PRINTER statement, the SYSTEM-DIALOG PRINTER-SETUP statement, and the SESSION system handle, see *ABL Reference*. For more information about the Printer (-o) startup parameter, see *Startup Command and Parameter Reference*. For more information about streams, see *OpenEdge Programming Interfaces*.

### OUTPUT THROUGH statement

The OUTPUT THROUGH statement allows an application to redirect output to a process that OpenEdge starts. On UNIX, this statement allows you to pipe OpenEdge output to a UNIX process. The following is a partial syntax example of the OUTPUT THROUGH statement:

**Syntax**

```
OUTPUT [ STREAM stream | STREAM-HANDLE handle ] THROUGH
  { program-name | VALUE ( expression ) }[ argument | VALUE ( expression ) ]...
     .
     .
     .
```

You can also use the OUTPUT THROUGH statement to access spooling capabilities on UNIX systems. For example, this command sends output to the printer named lw on a UNIX system:

```
OUTPUT THROUGH lpr -Plw.
```

For a complete description of the OUTPUT THROUGH statement, see *ABL Reference*. For more information about streams, see *OpenEdge Programming Interfaces*.

## Print in Windows

In Windows, you can choose either of the following two printing modes:

- Default mode
- Windows Passthrough Printing (WPP)

In default mode, OpenEdge uses the Windows device drivers. This mode is sufficient for all basic printing that does not use any printer access control codes, such as those sent by PUT or DISPLAY statements.

In WPP mode, OpenEdge bypasses the Windows device drivers. This means you can send control codes (such as POSTSCRIPT commands) directly to the printer with the PUT or DISPLAY statements. To enable windows passthrough printing for a session, use the Windows Passthrough Printing (-Wa -wpp) startup parameter. You can only use this parameter on the command line.

You cannot use WPP mode with a POSTSCRIPT printer to print OpenEdge standard reports, such as those produced by the Data Dictionary.

---

**Note:** When using windows passthrough printing in Windows95, you must change the Spool Data Format from bmp spooling to RAW spooling. Use the Control Panel to access the Printer Properties for the printer, then select Spool Setting from the Details tab of the Printer Properties tab. Change the Spool Data Format to RAW spooling.

---

For a complete description of the PUT and DISPLAY statements, see *ABL Reference*. For more information about the Windows Passthrough Printing (-Wa -wpp) startup parameter, see *Startup Command and Parameter Reference*.

# Set up output-routing

For systems with multiple printers, you might want to set up an output-routing scheme. Output-routing schemes direct application output to different devices based on criteria that you specify. Since OpenEdge uses the printer port or spooler named at execution time and not at compile time, you can set up output-routing schemes to send application output to different printers based on user identification, the type of procedure the user runs, or some other criteria.

When setting up an output-routing scheme, examine the application and system requirements. For example, your system users might want to direct output to different printers. In this case, you would have to set up an output-routing scheme based on the user identification. An application might have reports that require different types of printers. For example, one report might require a 132-character printer and another report might require an 80-character printer. In this case, you would have to set up an output-routing scheme based on the report type. Another output-routing scheme could direct output to different printers based on both the user and the type of report.

You can set up an output-routing scheme in the following ways:

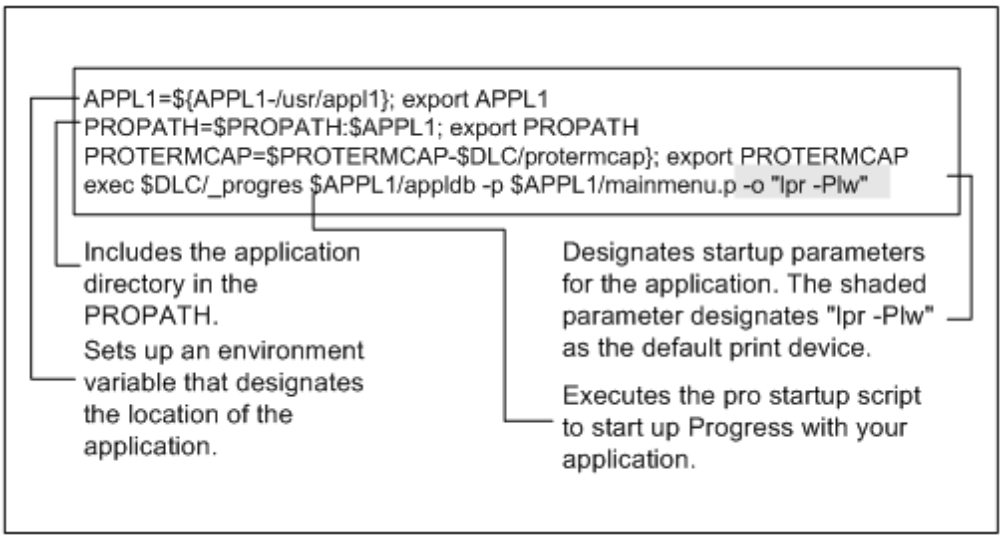

- Use a startup procedure on page 138
- Use an output-routing table on page 139
- Use interactive output-routing on page 140


## Use a startup procedure

The simplest output-routing scheme consists of setting up an OpenEdge application startup procedure for each printer on a system. Each startup procedure could contain the Printer (-o) startup parameter to designate a particular printer as the default printer for the current OpenEdge session.

The following figure shows a sample application startup procedure on UNIX. This application startup procedure designates lpr -Plw as the default print device for the current OpenEdge session and starts up an OpenEdge application located in the `/usr/appl1` directory that access a database called `appldb`.

**Figure 8: Sample application startup procedure (UNIX)**




The above figure shows a sample application startup procedure on Windows. This application startup procedure designates LPT2 as the default print device for the current OpenEdge session and starts up an OpenEdge application located in the `/usr/appl1` directory that access a database called `appldb`.

**Sample application startup procedure (Windows)**

```
echo off
set APPL1=\usr\APPL1
set PROPATH=%PROPATH%;%APPL1%
%DLC%\_progres -D 20  -o LPT2 -p
\usr\APPL1\mainmenu.p appldb
```

After the startup procedures are set up for each system printer, you can designate users to use different startup procedures depending on which output destination they want. For easy user access and maintenance, all of the startup procedures should be located in the directory where the system software is located.

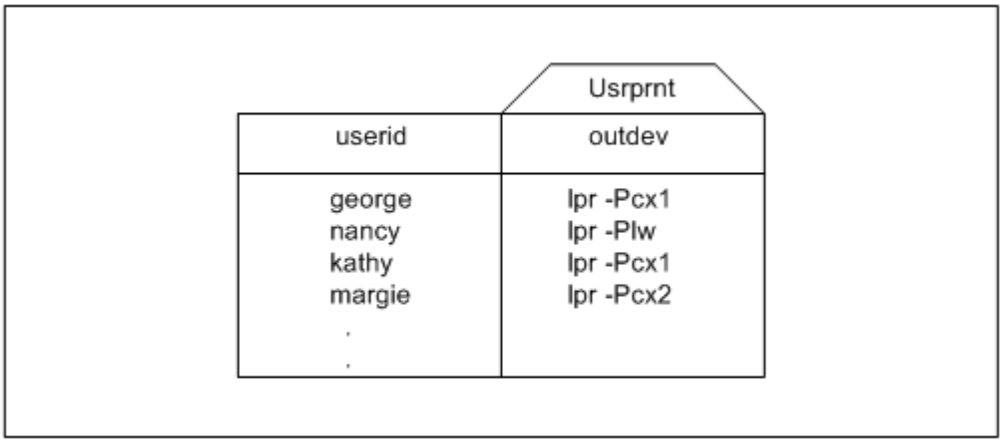
## Use an output-routing table

More complex output-routing schemes, such as routing output based on the user ID, require the creation of several related ABL tables and an include file that can access these tables and select the proper output command for the particular user.

Just as you can use ABL tables (`_User`) to set up security for OpenEdge applications, you can also use ABL tables for output routing. If you want to route application output to different printers based on user ID, set up a table in the application database containing each of the valid user IDs and the corresponding print commands.

T shows a sample output-routing table.

**Figure 9: Sample output-routing table**




The database table shown in the figure contains records that have a userid field and an outdev field containing an operating system output device. The userid field is a unique primary index for the table. You have to keep the Usrprnt table up to date with a record for each new user on your system.

After setting up the database table, create an include file that determines the current user ID and then searches the Usrprnt table for a matching user ID and corresponding output device. For example:

```
FIND Usrprnt WHERE Usrprnt.userid = USERID NO-ERROR.
  IF AVAILABLE Usrprnt THEN
    OUTPUT THROUGH VALUE(Usrprnt.outdev).
  ELSE
    OUTPUT TO PRINTER.
```

The include file searches the Usrprnt table for a record that has a user ID that matches the user ID established for the current application session. If there is no user ID match or established user ID for the application session, OpenEdge uses the default system printer. If there is a match, OpenEdge sends the application output to the output device contained in the corresponding outdev field.

The `VALUE` option of the `OUTPUT THROUGH` statement allows you to designate a substitutable output device. The `USERID` function allows you to capture system user IDs on UNIX. For more information about the `_User` table, see *Manage the OpenEdge Database*.

After creating an include file to route application output, replace all `OUTPUT` statements in your application with the include file. For example:

```
{output1.i}.
FOR EACH Customer NO-LOCK:
  PUT Customer.CustNum Customer.Name Customer.Address Customer.City     Customer.State
 Customer.PostalCode.
END.
```

## Use interactive output-routing

You can also set up interactive output-routing schemes that let application users select an output device at run time. In Windows, for example, you can change the destination of the `OUTPUTTO PRINTER` statement at run time by using the `SYSTEM-DIALOGPRINTER-SETUP` statement.

# Print on UNIX

Refer to your UNIX system documentation for information about printing on UNIX.

# Configure a printer

Many printers have a set of control sequences that you can use to specify different print characteristics, such as compressed printing or italics typeface. These control sequences often involve special characters that can be represented by their octal (base 8) equivalent. To denote these octal codes, precede the three octal digits with an escape character. On UNIX, the escape character is a tilde (~) or a backslash (\). The following table lists the standard control sequences using a tilde as the escape character.

**Table 29: Standard printer control sequences**

| Sequence | Interpreted as | Comments |
|---|---|---|
| ~nnn | Single character | Use to send a single character to the printer, where nnn is an octal code between 000 and 377. You must specify all three digits. |
| ~t | Tab character | Use to send the 011 octal code to the printer. |
| ~r | Carriage return | Use to send the 015 octal code to the printer. |
| ~n | Line feed | Use to send the 012 octal code to the printer. |
| ~E | Escape | Use to send the 033 octal code to the printer. |
| ~b | Backspace | Use to send the 010 octal code to the printer. |
| ~f | Form feed | Use to send the 014 octal code to the printer. |
| ~" | " | Use within quoted strings as an alternative to two quotes (""). |
| ~\ | \ | Use to send the backslash character to the printer. |
| ~~ | ~ | Use to send the tilde character to the printer. |

The PUT statement with the CONTROL option allows you to specify a control sequence that you want to send to a printer. The PUT statement has the following syntax:

## Syntax

```
PUT [ STREAM stream-name]
  CONTROL "ctrl-sequence" "ctrl-sequence" ...
```

In the following example, the control sequence ~017 turns on the compressed printing feature of the current print device:

```
PUT STREAM a CONTROL "~017".
```

The control sequences sent to the output destination do not affect the current line, page counters, and positions maintained within OpenEdge. For more information about the PUT CONTROL statement, see *ABL Reference*.

## Create a printer-control table

It is important to note that control sequences are hardware dependent. Applications with hard-coded printer-control sequences are not easily transportable. You cannot change the print devices that the application accesses without changing the hard-coded printer-control sequences in the application. To bypass this obstacle, create a printer-control table which contains a record for each printer on your system. Each record in the printer-control table must contain a field for the name of the print device and several other fields containing a corresponding set of standard control sequences.

There is no easy way to employ an ABL UPDATE statement to interpret the printer-control sequences and enter them into a printer-control table. For example, the ABL UPDATE statement interprets the octal sequence ~017 as the character string, as shown:

```
[TILDE][ZERO][ONE][SEVEN]
```

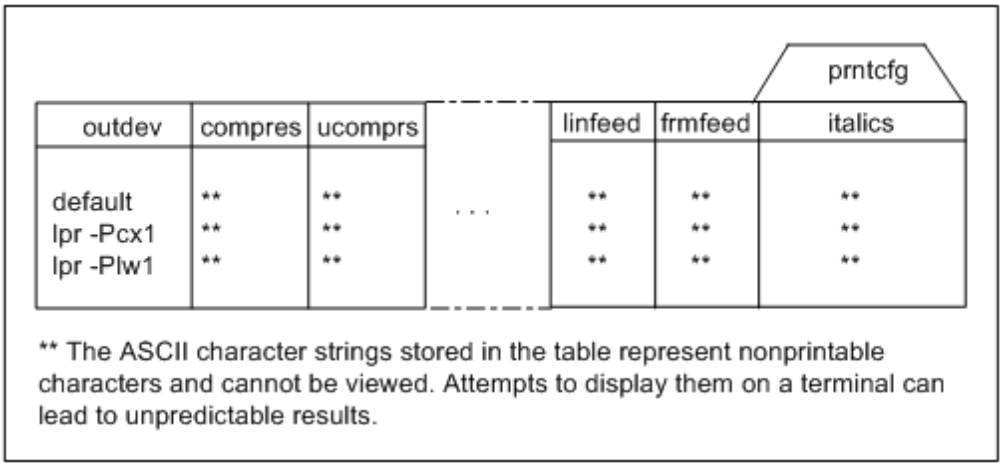
Instead of the proper code sequence:

```
[CONTROL-0]
```

You can create a system administration procedure that lets you convert printer-control sequences into the appropriate ASCII character strings, and store the printer-control sequences as ASCII character strings in the fields of a printer-control table.

Keep the printer-control table up to date with a record for each printer on your system. The following image shows a sample printer-control table.

**Figure 10: Sample printer-control table**



The field containing the print device name must index the table. In this sample control table, the outdev field indexes the table.

To access the proper control sequences for a printer from a printer-control table, set up an include file to determine the print device used in the application, then substitute the corresponding control sequences into the PUT CONTROL statements of the application. For example:

```
FIND Usrprnt WHERE Usrprnt.userid = USERID NO-ERROR.
  IF AVAILABLE Usrprnt
  THEN DO:
    OUTPUT THROUGH VALUE(Usrprnt.outdev).
    FIND Prntcfg WHERE Prntcfg.outdev = Usrprnt.outdev NO-ERROR.
  END.
  ELSE DO:
    OUTPUT TO PRINTER.
    FIND Prntcfg WHERE Prntcfg.outdev = "default".
  END.
```

The include file searches the Usrprnt table to determine the output device (Usrprnt.outdev) for the current user ID. After determining the output device, the include file searches the printer-control table to find the appropriate control sequences for the current printer. Notice that the printer-control table contains a default entry for the default printer.

The PUT CONTROL statements in your application should use a field in the printer-control table or a variable name to access the proper control sequence for the current printer. This allows you to change print devices without recoding the printer-control sequences for all the PUT CONTROL statements in your application. For example:

```
{output2.i}.
PUT CONTROL Prntcfg.compres.
FOR EACH Customer NO-LOCK:
  PUT Customer.CustNum Customer.Name Customer.Address Customer.City     Customer.State
 Customer.PostalCode.
END.
PUT CONTROL Prntcfg.ucomprs.
```

In this procedure, the first PUT CONTROL statement turns on compressed printing, and the second PUT CONTROL statement turns off compressed printing for the current print device.

II

# Deployment considerations

For details, see the following topics:

- Choose a Code Format
- Initial Deployment
- Upgrades
- Deployment Topics and Tasks

# 8

# Choose a Code Format

Choosing a code format is the fundamental decision that you must make about deploying an application. This set of topics describes the three types of code format, the OpenEdge product requirements for those code formats, and the advantages and disadvantages of each format.

For details, see the following topics:

- Unencrypted source
- Encrypted source
- R-code

## Unencrypted source

*Unencrypted source* is uncompiled source that users can read and edit with any standard text editor. Users with full compilation capabilities can read and modify unencrypted source. Thus, when you choose to deploy using unencrypted source, you give users unrestricted access to your application code and application database.

The following sections provide information about the requirements for using unencrypted source, and discuss some advantages and possible disadvantages to deploying unencrypted source.

### Development product requirements for unencrypted source

Developers must be able to repeatedly modify, compile, and test your application to ensure that your application behaves as expected. You must therefore have a full development OpenEdge product on your development platforms. The 4GL Development System, OpenEdge Studio, and Progress Developer Studio for OpenEdge products are all full development products.

## User product requirements for unencrypted source

To read, modify, compile, and execute unencrypted source, the user must have a full development OpenEdge product (that is, the 4GL Development System, OpenEdge Studio, or Progress Developer Studio for OpenEdge). The Query/Results Client product is not a full development product because it can compile only read-only application files (source files that contain no code that modifies the database). Also, products that contain client execution engines—for example, the Database Server or Client Networking products—cannot compile unencrypted source.

## Advantages of unencrypted source

Unencrypted source offers several advantages over other code formats:

- **Application extendability** — Since users have full access to your source code and full compilation capabilities, they can modify your application code any way they want.
- **Less to manage at development site** — Other code formats require you to manage multiple code trees and might require you to keep multiple copies of your application database.
- **Simpler initial deployment** — When you choose unencrypted source, deploying your application is usually easier than with other code formats. Initial Deployment on page 153 describes the steps required for each code format.
- **Simpler upgrades** — When you choose unencrypted source, upgrading your application is usually less complex than with other code formats. Upgrades on page 163 describes the steps required for each code format.
- **Easier maintenance** — Since users have full development environments, it is relatively easy to modify or enhance your application at their sites.
- **Full portability** — Both unencrypted and encrypted source are completely portable across platforms and user interfaces (character mode and GUI), provided you have followed the necessary guidelines for writing portable applications. Note that r-code is not portable across user interfaces.
- **Less space used on storage media** — Unencrypted source files usually occupy much less storage space than r-code files, decreasing their physical media shipment costs. (Encrypted source files also have this advantage over r-code files.)

## Possible drawbacks of unencrypted source

Unencrypted source has several possible drawbacks, including:

- **Does not prevent code modifications** — Users can modify the application source, which can potentially cause difficulty when applying application upgrades.
- **Does not provide application source code protection** — Unencrypted source does not protect your application from the user. Many Independent Software Vendors (ISVs) do not want the user to be able to see their code.
- **Does not prevent database schema modifications** — Many ISVs do not want users to modify their application database. If you deploy using unencrypted source, you lose the ability to prevent unwanted changes. Users can modify your application and application database any way they want.
- **More difficult internationalization** — Only r-code can contain multiple text segments for different spoken languages.
- **More difficult to support** — Users might create bugs when they modify the source code.

# Encrypted source

*Encrypted source* is source code that is encrypted with the XCODE utility (provided with OpenEdge). The user cannot make changes to encrypted source code because it is not readable by the user, so encrypting the source code protects your application.

The following sections provide information about the requirements for using encrypted source and discuss some advantages and possible disadvantages to deploying encrypted source.

More documentation for XCODE can be found in the XCODE utility on page 7.

## Development product requirements for encrypted source

The requirements for encrypted source are the same as for unencrypted source. However, you also need one copy of OpenEdge (which contains the XCODE utility) for the development platform. You do not need a copy of XCODE for the different target platforms.

## User product requirements for encrypted source

Any OpenEdge client, server, or standalone database product can compile and run encrypted source.

## Advantages of encrypted source

Encrypted source code has several possible advantages over other code formats, including:

- **Application protection** — Because encrypted source cannot be read by users, it protects your application from users by preventing them from making changes. Encrypted source shares this advantage with r-code, which also is not user-readable.
- **Less to manage at development site** — Encrypting source code requires storing two code trees: the unencrypted source tree and the encrypted source tree (which must be kept in a parallel directory structure). While this is twice what is required with unencrypted source, it is still less than what is required for r-code.
- **Full portability** — Like unencrypted source, encrypted source is completely portable across platforms and user interfaces (character mode and GUI). However, r-code is not portable across user interfaces.
- **Compile-time flexibility** — Because encrypted code is not precompiled, your application can take advantage of compile-time functionality. For example, you might want to pass arguments to include files to determine sort order, field lists, etc. You can take advantage of this behavior at the user site, allowing users to specify their preferences before compilation. This option is not available with r-code, which you must compile at the development site.
- **Flexible index definitions** — If users have full development OpenEdge products, they can modify their indexes without invalidating your application code (provided that you have not explicitly named indexes in your code). This flexibility is not available with r-code, since r-code that specifically references a new or changed index does not work. Because the index Cyclic Redundancy Check (CRC) value is checked at run time, not all r-code will be affected.
- **Less space used on storage media** — Encrypted source files usually occupy much less storage space than r-code files, making your physical media shipment smaller and less expensive. (Unencrypted source files also have this advantage over r-code files.)
- **Encryption keys** — Encrypted source allows you to specify different encryption keys for different code trees or subsystems within a code tree. Therefore, it is possible to deploy an entire application at once, but only give the user encryption keys for certain parts of the application. This way, you can upgrade the user's application without physically distributing code a second time.

### Possible drawbacks of encrypted source

Encrypted source code has the following possible drawbacks:

- **Does not prevent index modifications** — When compared to r-code, encrypted source is less restrictive because it allows modifications to the database's indexes. Whether this is an advantage or disadvantage depends on whether you want to give the user the flexibility to change indexes. If your code explicitly specifies indexes in its search criteria, user modifications to your indexes might invalidate your code.
- **The Encrypted Compiler Mode (-rx) parameter changes the capabilities of the Compiler** — When you start OpenEdge with the `-rx` parameter, ABL (Advanced Business Language) can compile only encrypted source, not unencrypted source. If users have the 4GL Development System, OpenEdge Studio, or Progress Developer Studio for OpenEdge, they must start OpenEdge again without the `-rx` parameter to write and compile their own procedures.

## R-code

*R-code,* or run-time code, is precompiled code. When you compile a source procedure, ABL places the compiled version of the procedure into a file that has the same name as the source procedure with a `.r` extension. For a complete discussion of r-code, see R-code Features and Functions on page 191.

Like encrypted source, r-code is not readable to the human eye and therefore protects your application from users attempting to make changes.

### Developer product requirements and r-code portability

R-code is portable between any two environments if the following are true:

- The user interface is the same—MS-Windows or character mode.

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**Note:** If a procedure contains no code that writes to the screen, its r-code is portable across user interfaces. For example, this is typical of database schema trigger procedures.

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- The database type (the DataServer or combination of DataServers connected during compilation) is the same.
- The r-code version is the same.

For more details about these requirements and how they affect r-code portability, see R-code Features and Functions on page 191.

### User product requirements

Any OpenEdge client, server, or standalone database product can run r-code.

### Advantages of r-code

R-code provides the following advantages over other code formats:

- **Speed** — This format is faster because the r-code does not have to compile at run time.
- **Application protection** — Like encrypted source, r-code protects your application from possible user changes.

- **Good for internationalization** — R-code is the only code format that can contain multiple text segments. This means that the same application can contain strings for multiple spoken languages (French and German, for example).
- **Prevents database modifications** — CRC-based r-code is more tightly coupled to the database than encrypted or unencrypted source. For each table in the database, ABL calculates a CRC value that represents the structure of the table. A CRC value ensures that the tables in the database match those in the r-code. However, a CRC value is not specific to a particular database.

  You can further restrict access to your application database with the DBRSTRCT utility. This procedure restricts everyone's access to the database, including your own. After you run this procedure, no one can write or compile code that updates the database or changes the database's schema. The only code that can access the database is r-code that you compiled before running the DBRSTRCT utility. This level of database protection is available only with r-code. For more information about the DBRSTRCT utility, see Deployment Topics and Tasks on page 171.

## Possible drawbacks of r-code

R-code has the following possible drawbacks:

- **Limited portability across user interfaces** — Developer product requirements and r-code portability on page 150 describes the limitations of r-code portability. Depending on the number of incompatible environments requiring a separate compilation, you might have to keep track of multiple r-code trees.
- **Loss of compile-time flexibility** — Because you deliver your application in a precompiled format, you cannot make use of compile-time functionality. For example, you cannot pass arguments to include files to determine sort order, field lists, etc. Users therefore cannot specify their preferences before compilation.
- **More to manage at the development site** — R-code's limited portability often requires you to manage multiple code trees for a single version of a single application. As you modify or fix your application and create new versions, the number of code trees can become quite large.

  R-code is also tightly coupled with the application database. This tight coupling requires you to keep a copy of all of your application databases that have different CRC values. After numerous upgrades and fixes, the number of databases can grow quite large.

# 9

# Initial Deployment

This set of topics provides an overview of the steps that are required to deploy an OpenEdge application using different code formats. It does not cover every possible contingency, but rather tries to give you a general understanding of the initial deployment process for the different code formats, emphasisizing what to do, rather than how to do it.

These steps are not meant to be performed in a strictly chronological order. More detailed information about particular aspects of deployment is provided in Deployment Topics and Tasks on page 171.

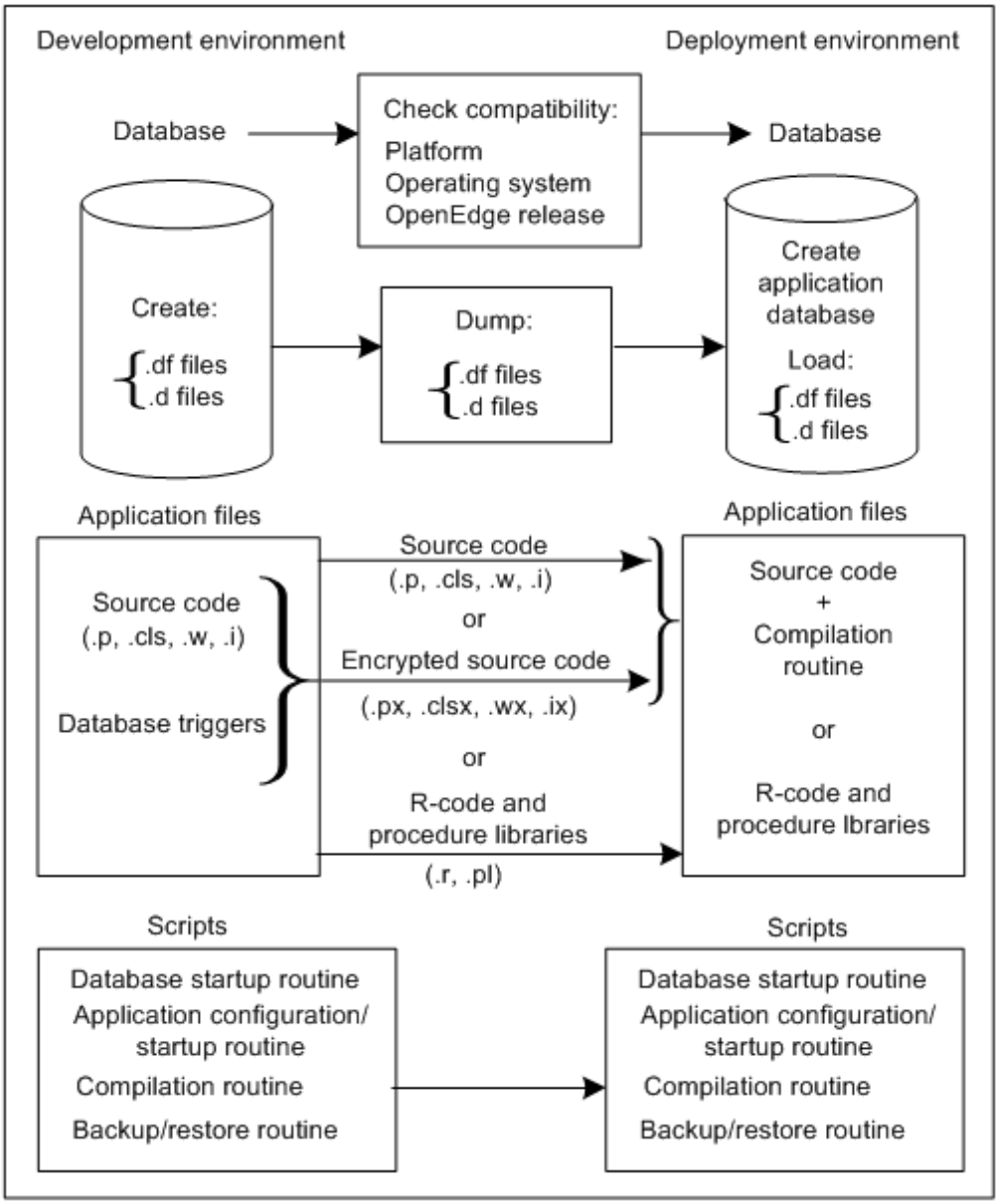
For details, see the following topics:

- Deploy database structures and application files
- Unencrypted source
- Encrypted source
- CRC r-code
- Deploy OpenEdge GUI for .NET applications

# Deploy database structures and application files

The following figure illustrates the steps required and options available when deploying new database structures and application files. When deploying a database, Progress Software Corporation recommends that you first create an empty database at the deployment site, then load the `.df` files to create the database structure. This method of deployment will help you avoid any difficulties resulting from incompatibility between platforms, operating systems, or software versions at the development and deployment sites.

**Figure 11: Deploying database structures and application files**



When deploying application files, you can choose to deploy either unencrypted source code, encrypted source code, or r-code. An important consideration in which method you choose is whether there is a full development product (4GL Development System, OpenEdge Studio, Progress Developer Studio for OpenEdge) capable of compiling code at the deployment site. Users with OpenEdge products that cannot compile unencrypted source code will have to deploy encrypted source code and compile it at the site, or deploy r-code. If you deploy r-code, you must ensure that the platforms, operating systems, and software versions at the deployment site match those at the development site. Otherwise, you will have to compile the r-code at the deployment site to ensure compatibility. The following sections address these considerations in more detail.

## Unencrypted source

This section provides an overview of the steps to follow to deploy an application using unencrypted source when you are done developing and testing your application.

1. **Dump .df and .d files** — You must dump your application schema (.df) and/or data (.d) into ASCII format. This step copies your data from the application database, which is not portable, into a format that is portable.

   **Note:** Keep in mind that the `.d` and `.df` files should be represented with the appropriate code page for the target platform.

2. **Transfer files** — You must transfer the resultant `.d` and `.df` files and your unencrypted source procedures (which also must be in the appropriate code page) to the target platform. This is a preliminary step to creating your distribution media.

   **Note:** There is more than one way to transfer files. For example, you can use FTP or other protocols, or you can put the files on CD or other storage media and physically transport the files.

3. **Rebuild the application database at the user site** — You must provide a way for users to build the application database at their site. To do this, the users must be able to load your .df and .d files into an empty database.

   Because you are deploying unencrypted source, users must have a full development product. These products contain a complete Data Dictionary, which users can use to load the `.df` and `.d` files into an empty database. (In character environments, the Data Dictionary contains data administration capabilities. In Windows, these capabilities are provided with the Data Administration tool.)

   However, even though the user can perform these tasks, usually it is a good idea to write a script that automates this process. This not only frees the user from performing this task, but also makes your application easier to install. A full development OpenEdge product includes all of the Data Dictionary procedures in the *`install-dir/gui`*|*`tty`* subdirectories. The procedures that load data definitions and data are called `load_df.p` and `load_d.p` respectively. Within your script, you can start OpenEdge and run these procedures to load your data definitions and data.

   If you decide not to write a script and instead rely on the users' ability to load the data definitions and data, make sure you provide the users with adequate documentation to guide them through the process.

4. **Copy an empty database and rename it** — To rebuild your application database at the user's site, you must make a copy of the empty database and rename it. An empty database is included in the installation directory at the user's site. Because databases are not portable, you must use an empty database that already is ported to the target platform.

Users can copy their empty database and rename it, or you can write a script that does this task for them. This script can call the PRODB command to make a copy of the database and rename it appropriately. OpenEdge also provides a newdb script that creates a database. For more information about this script, see Deployment Utilities and Scripts on page 219.

If you decide to let the users perform this step, you must provide adequate documentation to guide them through the process.

5. **Provide an install utility** — You must provide a way for users to install your application. OpenEdge must be installed before they can use your application. You can create one install for both OpenEdge and your application. To do this, create an install program using a third-party tool, such as Installshield, and call the OpenEdge Install batch mode from within it.
6. **Provide a compilation routine** — This step is optional because users must have a full development product, which can compile your application on the fly. However, an application that is precompiled runs faster than an application that is compiled at run time. Therefore, you might want to provide a routine that compiles all of your procedures before it is run.

   You can provide a script to do the compilations, or you can provide the user with adequate documentation to do this task on their own. OpenEdge provides a template procedure, `compile.p`, that you can use to compile your application.
7. **Provide a startup routine** — Provide a way for users to start the application. You can either write a script to do this or provide adequate documentation.
8. **Provide documentation** — You must provide users with enough documentation to use your application and to complete the previous tasks if you do not automate them.
9. **Provide online help** — You might want to provide online help for your application.
10. **Prepare distribution media** — You must prepare your distribution media. It should include all:

    - Procedures and include files
    - `.df` and `.d` files
    - Scripts
    - Bitmap files, if any
    - DLLs, if deploying in MS-Windows
    - Help files
    - Online documentation

    Now you are ready to deploy your application.

# Encrypted source

This section provides an overview of the steps to follow to deploy an application using encrypted source when you are done developing and testing your application.

1. **Encrypt your procedures and include files** — Before you can deploy your application, you must encrypt all of your procedures and include files with the XCODE utility. For more information about how to do this, see Encrypt source code procedures on page 171 in in Deployment Topics and Tasks on page 171. Before encrypting the files, make sure they are represented with the appropriate code page for the target platform.
2. **Dump .df and .d files** — As with unencrypted source, you must dump your application schema (`.df`) and/or data (`.d`) files into ASCII format. This step copies your data from the application database, which is not portable, into a format that is portable. You do not have to encrypt your `.df` and `.d` files.

   Like your procedure files and include files, the `.d` and `.df` files must be represented with the appropriate code page for the target platform.
3. **Transfer text files** — You must transfer the resultant `.d` and `.df` files to the target platform. This is a preliminary step to creating your distribution media.

   There is more than one way to transfer files. For example, you can use FTP or other protocols, or you can put the files on CD or other storage media and physically transport the files.
4. **Transfer binary files (encrypted files)** — After you encrypt procedures and include files, they become binary files.
5. **Rebuild the application database at the user site** — You must provide a way for users to build the application database at their site. To do this, users must be able to load your `.df` and `.d` files into an empty database.

   Any OpenEdge client, server, or stand-alone database product can compile and run encrypted source. However, only those products that can fully compile can load `.d` files into a database. The 4GL Development System, OpenEdge Studio, and Progress Developer Studio for OpenEdge are the only products with this capability.

   If you deploy to users whose licensed products do not have this capability, you must provide a way for them to load your `.d` files. For more information about providing a dump/load facility for users, see Dump and load on page 179.

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**Note:** The dump/load procedures should be considered part of your application. The decision to distribute encrypted source versions of your application procedures applies to the dump/load procedures as well.

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A full development product contains a complete Data Dictionary, which users can use to load the `.df` and `.d` files into an empty database. (In character environments, the Data Dictionary contains data administration capabilities. In Windows, these capabilities are provided with the Data Administration tool. Progress Developer Studio for OpenEdge provides the Database Navigator.) However, even though the user can perform these tasks, usually it is a good idea to write a script that automates this process. This not only frees the user from performing this task, but also makes your application easier to use.

Within your script, you can use pre-existing procedures in the *`install-dir`*/tty and *`install-dir`*/gui directories (installed for full development OpenEdge products). Within these directories are procedures that load `.df` and `.d` files, called load_df.p and load_d.p, respectively. Your script can start OpenEdge and run these procedures to load your data definitions and data. To run these procedures at the user site in the case where users do not have a license for a full development product, the procedures must be encrypted or in r-code format. This step is necessary because OpenEdge must be started with the `-rx` parameter to run or compile the procedures where users do not have a license. When started with this startup parameter, OpenEdge cannot run or compile unencrypted source.

If you decide not to write a script and instead rely on the users' ability to load the data definitions and data, make sure you provide adequate documentation to guide them through the process.

6. **Copy an empty database and rename it** — To rebuild your application database at the user's site, you must make a copy of the empty database and rename it. An empty database is included in the installation directory of all OpenEdge client, server, or stand-alone database products. Because databases are not portable, you must use an empty database that already is ported to the target platform.

   Users can use OpenEdge to copy the empty database and rename it, or you can write a script that does this task for them. This script can call the PRODB command to make a copy of the database and rename it appropriately. OpenEdge also provides a newdb script that creates a database.

   If users have an OpenEdge product that provide these capabilities, and you decide to let them perform this step, you must provide them with adequate documentation to guide them through the process.

7. **Provide an install utility** — You must provide a way for users to install your application. However, OpenEdge must be installed before they can use your application. You can create one install for both OpenEdge and your application. To do this, create an install program using a third-party tool, such as Installshield, and call the OpenEdge Install batch mode from within it.

8. **Provide a compilation routine** — When you deploy with encrypted source, you typically provide a compilation routine. Though this is not necessary in all cases, it is usually a good idea because it frees the user from performing the task of compiling your application. In the case where you specify unique encryption keys, providing a compilation routine becomes a necessity.

   All OpenEdge client, server, and stand-alone database products can compile encrypted source. Therefore, if you use the default encryption key, users can compile your application without a specialized routine. However, if you have users compile your application, you must provide adequate documentation to guide them through the process.

   Because encrypted code is not precompiled, your application can take advantage of compile-time functionality. For example, you might want to pass arguments to include files to determine sort order, field lists, and so on. You can take advantage of this behavior at the user site, allowing users to specify their preferences before compilation. This option is not available with r-code, which must be compiled at the development site. Whether you can repeatedly take advantage of compile-time features during the ordinary day-to-day operation of your application depends on what OpenEdge products the users have.

   To compile encrypted source code, OpenEdge must be started with the `-rx` startup parameter. When an OpenEdge session is running with this startup parameter, ABL (Advanced Business Language) can compile encrypted source but cannot compile unencrypted source. If users have a full development product, they will probably want to write and compile their own unencrypted procedures. Thus, in their day-to-day operation of OpenEdge, they must run OpenEdge **without** the `-rx` startup parameter. For users with full development products, therefore, you probably want to perform a one-time compilation with the `-rx` parameter, then restart OpenEdge without this parameter. For users with OpenEdge products that cannot compile ordinary unencrypted source, running permanently with the `-rx` parameter is not an issue.

   OpenEdge provides a template procedure, `compile.p`, that you can use to compile your application. For more information about `compile.p`, see Compilation on page 173.

9. **Provide a startup routine** — You must provide a way for users to start the application. You can either write a script to do this or provide adequate documentation.

10. **Provide documentation** — You must provide users with enough documentation to use your application and to perform the previous tasks if you do not automate them.

11. **Provide online help** — You might want to provide online help for your application.

12. **Prepare distribution media** — You must prepare your distribution media. It should include all:

    - Procedures and include files (encrypted)
    - Data definition (`.df`) and data (`.d`) files
    - Scripts

- Bitmap files, if any
- DLLs, if deploying on MS-Windows
- Help files
- Online documentation

Now you are ready to deploy your application.

## CRC r-code

This section provides an overview of the steps to follow to deploy an application using CRC-based r-code when you are done developing and testing your application. For a complete description of CRC-based r-code, see R-code Features and Functions on page 191.

To deploy your application:

1. **Decide whether to restrict database access** — If you deploy your application to users with full development products, they can write their own applications to access the database and modify the database schema. Depending on the nature of your application, you might not want this to happen. To restrict access to the database, you can use the DBRSTRCT utility that comes with OpenEdge. For more information about using this procedure, see Restrict database access on page 181.

   If you decide to restrict access to the database, you must physically deploy a copy of your application database with your application. It is not possible for users to build your database at their site. Because databases are not portable, you must generate a copy of the database for each target platform. Then you must run the DBRSTRCT utility on each platform against all of the databases.

   In general, restricting access to the database makes it more difficult to initially deploy and upgrade applications, but it also helps minimize user-created errors. For each release of the application, the development site must:

   - Generate a database for each platform
   - Compile the application against each database
   - Save copies of each database and each r-code tree

   To update the application, the user must dump the existing database and load the data into a new database that you supply. For users with large mission-critical databases, this might be an unacceptable requirement.

2. **Compile your procedures and include files** — As described in Choose a Code Format on page 147 r-code is not completely portable. For each combination of factors requiring a separate compilation, you need to perform a separate compilation and keep track of a different code tree at the development site. For each combination, you also need a full development OpenEdge product to do the compilations.
3. **Dump .df and .d files** — If you decide not to restrict database access, you should dump your application schema (`.df`) and/or data (`.d`) files into ASCII format. This step copies your data from the application database, which is not portable, into a format that is portable. The `.d` and `.df` files should be represented with the appropriate code page for the target platform.
4. **Transfer text files** — You must transfer the resultant `.d` and `.df` files to the target platform.

   There are several ways to transfer files. For example, you can use FTP or other protocols, or you can put the files on CD or other storage media and physically transport the files.

5. **Transfer r-code files** — To aid in moving r-code files between platforms, you can use the BUNDLE utility. For more information about the BUNDLE utility, see Deployment Topics and Tasks on page 171.

6. **Rebuild the application database at the user site** — If you have decided not to restrict access to the database, then you must provide a way for users to rebuild your application database at their site. To do this, users must be able to load your `.df` and `.d` files into an empty database.

   ---

   **Note:** You can restrict access to the database and provide compiled code to load `.d` files.

   ---

   Any OpenEdge client, server, or stand-alone database product can run r-code. However, not all of these products can load `.d` files into a database. Full development products are the only products that have this capability.

   If you deploy to users whose licensed products do not have this capability, you must provide a way for them to load your `.d` files. For more information about providing a dump/load facility for users, see Dump and load on page 179.

   ---

   **Note:** The dump/load procedures should be considered part of your application. The decision to distribute r-code versions of your application procedures applies to the dump/load procedures as well.

   ---

   Full development products contain a complete Data Dictionary, which users can use to load the `.df` and `.d` files into an empty database. (In character environments, the Data Dictionary contains data administration capabilities. In Windows, these capabilities are provided with the Data Administration tool. Progress Developer Studio for OpenEdge provides the Database Navigator.) However, even though the user can perform these tasks, usually it is a good idea to write a script that automates this process. This not only frees the user from performing this task, but also makes your application easier to use.

   Within your script, you can use pre-existing procedures in the *`install-dir`*`/tty` and *`install-dir`*`/gui` directories (installed for full development OpenEdge products). Within these directories are procedures that load `.df` and `.d` files, called `load_df.p` and `load_d.p`, respectively. Your script can start OpenEdge and run these procedures to load your data definitions and data. To run these procedures at user sites where users do not have a license for the 4GL Development System or OpenEdge, the procedures must be in r-code format.

   If you decide not to write a script and instead rely on the users' ability to load the data definitions and data, make sure you provide adequate documentation to guide them through the process.

7. **Copy an empty database and rename it** — To rebuild your application database at the user's site, you must make a copy of the empty database and rename it. An empty database is included in the installation directory of all OpenEdge client, server, or stand-alone database products. Because databases are not portable, you must use an empty database that already is ported to the target platform.

   Users can use OpenEdge to copy the empty database and rename it, or you can free them from this responsibility by writing a script that does this task for them. This script can call the PRODB command to make a copy of the database and rename it appropriately. OpenEdge also provides a newdb script that creates a database.

   If users have an OpenEdge product that provide these capabilities, and you decide to let them perform this step, you must provide adequate documentation to guide them through the process. For example, you should let them know there are multiple empty databases, and you should recommend which one they should use.

8. **Provide an install utility** — You must provide a way for the user to install your application. OpenEdge must be installed before they can use your application. You can create one install for both OpenEdge and your application. To do this, create an install program using a third-party tool, such as Installshield, and call the OpenEdge Install batch mode from within it.
9. **Provide a startup routine** — You must provide a way for the user to start the application. You can write a script to do this or provide adequate documentation.

10. **Provide documentation** — You must provide the user with enough documentation to use your application and to perform the previous tasks if you do not automate them.
11. **Provide online help** — You might want to provide online help for your application.
12. **Prepare distribution media** — You must prepare your distribution media. It should include all:
    - Compiled procedures
    - Application procedures
    - Dump and load procedures
    - Data definition (`.df`) and data (`.d`) files
    - Scripts and bitmap files, if any
    - DLLs, if deploying in MS-Windows.
    - Help files
    - Online documentation

# Deploy OpenEdge GUI for .NET applications

This section discusses the extra considerations for deploying an OpenEdge GUI for .NET application. In general, you perform the same tasks in the same order and have the same options for the kind of source code you deploy. The .NET portion of a GUI for .NET application requires additional configuration files and directory structures.

## Install .NET Framework

Any client machine running the GUI for .NET requires .NET Framework 3.0 or later. When deploying a GUI for .NET application, you must check for an appropriate version and install the framework if necessary. The OpenEdge installer has an option to install .NET Framework 3.0 if it is missing. If you create your own custom installation package for a GUI for .NET application, it must check for and, if necessary, install an appropriate version of the framework before it installs OpenEdge.

---

**Note:** Microsoft requires users to accept an EULA before installing the .NET Framework. The Microsoft EULA appears during the OpenEdge installation if the framework is installed. This prevents silent installs on client machines that do not already have an appropriate version of the framework.

---

If your application makes extensive use of the GUI for .NET, consider using the Preload CLR (`-preloadCLR`) startup parameter to force the .NET CLR and any specified assemblies to load at startup. For more information on `-preloadCLR`, see *Startup Command and Parameter Reference*.

## Create an assemblies directory

An *assembly* is a .NET library or collection of classes. By default, .NET would look for all assemblies used by a GUI for .NET application in the `OpenEdge-install-dir/bin` directory. However, your applications should not install files in the `OpenEdge-install-dir/bin` directory.

Instead, GUI for .NET applications have an assemblies directory that contains the assemblies and the related configuration files. By default, the assemblies directory is the session's working directory. However, you can use the Assemblies (`-assemblies`) startup parameter to specify a different assemblies directory. For more information on `-assemblies`, see *Startup Command and Parameter Reference*.

## Deploy application source code

As in other ABL applications, your OpenEdge session uses the PROPATH to look for the ABL source code for a GUI for .NET application. A GUI for .NET application includes additional types of configuration and source code files to support the .NET controls. OpenEdge looks for these files in the assemblies directory.

The additional source code files include:

- **OpenEdge internal assemblies** — OpenEdge uses several assemblies to connect the ABL and .NET sides of the application. OpenEdge installs these assemblies in the `OpenEdge-install-dir/bin` directory.
- **OpenEdge Ultra Controls for .NET** — The GUI for .NET includes support for a set of .NET controls. The Ultra Controls are licensed separately for development environments. However, OpenEdge deployment products install assemblies containing run-time versions of these controls that do not require a separate license. OpenEdge installs these assemblies in the `OpenEdge-install-dir/bin` directory and looks for them there.
- **ABL controls derived from .NET controls** — OpenEdge handles an ABL class that inherits from a .NET class in the same way as every other ABL class. The application PROPATH must contain the class file or its r-code (`.r` or `.pl`).
- **Application-specific assemblies** — Application-specific assemblies might include third-party controls or your own custom .NET assemblies. You can install these assemblies in the .NET Global Assembly Cache (GAC) or in the application's assemblies directory.
- **.NET Resource Files** — Some .NET controls require resource files (`.resx`) to operate. Deploy resource files to the same directory as the assemblies containing the controls that require the resource file.
- **.NET Icons and Bitmaps** — If a .NET control uses .NET icons (`.ico`) and bitmaps (`.bmp`), the icons and bitmaps generally should be in the same directory as the code for the controls that use them.

The additional configuration files include:

- **Assembly References file** — The Assembly References file (`assemblies.xml`) lists all the assemblies used by a GUI for .NET application. You must deploy this file in the application's assemblies directory. For more information on `assemblies.xml`, see .NET Framework on page 83.
- **Assemblies Application Configuration file** — An Assemblies Application Configuration file (`assemblies.config`) is a means to alter how specific assemblies are loaded in exceptional situations. You must deploy this file in the application's assemblies directory. For more information on `assemblies.config`, see .NET assemblies on page 83.
- **Application Configuration file** — OpenEdge might require an Application Configuration file (`prowin32.exe.config`) to configure its internal assemblies. If one is needed, OpenEdge provides the file and installs it in `OpenEdge-install-dir/bin`.

---

**Note:** You should never use or modify this file directly.

---

# 10

# Upgrades

After you distribute your application and users have been using it, you might want to upgrade, fix, or modify either the application procedures or the application database. It is a good idea to develop a strategy for dealing with application upgrades before distributing an application. That way, when you have to upgrade an application, you are less likely to have unexpected problems.

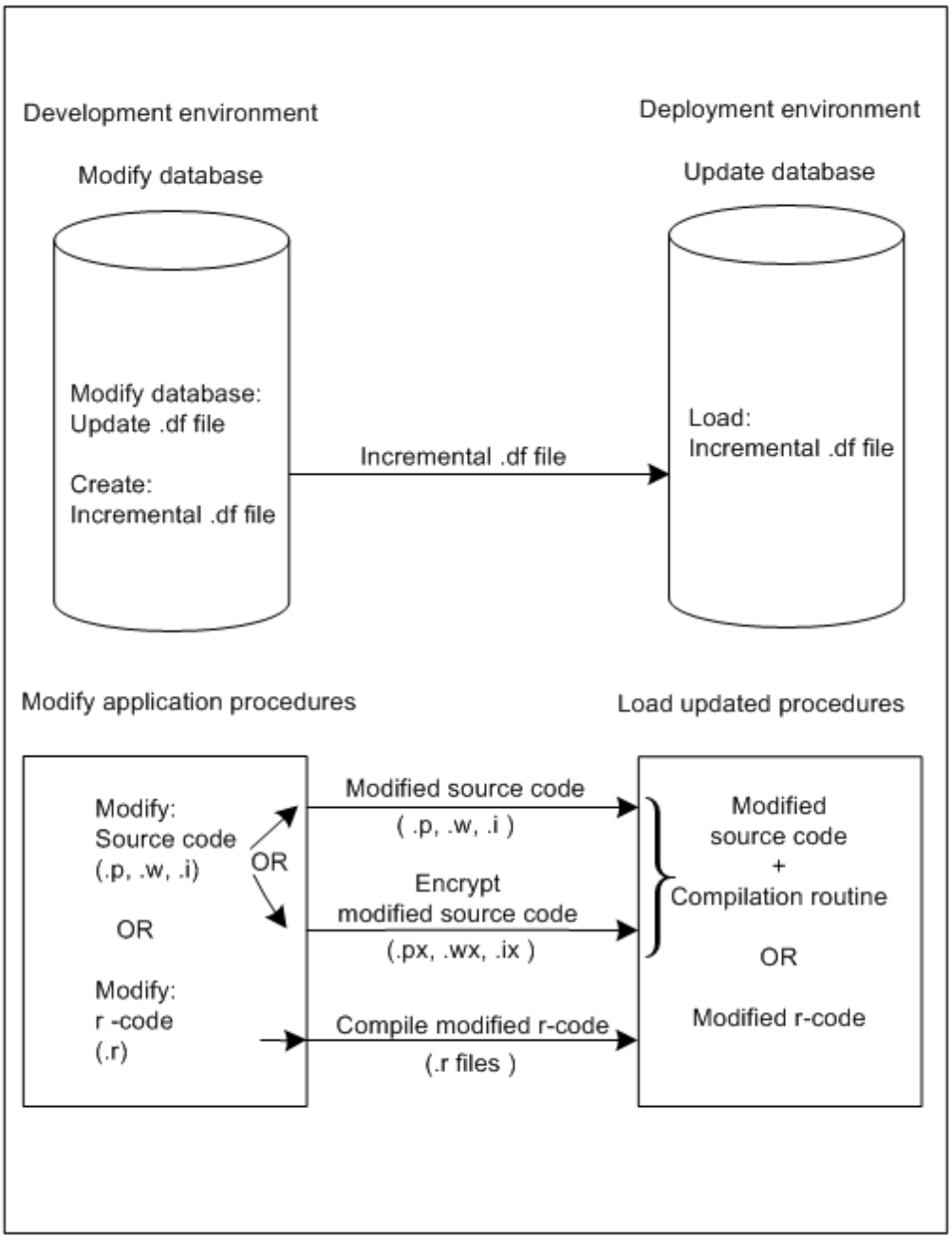
For details, see the following topics:

- Deploy upgrades
- Modify the application procedures
- Modify the application database

# Deploy upgrades

The following image illustrates the steps needed and options available when upgrading and distributing changes to the database structure or application procedures. When making changes to the database structure, you must create an incremental `.df` file that contains the changes in the database structure. You can then load this `.df` file into the existing database structure to update that database. For information on creating an incremental ABL (Advanced Business Language) `.df` file, see *Manage the OpenEdge Database*. See R-code Features and Functions on page 191 for more information about deploying changes to database structures.

**Figure 12: Deploying upgraded database structure and application procedures**



When modifying application procedures, you can choose to deploy either unencrypted or encrypted source code, or to deploy modified r-code. An important consideration for which method you choose is whether there is a full development product (4GL Development System, OpenEdge Studio, and Progress Developer Studio for OpenEdge) capable of compiling code at the deployment site. When deploying to users with OpenEdge products that cannot compile unencrypted source code, developers will have to deploy encrypted source code and compile it at the site, or deploy r-code. If you deploy r-code, you must ensure that the platforms, operating systems, and software versions at the deployment site match those at the development site. Otherwise, you will have to compile the r-code at the deployment site to ensure compatibility.

Modifying an application is relatively straightforward if you have not made changes to the database schema. If you have made changes to the database schema, modifying the application requires more steps.

# Modify the application procedures

As with any distribution, you can choose to distribute unencrypted source, encrypted source, or r-code. This section describes upgrading an application without any modifications to the database. If you have modified the database schema, upgrading becomes more complicated, as described in Modify the application database on page 165.

## Unencrypted source

To upgrade your application, distribute the modified versions of your procedures.

## Encrypted source files

To upgrade your application, distribute the modified versions of your procedures. If you specify an encryption key, you must also provide a compilation procedure.

As described in Initial Deployment on page 153 when you deploy with encrypted source, you usually want to provide a compilation procedure. Although this is not necessary in all cases, it is a good idea because it frees the user from having to compile your application. When you specify unique encryption keys, providing a compilation routine is a necessity.

All OpenEdge client, server, and stand-alone database products can compile encrypted source. Therefore, if you use the default encryption key, the user can compile your application without a specialized procedure. However, if you have the user compile your application without a script, you must provide adequate documentation to guide them through the process.

## CRC-based r-code

If you supply new or modified CRC-based r-code files, you must precompile the procedures against a version of the database that is structurally the same as the user's database. You must also compile it on a machine of the same class, same user interface, and same combinations of DataServers (if any). It does not matter when the database tables were created or modified.

# Modify the application database

Upgrading is more complicated when you have to change the database schema. If you are upgrading with unencrypted source, encrypted source, or CRC-based r-code, you can supply an incremental `.df` file and copies of the modified procedures.

## Upgrade with updated .df and encrypted source

When you update a database structure in the development environment, you must then re-create these changes in the database that is already established at the deployment site. To accomplish this transfer, an incremental `.df` file is generated in the development environment. Copies of the original and updated databases are compared, and the differences between them are incorporated into an incremental `.df` file. For more information on creating an incremental ABL data definitions file see *Manage the OpenEdge Database*.

The following general steps tell you how to prepare a `.df` file that includes new or modified data definitions:

- Obtain copies of the current user database and the new modified database.
- Connect the two databases.
- Compare the data definitions in the user database with the data definitions of your new updated database, creating a new incremental `.df` file that reflects the changes.
- Provide a utility for users that loads the incremental `.df` file into the existing database.
- Encrypt the procedures affected by changed data definitions.

To prepare a data definitions file:

1. In Windows, open the **Data Administration** Tool (for character interfaces, open the **Data Dictionary**).
2. Connect the two databases by choosing **Database** > **Connect**.
3. Select the database that includes the new, modified data definitions as your current database by choosing **Database** > **Select Working Database**.
4. Create an incremental definition file by choosing **Admin** > **Dump Data and Definitions** > **Create Incremental .df File**.

   This option compares the data definitions in the non-empty copy to the current database schema and creates a new data definition (`.df`) file. The new `.df` file contains a record for each difference between the two schemas. The differences include any added, renamed, changed, or deleted file, field, or index.

   If a file, field, or index exists in the old database but not in the new schema, OpenEdge asks you whether the object has been renamed. If you respond `no`, a record appears in the new `.df` file marking the object as deleted.

   If the new schema includes a new unique active index, OpenEdge asks you whether you want to deactivate it. If you do not deactivate the index, and there are duplicate keys in the old database, OpenEdge aborts your attempt to load new definitions into the old database. If you deactivate the index, the load procedure defines the new index, but does not create the index file. You must build and activate the index after loading the new data definitions.

5. Perform steps a through d below for testing purposes. Then prepare a tool for users that performs these steps on site:

   a) Select the copy of the old database as your working database.

   b) Load the updated data definitions by choosing **Admin** > **Load Data and Definitions** > **Load Data Definitions (.df file)**.

   c) If you deactivated any indexes in Step 3, re-create data in the indexed fields as required to avoid duplicate keys. Then reactivate the indexes with `PROUTIL IDXBUILD`. For more information, see *Manage the OpenEdge Database*.

   d) OpenEdge now updates the old database schema to match the modified schema. Compile and test all your procedures against the updated database.

**Note:** The `upgrade` template provided with OpenEdge outlines one way to do this. Before you can use this template, you probably need to modify it. See Use the upgrade template on page 167.

6. Test your procedures.
7. Use the XCODE utility to encrypt procedures invalidated by the new data definitions.

   Since the new `.df` file changes CRC check sums and time-stamps only on the database tables that are actually modified, you only have to encrypt and ship the source versions of those procedures that access the changed tables. (If you compile your procedures with the XREF option, you get a listing of the tables accessed by each procedure.)

## Use the upgrade template

The `upgrade` template, all `.p` files it uses, and all `.inp` files it uses are only templates; you must check each file and modify it to suit your particular application. Following is a list of checks and modifications you must make before using `upgrade`; your application might require additional changes.

The UNIX version of `upgrade` is found in *`/install-dir`*`/toolkit/samples/unix`. The DOS version is located in *`/install-dir`*`/toolkit/samples/dos`. The files that `upgrade` uses can be found in *`/install-dir`*`/toolkit/samples`.

The `upgrade` template performs three basic actions to upgrade an application at the user's site:

1. Loads the new `.df` file, which you created from your version of the upgraded database with the **Admin** > **Dump Data and Definitions** > **Create Incremental .df File option**
2. Rebuilds any indexes deactivated during the data definition load process
3. Compiles encrypted source procedures

   The changes to the `upgrade` template for the data definition load stage (Step 1) include modifying `upgrade.p` (not the upgrade template) and the files it uses:

   - Set the system administrator ID and password appropriately in `loginupg.p` (or prepare a tool your users can use to set them).
   - Modify `upgrade.inp` to name the new `.df` file.
   - Test `load_df.p` (a standard OpenEdge Dictionary procedure). If you created a new unique active index, `load_df.p` asks if you want to deactivate the index. You need to add a response (`Y` or `N`) to `upgrade.inp`.
   - If you and your users do not freeze the database files, delete the call to `freeze.p`. (Leave the call to `unfreeze.p` in case your users ever freeze the database files without your knowledge.)
   - Modify `unfreeze.p` and `freeze.p` to include the correct filenames.
   - Check `upgrade.log` for any problems.

   The changes to the `upgrade` template for the rebuild deactivated indexes stage (Step 2) are:

   - If you and your users will not be deactivating indexes, remove the `_proutil` command line from `upgrade`.
   - If you added a new unique active index, modify `rebuild.inp` to include the correct responses to prompts by `_proutil $1 -C idxbuild`. That is, test `_proutil idxbuild` on your database and add a line to `rebuild.inp` to answer each question appropriately.
   - Check `rebuild.log` for problems.

- You might want to add a procedure to `upgrade` that checks `rebuild.log` and, if necessary, fixes duplicate key data and rebuilds the index again. Alternatively, you might want to check the `.log` file and just stop before compilation proceeds.

The changes to `upgrade` template for the compile encrypted procedures stage (Step 3) are:

- Modify `compile.inp` to name the procedures to be compiled.
- Modify the `COMPILE` statement in `compile.p` to use the encryption key you want.
- Prepare to ship `compile.p`: either encrypt `compile.p`, possibly with the default key, or compile `compile.p`, thereby hiding your encryption key in the `.r` file. If you ship `compile.r`, it must be compiled on the target machine type. It can be compiled against any database because it does not reference any database files. The `upgrade` template is relevant when you want to distribute only new data definitions and encrypted versions of affected application procedures. However, you might choose to ship a complete new version of the database and application instead, as described in the following section.

## Upgrade with updated .df and CRC-based r-code

The flexibility of CRC-based r-code makes it easy to distribute a new release of an existing application.

To distribute a new release of an existing application:

1. Create an incremental `.df` file of your application database using the **Data Administration** tool (for graphical environments) or the **Data Dictionary**'s **Admin** submenu (for character environments). For more information on creating an incremental `.df` file, see *Manage the OpenEdge Database*.
2. Recompile source files that were affected by the new schema changes.
3. Send the `.df` file and copies of the new r-code files that were affected by the schema changes to your users. After the users load the incremental `.df` file, they can immediately run your new `.r` code.

   Essentially, the steps you take are the same as when you use encrypted source, but you gain the following advantages:

   - You do not have to encrypt your procedures. However, you need to recompile some r-code.
   - The user does not have to compile your procedures.

   One possible disadvantage of using CRC-based r-code is that a user with the 4GL Development System, OpenEdge Studio, and Progress Developer Studio for OpenEdge can create a counterfeit database (a database with the same structure as your application database). The user can then write, compile, and run it against your application database.

   If this concerns you, you can either turn on run-time permission checking or use the PROUTIL utility's `DBAUTHKEY` qualifier. For details on how to turn on run-time permission checking, see Maintain Application Security on page 41.

   The PROUTIL utility's `DBAUTHKEY` qualifier enables you to set an authorization key for your database. When compiling a procedure, OpenEdge includes the value of this key in your r-code. CRC-based r-code that does not include the correct authorization key will not run against your database. You can insert the authorization key into existing CRC-based r-code with the PROUTIL utility's `RCODEKEY` qualifier. For more information on the PROUTIL utility's `DBAUTHKEY` and `RCODEKEY` qualifiers, see *Manage the OpenEdge Database*.

## OpenEdge product upgrades

The user might upgrade from an OpenEdge product that does not support full development to either the 4GL Development System, OpenEdge Studio, or Progress Developer Studio for OpenEdge.

To allow the users of a previously restricted application database to run your application using the capabilities of their new, less restrictive version of OpenEdge:

1. Create a new basic database.
2. Distribute the new basic database to the user.

   The user must use the dump/load facility you provided to dump the existing database, make a copy of the new basic database, and reload the existing data into that new database.

   If the new version of OpenEdge is being installed in a different directory than the old version, UNIX users can use the `_tlr` module to edit the value of the `DLC` variable in your application scripts.

# 11

# Deployment Topics and Tasks

This set of topics describes issues related to deploying OpenEdge application.

For details, see the following topics:

- Encrypt source code procedures
- Use the BUNDLE utility
- Dump and load
- Restrict database access

## Encrypt source code procedures

This section describes the XCODE utility and the process of encrypting source code before deploying an application.

### XCODE utility

Use the XCODE utility to encrypt ABL (Advanced Business Language) procedures and include files. This is the syntax:

**Syntax (UNIX)**

```
xcode [ -k key] -d directory[files][ - ]
```

*key*

A character string up to eight characters long. On UNIX, *key* is case sensitive. If you do not specify *key*, XCODE uses a default key. When OpenEdge is started with the Encrypted Compiler Mode (-rx) startup parameter, ABL automatically uses this default key, unless you specify the XCODE option on the COMILE statement or set the XCODE-SESSION-KEY attribute on the SESSION-POLICY handle. (The XCODE option takes precedence over the XCODE-SESSION-KEY attribute if both are in effect for a compile operation.

The XCODE utility uses the default codepage of the operating system where it runs. To avoid possible conflicts from automatic codepage conversions, key values should use only US-ASCII characters. These characters are included in all codepages and can be located below code point 128 in the codepage.

Note that keys longer than eight characters do not generate warning or compile errors. Both the XCODE utility and the COMPILE statement ignore extra characters if present.

*directory*

The directory where XCODE places the encrypted files. The specified directory must be different from the source directory, because each encrypted file retains the name of its original source file. XCODE overwrites existing files in directory if they are encrypted.

*files*

The pathnames, relative to the current directory, of the files you want to encrypt. XCODE appends the pathnames supplied to *directory*.

## Prepare to use XCODE

Before running XCODE, create a directory structure exactly parallel to your source directory structure, then move to the root of the original source directory structure. Supply the root of the new structure as *directory*, and then supply the pathnames, relative to the current directory, of the files to be encrypted as *files*. The relative path names are appended to *directory*. Because XCODE does not create new directories, any directories implied by the *directory* or *files* arguments must be created before running XCODE. Encrypted files have the same names as the original source files. You must encrypt both your procedure and include files in order for your encrypted procedures to run.

The dash (-) option tells XCODE to take filenames from the standard input. On UNIX, this allows you pipe output from an ls, cat, or find command to XCODE.

The following shows how you can use XCODE on UNIX. Suppose you have just finished developing and testing the procedures in /usr/test and its four subdirectories and you want to encrypt them for shipment to users.

To encrypt procedures for shipment to users:

1. Create a directory structure parallel to `/usr/test`, as shown:

```
cd /usr/test
mkdir /usr/testx
mkdir /usr/testx/ar
mkdir /usr/testx/fm
mkdir /usr/testx/inv
mkdir /usr/testx/oeFk
```

2. Move to the original development root in preparation for encryption, as shown:

```
cd /usr/test
```

3. Encrypt your procedures, as shown:

```
xcode -k mykey -d usr/testx *.p ar/*.p fm/*.p inv/*.p oe/*.p
```

   Encrypted versions of the source procedures in `/usr/test` and its subdirectories now reside, with the same names, in `/usr/testx` and its subdirectories.

   **Note:** You must also encrypt include (`.i`) files.

## Compilation

If you distribute encrypted source code, you must also prepare and distribute a program that compiles your application procedures at a user site. The core of this program is one or more `COMPILE` statements with the `XCODE` option. If you encrypt your procedures using the default key, the `XCODE` option is unnecessary because the Compiler recognizes that the procedures are encrypted.

The `XCODE` option of the `COMPILE` statement compiles the specified source files, and any encrypted include files, using the same keys supplied in the `XCODE` option.

Alternatively, you can specify a key at the session level. The `XCODE-SESSION-KEY` attribute of the `SECURITY-POLICY` handle, when set, overrides the default key but does not override the `XCODE` option on a `COMPILE` statement.

When started with the Encrypted Compiler (`-rx`) startup parameter, OpenEdge places you (or a user) by default in the Procedure Editor. The `COMPILE` statement and the `icompile.p` procedure will only compile encrypted procedures when OpenEdge is started with `-rx`. When shipping encrypted source code, you must supply either an encrypted `.p` or a `.r` version of your compile program, which can be run in encrypted compiler mode. The OpenEdge installation includes a sample template, called `upgrade`, that invokes OpenEdge with the `-rx` parameter and compiles encrypted source programs.

You invoke the encrypted source code compiler with the command `PROGRESS/XCOMPILER`. See `upgrade.com` in the Toolkit `samples` subdirectory for more information.

After the procedures are compiled, you might want users to delete the source to regain the disk space. If you do this, consider freezing the database files; otherwise, the user can modify the database and invalidate object procedures for which the user no longer has the source.

# Use the BUNDLE utility

The BUNDLE utility lets you put binary files into a file called a bundle, transport the bundle to another machine by one of the standard means, and extract the files from the bundle. The BUNDLE utility is designed for copying encrypted source files and r-code files, but any platform-independent binary file or ASCII file can be copied as well. It is not designed to handle executables, object files, OpenEdge RDBMSs, or other platform-dependent files.

The BUNDLE utility consists of two C language programs: `bundle.c` and `unbundle.c`. These programs are described in the following sections.

## The bundle.c program

The bundle program puts input files into a bundle. This is the command syntax to run it:

**Syntax (UNIX)**

```
bundle [ -ascii | -binary ][ -uppercase | -lowercase ]bundle-file{{ -select
[selection-file]}|input-file}
```

`-ascii | -binary`

Specifies whether the input file is to be read as an ASCII text file or as a binary file. The default is binary.

`-uppercase | -lowercase`

Tells bundle to convert the names of files being bundled to uppercase or lowercase. By default, filenames are used without case conversion.

*`bundle-file`*

Provides the name of the file into which input files are bundled. If the file does not exist, bundle creates it. If it does exist, bundle appends data to the end of it.

`-select` *`selection-file`*

Indicates that the names of the input files are to be read from a selection file. By default, the selection file is read from standard input.

This is the Syntax of *`selection-file`*:

```
filename
[ ascii | binary ]
```

Each entry must be on a line by itself and cannot continue across lines.

If ascii or binary is absent, the command line specification is used. Use an exclamation point ( ! ) or pound sign ( # ) as comment characters. Everything from a comment character to the end of line is ignored. The comment character must be separated from any preceding text by a blank space. Blank lines are also ignored. Wild cards are not supported.This is a sample file:

```
# First line.
# Config files follow.
cfg-show.x   # Depending on command-line, ascii or binary.
cfg-doc.txt  ascii
cfg-make     ascii
# The next line is blank.    # Last line.
```

*input-file*

The name of a single input file. Wild cards are not supported.

## The unbundle.c program

The unbundle program takes files out of a bundle. This is the command syntax to run it:

**Syntax (UNIX)**

```
unbundle [ -toc | -fulltoc | -date | -all ] bundle-file
             [ -select [selection-file ]]
```

-toc | -date | -fulltoc | -all

Indicates the operation to perform. The default, toc, lists a table of contents that shows the name and type (ascii or binary) of each file in the bundle. The fulltoc value lists a table of contents containing toc information, date information, and the input files' file specifications, modify dates, and sizes. The date value lists time stamps showing when bundle was run. The all value unbundles all files in the bundle putting the unbundled files in the current directory.

-select *selection-file*

Allows you to select by name the files to unbundle or to list with toc or fulltoc.

This is the Syntax of *selection-file*:

```
filename
                        [ unbundle-as-file-spec ]
```

The *filename* value names the file to be processed. When you are unbundling, unbundle-as-file-spec specifies the name unbundle is to use as the unbundled filename. Comments and blank lines are permitted as described earlier for the bundle command's *selection-file*. Wild cards are not supported.

If select is specified and no *specification-file* is provided, selections are read from standard input.

The following is a sample file:

```
# UNIX example
# First line.
cfg-show.x   pdir/cfg-show.p
cfg-doc.txt  docdir/cfg-doc.doc
cfg-make     # Created as cfg-make in current directory.
readme.txt   # Created as readme.txt in current dir.
# The next line is blank.

# Last line.
```

## Examples using BUNDLE

The following synopsis shows how to use bundle and unbundle. This section assumes you have to transfer encrypted source files, which are binary files.

First you have to create a "bundle" file. To do this you specify the output file (that is, the bundle) and one or more input files (the encrypted source files). For these examples, the bundle file has a `.bun` extension and the encrypted source files have a `.x` extension. The bundle is created on UNIX, copied to Windows, and unbundled in Windows.

Put a single file named `foo.x` in the bundle, as shown:

```
# bundle xcode.bun foo.x
```

Or, put all encrypted source files in the current directory in the bundle, as shown:

```
# ls *.x | bundle xcode.bun -select
```

Or, put some selected files (this, that, what) in the bundle, as shown:

```
# bundle xcode.bun -select
this.x
that.x
what.x
^D
```

You can also put the selections into a file, as shown:

```
# cat >xcode.sel
this.x
that.x
what.x
^D
# bundle xcode.bun -select xcode.sel
```

Note that files are always appended to the bundle, so you can incrementally add files to it. Thus, the above sequence created `xcode.bun` with this in it: `foo.x`, all xcode files in the current directory, `this.x`, `that.x`, and `what.x`.

Now you need to copy the bundle to some destination. You can use FTP, making sure that binary mode is in effect.

To see what is in the bundle, enter this command:

```
C:> unbundle /toc xcode.bun
```

The unbundle program lists a short table of contents. To see a full table of contents, enter this command:

```
C:> unbundle /fulltoc xcode.bun
```

To unbundle everything in the bundle and put the files in the current directory, enter this command:

```
C:> unbundle /all xcode.bun
```

To unbundle selected files (`this.x` and `that.x`) and put them in specified directories, enter this command:

```
C:> unbundle xcode.bun /select
this.x   usr2:[xcode]this.x
that.x   usr1:[xcode]that.x
^Z
```

You can also put the selections into a file, as shown:

```
C:> create xcode.sel
this.x   usr2:[xcode]this.x
that.x   usr1:[xcode]that.x
^Z
C:> unbundle xcode.bun /select xcode.sel
```

Once you have unbundled the files, they can be executed or compiled in OpenEdge.

Text files can also be bundled. You can specify `-ascii` on the command line, thereby making ascii the default file type; or you can specify ascii after the filename in the selection list, as shown:

```
C:> dir *.p | bundle -ascii pcode.bun
C:> bundle pcode.bun -select
foo.p ascii
^D
C:>
```

Binary and ascii can be mixed in a bundle, as shown:

```
C:> bundle allcode.bun -select
foo.p ascii
foo.x binary
^D
C:>
```

Since bundle always appends files to the end, multiple files with the same name might appear in a bundle, as shown:

```
C:> bundle allcode.bun -select
foo.p ascii
xcode/foo.p binary
^D
C:>
```

In this example, the filename `foo.p` appears twice and represents two different files. When unbundling this (with -all) `foo.p` (ascii) is unbundled first and then `foo.p` (binary) is unbundled overwriting the other `foo.p`. To unbundle both files, use a selection list to give each file a unique name or put each in a different directory, as shown:

```
C:> unbundle allcode.bun -select
foo.p src/foo.p   # This is the ascii foo.p
foo.p xcode/foo.p # This is the binary foo.p
^D
C:>
```

You can also use a selection list to skip over a file by directing it to the null device, as shown in the following UNIX example:

```
$ unbundle allcode.bun -select
foo.p /dev/null
foo.p
^D
$
```

To help differentiate files with identical names, unbundle -full shows files' input file specifications, modify dates, and sizes in bytes; the current directory when the bundle was created; and a time stamp showing when the files were bundled, as shown:

```
$ unbundle mystuff.bun -full
# V0 Time-stamp: Thu Apr 15 19:59:19 1993
# V0 Current-directory: C:\TEMP
 mon03.txt      #ascii
# V0 Input-file: MON03.TXT
# V0 File-modify-time: Thu Apr 15 19:57:12 1993
# V0 File-size: 2503
 mon03.txt      #ascii
# V0 Input-file: ..\WVM\DOC\MON03.TXT
# V0 File-modify-time: Sun Apr 04 18:17:48 1993
# V0 File-size: 2655
# V0 Time-stamp: Thu Apr 15 20:00:23 1993
# V0 Current-directory: C:\TEMP
 mon03.txt      #ascii
# V0 Input-file: mon03.txt
# V0 File-modify-time: Thu Apr 15 20:00:10 1993
# V0 File-size: 2666
$
```

V0 denotes version 0 of the bundle record format. It allows backward compatibility should this format have to be changed. You can use `-select` with `-full` to see information on selected file names.

**Note:** Binary dump and loads are dramatically faster. See the section on PROUTIL in *Manage the OpenEdge Database* for more information on binary dump and load.

# Dump and load

You have to supply a facility to dump and reload the application database. Your users need a dump and reload facility to:

- Convert data to ASCII format for transporting among machines or database products
- Increase index efficiency
- Convert from one version of the software to another

The 4GL Development System, OpenEdge Studio, and Progress Developer Studio for OpenEdge products all provide full dump/load capabilities via either the GUI Data Administration Tool, Character Data Dictionary Tool, or command line PROUTIL utility. For more information about these capabilities, see *Manage the OpenEdge Database*. Other OpenEdge products provide less complete dump/load capabilities. Other OpenEdge products such as Query Results provide less complete dump/load capabilities.

**Note:** Progress Software Corporation recommends you use binary dump and load instead of MKDUMP when moving table contents. Refer to *Manage the OpenEdge Database* for more information about binary dump and load, and loading of sequence values.

The Progress Developer's Toolkit includes sample utilities that you can use to create your own dump/load facility. This section covers these samples and explains how to modify them for your own use.

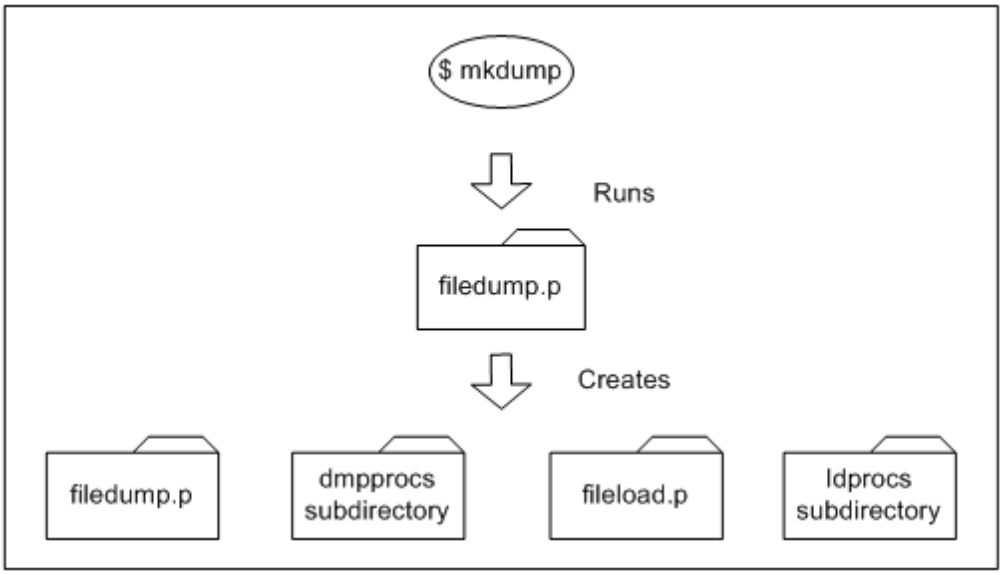
## MKDUMP utility

This sample utility contains a dump/load facility. When you run the MKDUMP utility, it creates two ABL procedures: one that dumps a database and one that reloads a database. For example, you can run MKDUMP to create a dump/reload facility for the sports2020 database, as follows:

```
mkdump sports2020
```

The following image shows the files produced by running MKDUMP.

**Figure 13: Output of mkdump**




The MKDUMP utility runs an ABL procedure, `mkdump.p`, which creates and compiles two other ABL procedures, `filedump.p` and `fileload.p`. The `filedump.p` procedure dumps the files from a database; `fileload.p` loads the files into a database.

In addition, `mkdump.p` creates two directories. The `dmpprocs` subdirectory contains a database dump procedure for each of the files in the database. The `ldprocs` subdirectory contains a database load procedure for each of the files in the database. The `mkdump.p` procedure also precompiles all the procedures it creates. These precompiled procedures may not be appropriate for your use if the deployed database does not have the same name as the original database that MKDUMP was run against.

The MKDUMP utility creates these files and subdirectories in your current working directory. Before distributing them to users, you must move them to your application master directory. You can then supply either the encrypted source or object versions of the `filedump.p` procedure, `fileload.p` procedure, and each of the procedures in the `dmpprocs` and `ldprocs` subdirectories.

You can modify MKDUMP or any of the `mkdump.p`, `filedump.p`, or `fileload.p` procedures as needed. However, once you have created and perhaps modified the dump/load scripts or batch files, be sure to provide a way for users to use these procedures. You should also provide adequate documentation for users to use the facility.

---

**Note:** The dump/load procedures should be considered part of your application. The decision to distribute r-code or encrypted source versions of your application procedures applies to the dump/load procedures as well.

---

## Use your dump/reload facility

To dump and reload a database:

- Use `dumpdb` to dump the current copy of the database.
- Use either `prodb` or `newdb` to make a fresh copy of the basic database.
- Uses `reloaddb` to reload the database.

Before you supply the `filedump.p,fileload.p,` and subdirectories of dump and reload procedures to a user, you must understand the following points:

- The `filedump.p` and `fileload.p` procedures were written to run from an interactive ABL procedure. If you plan to have users run these procedures from the operating system command level, you must supply an output destination by adding `OUTPUT TO`*`filename`* at the top of each procedure. Comments in the `dumpdb` and `reloaddb` files explain these modifications.
- If you modify the procedures, remember to recompile.
- If the database to be loaded does not have the same name as the database that the MKDUMP was run against, then you must recompile the `fileload.p` procedure against the database with the proper name.

# Restrict database access

OpenEdge provides the DBRSTRCT utility to restrict access to a database. If you restrict the database with DBRSTRCT, you cannot compile procedures or upgrade the database at the user site. You must provide a new empty database and a complete set of `.r` files to upgrade the application, and users must dump and reload their databases.

Because database access restrictions apply to you as well as to your users, you must make a copy of your original, unrestricted and unfrozen database, and store it under a separate name. That way, if you want to lessen the restrictions at a later time, you can dump the data in the restricted database and reload it into a copy of the original, unrestricted database.

You use the DBRSTRCT utility to define the kinds of database access all users, including yourself, are allowed. This is the syntax:

**Syntax (UNIX)**

```
dbrstrct database-name
```

In these commands, *`database-name`* is the name of the database you want to restrict. The utility starts OpenEdge and displays the following menu from which you can choose options that let you define privileges for the update and query activities:

```
             Database Restriction Utility

This utility lets you make IRREVOCABLE changes to
EVERYONE's ability to modify or query database files.
Before doing this, you should:

         - make a copy of the database
         - precompile all procedures

   Deny (except for precompiled procedures):

1. Update access and/or query access to all current files.
2. Update access and/or query access to individual files.
3. Addition of new files to the database.

                  Selection:
```

To deny update or query access to all database files that are currently defined, choose **1**. A second menu screen appears.

At the second menu, if you choose **1 (Deny updates)**, users can query but not update the database.

Any procedures you compile against a database before restricting that database are exempt from any restrictions you apply with the DBRSTRCT utility.

Make sure that you compile a complete set of dump procedures before you restrict the database. Otherwise, users will not be able to dump their database.

**Note:** Encrypted source procedures **cannot** be compiled against a restricted database.

# A

# Build OpenEdge Executables

When you purchase an OpenEdge product, you receive a set of executable files, database files, and other files that are necessary to run the product on your system. In most cases, the files included in your initial product installation fulfill your system requirements. However, you might need to customize an OpenEdge executable by adding or removing product capabilities. For example, you might need to call a custom C function or access a non-OpenEdge data source. When you need to customize an OpenEdge executable, use the OEBuild utility. The OEBuild utility is a set of scripts that you use to build customized versions of certain OpenEdge executables. This appendix provides information about the process and requirements for building customized OpenEdge executables. It also provides instructions for using the OEBuild utility scripts on UNIX and in Windows.

**Note:** This appendix describes how to customize an OpenEdge client to access a custom C function. For an OpenEdge client to access an OpenEdge DataServer for Oracle, you must also build a customized executable. For more information, see *Use the Oracle Data Server*.

For details, see the following topics:

- Requirements
- Build executables on UNIX
- Build executables in Windows
- Troubleshoot OpenEdge executables

# Requirements

To use a custom C function in ABL, you must invoke it using the ABL CALL statement. This statement accesses your C function in an OpenEdge procedure as part of the Host Language Call (HLC) interface that you run using an OpenEdge executable customized to access this function. This appendix describes how to customize an OpenEdge executable to access a C function using the HLC interface. For more information on using custom C functions in ABL, see the Host Language Call Interface appendix in *OpenEdge Programming Interfaces*.

You must ensure that the customers who purchase your product have purchased and installed a properly licensed version of OpenEdge before you install any OpenEdge executables you deliver as part of your product.

# Build executables on UNIX

This section provides instructions for building a customized executable on UNIX, as described in the following sections:


- Prepare the UNIX software environment on page 184
- Build a customized executable on UNIX on page 184
- Use the customized UNIX executable on page 186
- Build and run the HLC examples for UNIX on page 187


## Prepare the UNIX software environment

When you install OpenEdge, the installation program prepares the software environment. In the UNIX software environment, OpenEdge uses the buildenv script to maintain environment variables.

The OEBuild utility script calls the `buildenv.sh` script. The `buildenv.sh` script sets default values for environment variables that point to objects, libraries, and options involved in linking executables. You can edit this script to customize environments for different sites.

The OEBuild script has the following software and environment requirements:

- Building the executable on the same platform on which it is to be run.
- Installing a linker on your system. The PATH environment variable contains the path to the C++ compiler and the linker.
- Setting OpenEdge environment variables. Set `DLC` to the directory where you have installed OpenEdge.
- Including appropriate environment variable settings for your system in the `buildenv.sh` script, which is located in the `$DLC/oebuild/make` directory.

For more information about UNIX environment variables, see *Install OpenEdge*.

## Build a customized executable on UNIX

This section contains instructions for building OpenEdge client executables running under UNIX to access custom C functions. The OEBuild script is located in the `oebuild/make` directory under the root of your OpenEdge installation.

To build a UNIX OpenEdge client executable:

1. Open a terminal and invoke a Bourne shell (`/bin/sh`) on the system where OpenEdge is installed.
2. Change to user `root`.
3. Run the PROENV utility to set the DLC variable. For example:

```
>$DLC/bin/proenv
```

4. Optionally set and export the environment variable `IMAGE` to the full pathname of the executable to be generated. For example:

```
proenv> IMAGE=/tmp/_myprogres
proenv> export IMAGE
```

**Note:** By default, the custom client executable is named `$DLC/oebuild/_progres` if you are building the OpenEdge client executable.

5. Make sure that the environment variable `PATH` contains the directory to the supported compiler and linker on your system.
6. Unset all the library path variables for your operating system. The script will set these variables as required. For example, on HP-UX:

```
proenv> unset SHLIB_PATH
```

7. Make a backup copy of the original OEBuild link options script, **build_rx.sh**, and the OpenEdge tie-in object used to access custom C functions, `hlprodsp.o`.

   For example, to copy the original OpenEdge client and OpenEdge tie-in object:

```
proenv> cp $DLC/oebuild/make/build_rx.sh $DLC/oebuild/make/build_rx.sh.orig
proenv> cp $DLC/oebuild/obj/hlprodsp.o $DLC/oebuild/obj/hlprodsp.o.orig
```

8. Edit the C source file for the OpenEdge tie-in object in order to tie in your C functions to ABL as explained in the source file comments. This file is located at the following path:

```
$DLC/oebuild/hlc/hlprodsp.c
```

9. Compile the new tie-in object. For example:

```
proenv> cc -c -o $DLC/oebuild/hlc/hlprodsp.o $DLC/oebuild/hlc/hlprodsp.c
```

10. Set and export the environment variable HLC_OBJS to contain the paths of all objects that need to be included in your new OpenEdge executable, including the OpenEdge tie-in object you built in Step 9 on page 185. For example:

```
proenv> HLC_OBJS="/home/foo.o /home/foo1.o
$DLC/oebuild/hlc/hlprodsp.o"
proenv> export HLC_OBJS
```

11. Run the OEBuild script, **build_rx.sh**, located in $DLC/oebuild/make, with no arguments.

    For example, to build a customized character client use the following command:

```
proenv> $DLC/oebuild/make/build_rx.sh
```

**Note:** If you do not set the IMAGE variable, as in 4 on page 185, the client executable is built as $DLC/oebuild/_progres for the OpenEdge character client agent; otherwise, the executable is built as specified by $IMAGE.

## Use the customized UNIX executable

To use the new executable, you must replace the default executable and set appropriate permissions.

To replace your default client executable:

1. Backup the original OpenEdge client executable. For example:

```
proenv> cp $DLC/bin/_progres $DLC/bin/_progres.orig
```

**Caution:** Do not skip this step. This provides you with a way to rollback your change without reinstalling OpenEdge.

2. Replace the original OpenEdge client executable with a copy of your customized executable. For example, assuming the default setting of IMAGE, use the following command:

```
proenv> cp $DLC/oebuild/_progres $DLC/bin/_progres
```

3. Change permissions on the newly created executable to include the Set UID bit.For example:

```
proenv> chmod u+s $DLC/bin/_progres
```

## Build and run the HLC examples for UNIX

OpenEdge comes installed with working HLC examples that you can build and test for UNIX. For more information on these examples, see the Host Language Call Interface appendix in *OpenEdge Programming Interfaces*.

# Build executables in Windows

This section provides instructions for building a customized executable in Windows, as described in the following sections:


- Prepare the Windows software environment on page 187
- Build a customized executable in Windows on page 188


## Prepare the Windows software environment

When you install OpenEdge, the installation program prepares the software environment. In the Windows software environment, OpenEdge uses the progress.ini file as well as the Registry to maintain environment variables.

The OEBuild script calls the progress.ini file. The progress.ini file sets default values for environment variables that define objects, libraries, and options required for building executables in Windows. You can edit the progress.ini file to customize environments at different sites.

When you install OpenEdge, the installation program automatically updates the Registry with the information in the progress.ini file that is shipped to you. Progress Software Corporation recommends that you maintain environment variables in both the progress.ini file and the Registry. If you modify environment variables in the progress.ini file, you must update the information in the Registry.

Although there are several methods for adding and deleting information from the Registry directly, Progress Software Corporation recommends that you do not use these direct update methods. Instead, maintain the Registry information by editing the progress.ini file and using the INI2REG utility to update the Registry. This approach synchronizes the information in the progress.ini file and the Registry without causing unintended edits to the Registry.

The OEBuild script has the following software and environment requirements:

- Setting OpenEdge environment variables. Set `DLC` to the directory where OpenEdge is installed.
- Including the appropriate environment variables for your system in the `progress.ini` file (located in the `C:\Progress\OpenEdge\bin` directory, by default) and the Registry.
- Installing the Microsoft Visual C++ .NET compiler on the system.
- Adding the path to the C++ compiler and the linker command (link.exe) to the `PATH` environment variable.

For information about Windows environment variables, see *Configure OpenEdge*. For more information about maintaining environment variables in the `progress.ini` file and the Registry, and using the INI2REG utility, see the sections on maintaining the Windows user environment in Maintain User Environments on page 53.

# Build a customized executable in Windows

This section contains instructions for building OpenEdge client executables running in Windows to access custom C functions. The script is located in the `oebuild/make` directory under the root of your OpenEdge installation.

To build a Windows client executable:

1. Log in as Administrator and run the Proenv utility (**StartProgramsOpenEdge Proenv**) on a system where OpenEdge is installed. This sets the DLC variable.
2. Change directory to the OpenEdge `make` directory. For example:

```
proenv> cd %DLC%\oebuild\make
```

3. Set up the Microsoft Visual C++ environment by running `vcvars32.bat`. For example:

```
proenv> "C:\Program Files\Microsoft Visual Studio        .NET\Vc7\bin\vcvars32.bat"
```

4. Make a backup copy of the original OEBuild link options script and the OpenEdge tie-in object used to access custom C functions, `hlprodsp.o`. There are two versions of the OEBuild link options script, depending on the OpenEdge client executable you plan to build:

   - **`build_prow32.link`** — OpenEdge GUI client executable
   - **`build__prchar.link`** — OpenEdge character client executable

   For example, to copy the original GUI OpenEdge client and OpenEdge tie-in object use the following commands:

```
proenv> copy build_prow32.link build_prow32.link.orig
proenv> copy ..\obj\hlprodsp.obj ..\obj\hlprodsp.obj.orig
```

5. Edit the C source file for the OpenEdge tie-in object in order to tie in your C functions to ABL as explained in the source file comments. This file is located at the following path:

```
%DLC%/oebuild/hlc/hlprodsp.c
```

6. Compile the new tie-in object. For example:

```
proenv> cl -c -Fo ..\obj\hlprodsp.obj ..\hlc\hlprodsp.c
```

7. Edit the link options script for your executable (`build_prow32.link`, `build__prchar.link`, or `build__proapsv.link`) to add customized objects and any necessary libraries to accommodate them on the link line. Save the file.

8. Run the `link` command to create a customized OpenEdge client dynamic link library (DLL). For example, to create a customized GUI OpenEdge client DLL:

```
proenv> link @build_prow32.link
```

9. Back up the original OpenEdge client DLL. For example:

```
proenv> copy %DLC%\bin\prow32.dll %DLC%\bin\prow32.dll.orig
```

10. Copy the customized OpenEdge client DLL into the installed `bin` directory. For example:

```
proenv> copy %DLC%\oebuild\make\prow32.dll %DLC%\bin\prow32.dll
```

# Troubleshoot OpenEdge executables

The following are some common errors that might occur when you attempt to link an executable:

- An object or library file cannot be found.
- An environment variable is not properly set.
- The system has insufficient memory or disk space.

For link utility error and troubleshooting information, see the documentation supplied with your operating system.

# B

# R-code Features and Functions

*R-code* is the intermediate binary code that OpenEdge generates when it compiles ABL (Advanced Business Language) source files. This is the code that OpenEdge actually runs when it executes a procedure or class, whether from session compiles or from permanently generated r-code (.r) files.

**Note:** Whether the source code is an ABL procedure or ABL class, it compiles into r-code. For the purposes of this topic, procedure and class files are equivalent.

OpenEdge provides a dynamic r-code execution environment, as well as integrity and security mechanisms to ensure that your r-code is running in a compatible environment.

For details, see the following topics:

- R-code structure
- Procedure libraries
- Procedure libraries and PROPATH
- R-code execution
- R-code portability
- Code page compatibility
- Database CRCs and time stamps
- R-code CRCs and procedure integrity

# R-code structure

R-code is divided into multiple segments of varying length. Each r-code file contains an object header and segment location table followed by the actual r-code segments. The object header is a fixed-length descriptor that identifies the file as an r-code file and contains information about the version and size of the r-code file. The segment location table is a variable-length descriptor that contains the size and location of each r-code segment in the file. The maximum size for all segment types is 4MB.

The following table describes and lists the types, maximum size, and maximum number of segments in an r-code file.

**Table 30: R-code segments**

| Segmenttype | Max.size | Max.number | Description |
|---|---|---|---|
| Action code | 4MB | 1 for main procedure1 per internal procedure | Holds the actual executable code in the form of action cells. Action cells drive the ABL interpreter and contain the executable code for ABL verbs. There is one segment for the main procedure, and one separate segment for each internal procedure. |
| Expression code | 4MB | 1 | Holds the executable expressions in Reverse Polish Notation (RPN) for the main procedure, all internal procedures, and all trigger blocks." |
| Text | 4MB | 1 per language | Holds all literal character strings for the r-code file. There is one text segment for the default language and one for each language specified in the COMPILE statement. Duplicate literals are removed. Only one text segment is loaded into memory at run time. |
| Initial value | 4MB | 1 | Contains information required to initialize an r-code file for execution, including database and table references, variable definitions, TEMP-TABLE and WORK-TABLE definitions, a list of defined frames, CRCs, and time stamps. There is one initial value segment per r-code file. |
| Frame | 4MB | 1 per frame | Contains layout information for a frame, including frame fields, attributes, and all RPN expression code from the frame phrase. There is one frame segment for each named and unnamed frame in the r-code file. Each frame segment has a 32K limit. |
| Debugger | 4MB | 1 | Used by the Application Debugger to maintain the debugger context for the procedure. There is one debugger segment per r-code file. This segment is loaded into memory on demand only when the Debugger is active. For information about the Debugger, see *Troubleshoot ABL Applications*. |

# Factors that affect r-code size

Compilation fails if you exceed segment size limits. However, you can affect r-code size by how you write your ABL, depending on the r-code segment. The action code and initial value segments are among the most tunable.

## Action code segment

You can reduce the size of an action code segment (for either the main procedure or an internal procedure) by consolidating multiple ABL statements into one. This can also increase the speed of execution, because the interpreter executes only one action instead of several.

For example, you can reduce action code size by combining several consecutive assignment statements into one ASSIGN statement. The following examples require the same amount of expression code:

```
a = 1.
b = 2.
c = 3.
```

```
ASSIGN a = 1
       b = 2
       c = 3.
```

## Initial value segment

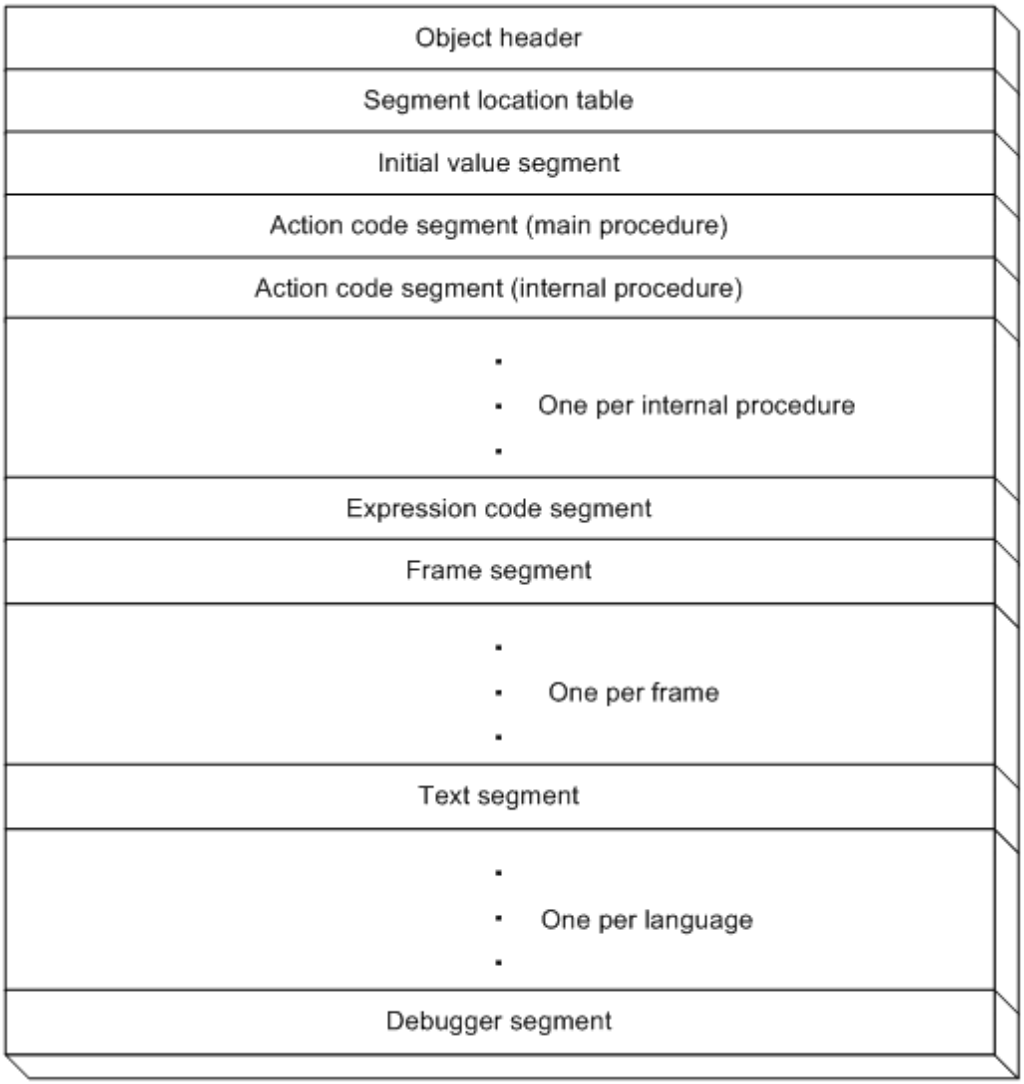
You can reduce the size of the initial value segment by limiting the number of SHARED variables that are accessed in a procedure. The r-code required to support a SHARED variable is larger than the r-code to support a NEW SHARED variable. OpenEdge uses approximately 36 additional bytes in the initial value segment to resolve each SHARED variable at run time. This value can change depending on the environment.

# R-code file segment layout

The following image shows the segment layout in an r-code file. A compiled procedure requires one initial value segment, one main action code segment, one expression code segment, one text segment, and one debugger segment. There can be more action and expression code segments, up to the limit, as required by your procedure. There can be multiple frame segments, one segment for each frame in your procedure. The maximum number of frame segments is virtually unlimited.

There can also be multiple text segments, one segment for the default language and each language that you choose for translation. The default language segment contains the literal character strings defined in the original ABL source file. You can create additional text segments by using the Translation Manager. Although multiple text segments are possible, only one text segment is available per language. Thus, the literal character strings for a given language cannot exceed 4MB.

**Figure 14: R-code file segment layout**




# Procedure libraries

You can organize and store r-code files in an ABL procedure library. An ABL procedure library is a collection of r-code and images combined in a single file. Procedure libraries allow you to manage and execute r-code more efficiently. You create procedure libraries by using the PROLIB utility.

**Note:** OpenEdge can only make use of r-code and images within a procedure library. It is technically possible to include other types of files in a procedure library. However, the user would need to extract them from the library before making use of them.

OpenEdge provides two types of procedure libraries: standard and memory-mapped. A standard library contains r-code that execute in local memory. A memory-mapped library contains r-code that execute in shared memory.

For information about using the PROLIB utility to create procedure libraries, see Manage Procedure Libraries on page 117.

# Procedure libraries and PROPATH

The following rules govern how standard and memory-mapped libraries interact with PROPATH during an OpenEdge session:

- The first time you run a member from a standard or memory-mapped library that is specified in the PROPATH, OpenEdge locates the member by searching through each directory and library in the PROPATH until it finds the member. To search a library for a member, OpenEdge must open the library. When OpenEdge opens a standard library, it loads the member into local memory. When OpenEdge opens a memory-mapped library, it maps the library in shared memory.
- When searching through directories and libraries in the PROPATH, OpenEdge starts at the beginning of the PROPATH and searches each directory and library, in defined order, until it finds the member. Thus, placing the library at the beginning of the PROPATH improves performance.
- A library remains open until the end of your OpenEdge session or until you remove the library from the PROPATH. If you remove a library from the PROPATH while a member is still active (either running, or waiting for a subprocedure to return), OpenEdge displays an error message and the library remains open until you end your OpenEdge session. Otherwise, OpenEdge closes a standard library or unmaps a memory-mapped library.
- If you use a `SEARCH` or `RUN` statement to open a library that is not in the PROPATH, the library remains open until you end your OpenEdge session.
- If you use libraries, OpenEdge accesses r-code as if you had specified the Quick Request (`-q`) startup parameter. That is, OpenEdge searches the PROPATH only on the first reference to a member. Thereafter, if the member still resides in memory, in the local session compile file, or in an r-code library, OpenEdge reuses the member instead of searching the PROPATH again. For more information about the Quick Request (`-q`) startup parameter, see *Startup Command and Parameter Reference*.

# R-code execution

OpenEdge executes r-code in different ways, depending on whether you store the r-code files in an procedure library and the type of library.

When executing r-code from an operating system file in a directory, or from a standard procedure library, OpenEdge accesses and executes the r-code file segments in an execution buffer in local memory. For more information about the standard r-code execution environment, see Standard r-code execution environment on page 196.

When executing r-code from a memory-mapped procedure library, OpenEdge accesses and executes the r-code segments in shared memory. For more information about the memory-mapped r-code execution environment, see Memory-mapped r-code execution environment on page 198.

For information about monitoring execution environment activity during an OpenEdge client session, see R-code execution environment statistics on page 200.

For information about monitoring and optimizing r-code performance, see Manage Client Performance on page 107.

# Standard r-code execution environment

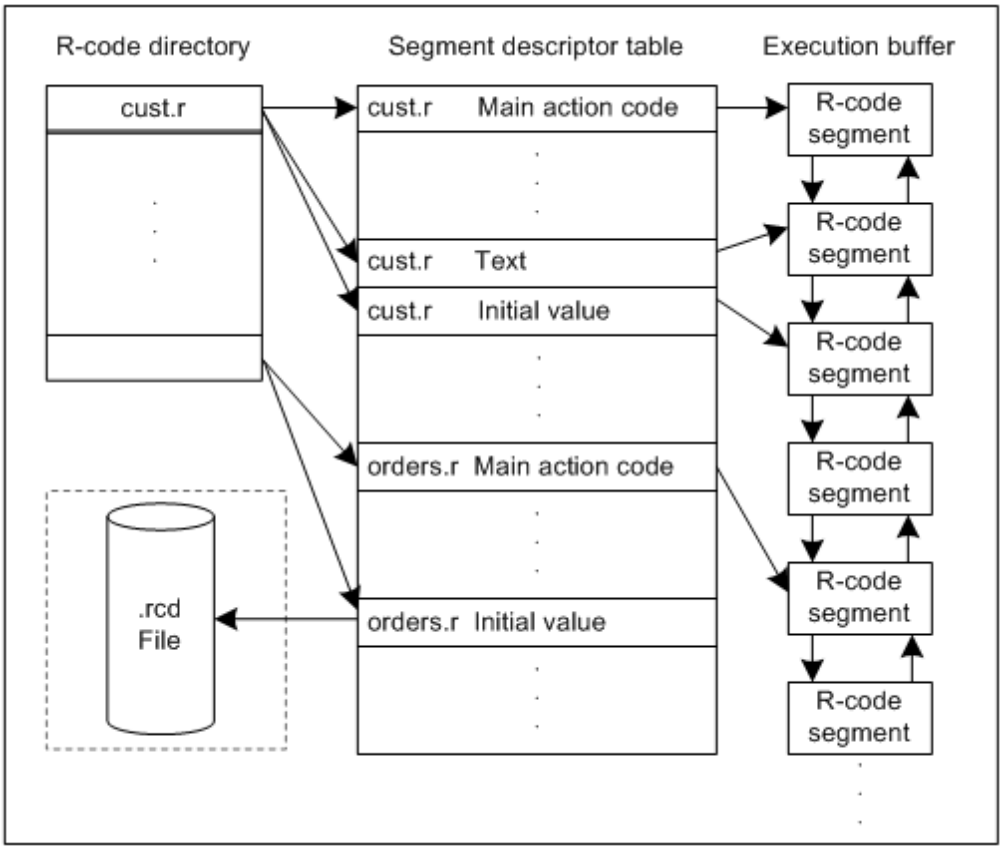
At run time, OpenEdge manages the execution of r-code from either an operating system file or a standard procedure library using the following components:

- **Execution buffer** — The portion of local memory that OpenEdge allocates and uses to store the chain of loaded r-code segments for all procedures executing in local memory.
- **R-code swap file (.rcd)** — A file that OpenEdge uses to dynamically swap r-code segments in and out of the execution buffer.
- **Segment descriptor table** — An in-memory table that references the r-code segments required by all executing procedures, including the location of each r-code segment in the execution buffer and usage count information.
- **R-code directory** — An in-memory table that contains information about each executing r-code, including r-code size, usage count, segment descriptions, and a reference to the segment descriptor table for each segment.

OpenEdge uses the segment descriptor table and the r-code directory to manage r-code from operating system files, standard libraries, and memory-mapped libraries.

The following image shows the layout for the standard r-code execution environment.

**Figure 15: Standard r-code execution environment**



In the above image, OpenEdge located and loaded the `cust.r` and `orders.r` files into local memory from either operating system files or standard libraries. The execution buffer is shown with three `cust.r` segments and two `orders.r` segments. Note that one `orders.r` segment is located in the execution buffer, while the other segment is swapped to the r-code swap file (`.rcd`). When space in the execution buffer is needed for new r-code segments, OpenEdge uses the r-code swap file to swap out the least-recently used segments. When OpenEdge needs a segment that has been swapped to the r-code swap file, it reloads the segment from the r-code swap file into the execution buffer.

## Standard execution sequence

When you run r-code for the first time, from either an operating system file or a standard library, OpenEdge loads and executes the r-code as follows:

1. Opens the file (`.cls`, `.p`, or `.r`) or procedure library (`.pl`), if the library is not already open.
2. Reads the r-code into memory and creates an r-code directory entry for it. OpenEdge first compiles a procedure into r-code, if necessary.
3. Registers each required r-code segment in the execution environment as follows:
   a) Loads the r-code segment at the head of the segment chain in the execution buffer
   b) Adds an r-code segment entry to the segment descriptor table that references the segment in the execution buffer
   c) Inserts a segment descriptor reference in the r-code directory entry for the r-code

   If all the required r-code segments do not fit in the execution buffer, OpenEdge attempts to free space by swapping r-code segments already in the buffer to the r-code swap file. If OpenEdge cannot free enough space by swapping segments, it increases the execution buffer ceiling and allocates more space for the execution buffer.

   **Note:** Codepage-converted text segments within standard or memory-mapped procedure libraries are swapped in and out of the r-code swap file, preserving any code page conversions that occurred during the initial load of the text segment. When accessing members stored in a standard library, OpenEdge does not swap r-code segments to the r-code swap file unless you specify the PROLIB Swap (`-pls`) startup parameter. By default, if OpenEdge needs an r-code segment in a standard library, it reloads the segment into the execution buffer from the library in local memory.

4. Once the required r-code segments are registered in the execution environment, the interpreter begins executing the r-code at the start of the first main action code segment and accesses the remaining segments directly from local memory as required.

## Standard execution environment limits

The amount of r-code that you can run at one time and how much memory it uses are determined by the following factors:

- **R-code directory size** — The default is 100 entries, the minimum is five entries, and the maximum is 2,147,483,647. You can set the initial number of entries using the Directory Size (`-D`) startup parameter. OpenEdge dynamically increases the directory size up to the maximum, as required. Use the Hardlimit (`-hardlimit`) startup parameter to force OpenEdge to adhere to the limit specified by the Directory Size (`-D`) startup parameter.
- **Execution buffer ceiling** — The default is 3096K. You can set the initial ceiling for this buffer up to 65,534K using the Maximum Memory (`-mmax`) startup parameter. OpenEdge dynamically increases the execution

buffer size up to the maximum, as required. Use the Hardlimit (`-hardlimit`) startup parameter to force OpenEdge to adhere to the limit specified by the Maximum Memory (`-mmax`) startup parameter.

- **Available memory** — Available memory is a factor only if it is smaller than the execution buffer ceiling or OpenEdge needs to allocate memory beyond that ceiling.

### Standard r-code segment management

While OpenEdge loads r-code, all of its segments are locked in memory. After all required segments are loaded from the r-code, OpenEdge unlocks all segments except its main action code segments and text segment. These segments stay locked in memory until execution of the r-code terminates. Internal procedure action code segments stay locked only until they return to the invoking procedure and are relocked each time they execute.

When a standard r-code segment does not fit in the execution buffer, OpenEdge attempts to free space by swapping r-code segments already in the buffer to the r-code swap file. OpenEdge can swap out any unlocked segments and then remove these segments from the tail end of the execution buffer chain, in least recently used (LRU) order.

If OpenEdge cannot free enough memory for a newly loaded segment by swapping out older segments, it dynamically increases the maximum execution buffer size (execution buffer ceiling) and allocates the required memory up to the memory available.

When OpenEdge needs a segment that has been swapped to the r-code swap file, it reloads the segment from the swap file into the execution buffer. However, OpenEdge keeps the reloaded segments in the swap file.

---

**Note:** The AVM swaps codepage-converted text segments for procedure libraries from the execution buffer to the r-code swap file and reloads the converted text segments from the swap file instead of the library when necessary. When accessing members stored in a standard library, OpenEdge does not swap r-code segments to the r-code swap file unless you specify the PROLIB Swap (`-pls`) startup parameter. By default, if OpenEdge needs an r-code segment in a standard library, it reloads the segment into the execution buffer from the library in local memory.

---

## Memory-mapped r-code execution environment

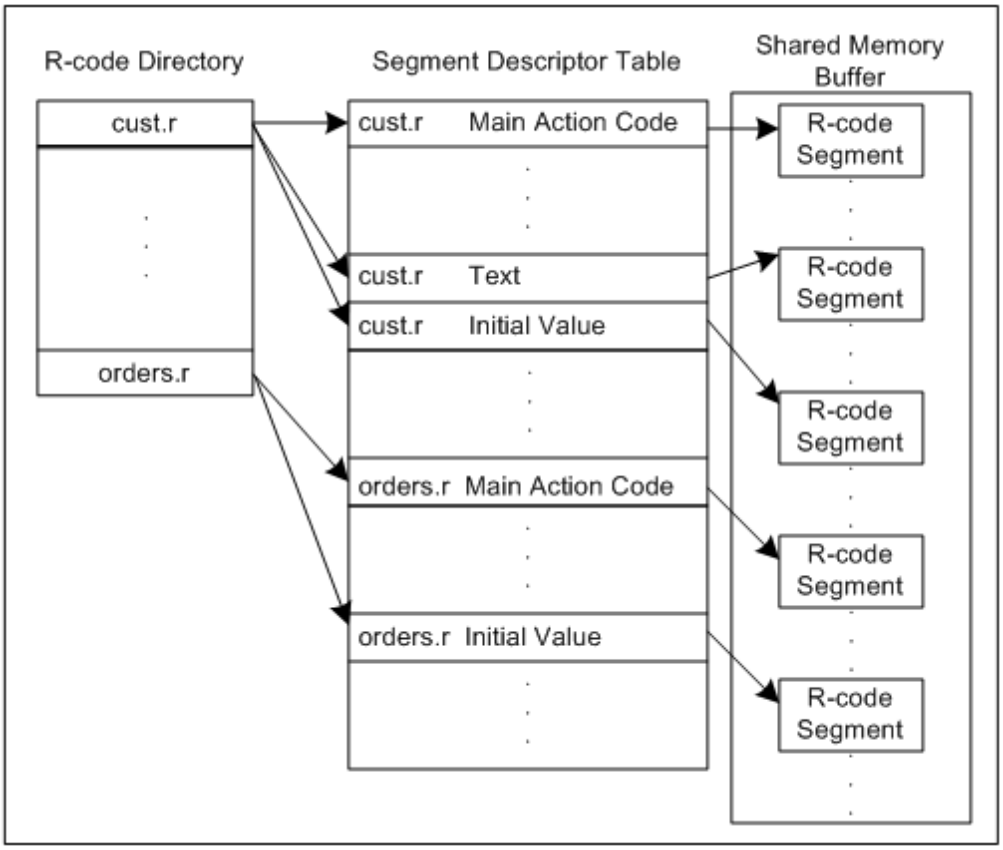
At run time, OpenEdge manages the execution of memory-mapped r-code using the following components:

- **Shared memory buffer** — The portion of shared memory that the operating system allocates and uses to store r-code segments for members in a memory-mapped procedure library
- **Segment descriptor table** — An in-memory table that references the r-code segments required by all executing members, including the location of each r-code segment in memory and usage count information
- **R-code directory** — An in-memory table that contains information about each executing member, including r-code size, usage count, segment descriptions, and a reference to the segment descriptor table for each segment

OpenEdge uses the segment descriptor table and the r-code directory to manage r-code from operating system files, standard libraries, and memory-mapped libraries.

The following image shows the layout for the memory-mapped r-code execution environment.

**Figure 16: Memory-mapped r-code execution environment**




In the above image, OpenEdge locates the `cust.r` and `orders.r` members in a memory-mapped library. Note that all r-code segments in a memory-mapped library are located in shared memory. When OpenEdge needs a segment, it executes the segment directly from shared memory.

## Memory-mapped execution sequence

When you run a memory-mapped member for the first time, OpenEdge loads and executes the r-code as follows:

1. Opens the procedure library, if not already open, and memory-maps the library in shared memory.
2. Reads the member and creates an r-code directory entry for the member.
3. Registers each required r-code segment in the execution environment as follows:
   a) Adds an r-code segment entry to the segment descriptor table that references the segment in shared memory
   b) Inserts a segment descriptor reference in the r-code directory entry for the member
4. Once the required r-code segments are registered in the execution environment, the interpreter begins executing the r-code at the start of the first main action code segment and accesses the remaining segments directly from shared memory as required.

### Memory-mapped execution environment limits

The amount of memory-mapped r-code that you can run at one time and how much shared memory it uses are determined by the following factors:

- **R-code directory size** — The default is 100 entries, the minimum is five entries, and the maximum is 2,147,483,647. You can set the initial number of entries using the Directory Size (`-D`) startup parameter. OpenEdge dynamically increases the directory size up to the maximum, as required. Use the Hardlimit (`-hardlimit`) startup parameter to force OpenEdge to adhere to the limit specified by the Directory Size (`-D`) startup parameter.
- **Available memory** — The number of memory-mapped procedure libraries you can have open is limited by the amount of shared memory available on the system.

### Memory-mapped r-code segment management

When OpenEdge needs a memory-mapped r-code segment, it executes the segment directly from shared memory. OpenEdge does not store active memory-mapped r-code segments in the execution buffer. Nor does it swap non-active segments to the r-code swap file. OpenEdge relies on the operating system to manage the swapping of r-code segments in and out of shared memory.

**Note:** The AVM swaps codepage-converted text segments for procedure libraries from the execution buffer to the r-code swap file and reloads the converted text segments from the swap file instead of the library when necessary.

## R-code directory management

If the r-code directory is full when loading additional r-code from any source, OpenEdge can reuse existing directory entries for any r-code files no longer in use.

To reuse an r-code directory entry, OpenEdge performs the following steps:

1. Identifies the least recently used (LRU) r-code directory entry.
2. Frees the LRU r-code directory entry.
3. Frees all of the segment descriptor entries in the segment descriptor table for the LRU r-code directory entry.
4. When reusing a standard r-code directory entry, OpenEdge removes all r-code segments for the LRU r-code file from both the execution buffer and the r-code swap file. When reusing a memory-mapped r-code directory entry, the memory-mapped r-code file remains mapped in shared memory.

   When OpenEdge needs to reload standard r-code, it follows the standard execution sequence. When OpenEdge needs to reload memory-mapped r-code, it follows the memory-mapped execution sequence.

## R-code execution environment statistics

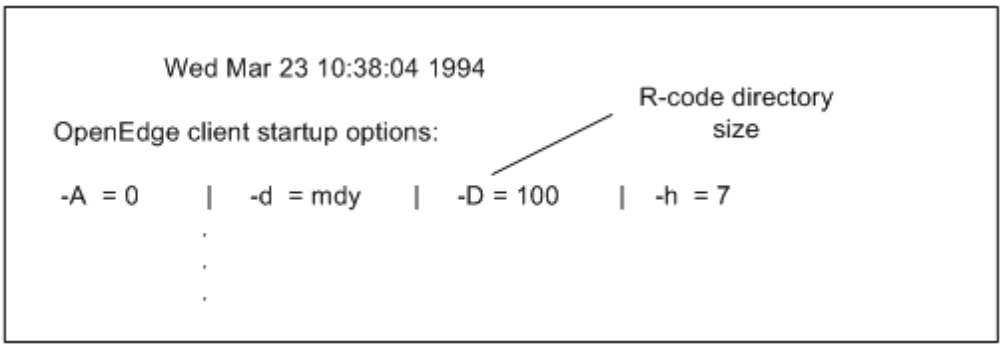
You can monitor execution environment activity using the Statistics (`-y`) and Segment Statistics (`-yd`) startup parameters. These parameters cause OpenEdge to write memory statistics to the `client.mon` file. The `-yd` parameter provides all of the information about memory usage available with `-y` plus additional information about r-code segments loaded during a client session. For more information about the `-yd` and `-y` startup parameters, see *Startup Command and Parameter Reference*.

For information about monitoring and optimizing r-code performance, see Manage Client Performance on page 107.

The following images show sections of `client.mon` output generated with the `-yd` startup parameter.

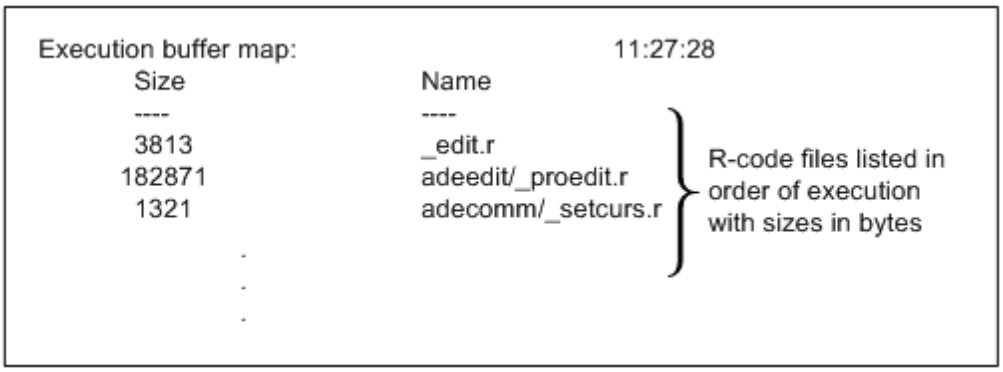
In the following image, the "OpenEdge client startup options" section shows the r-code directory size (`-D`), in this case, set to the default of 100 entries. The `-y` startup parameter also generates this information.

**Figure 17: OpenEdge client startup options for –yd**



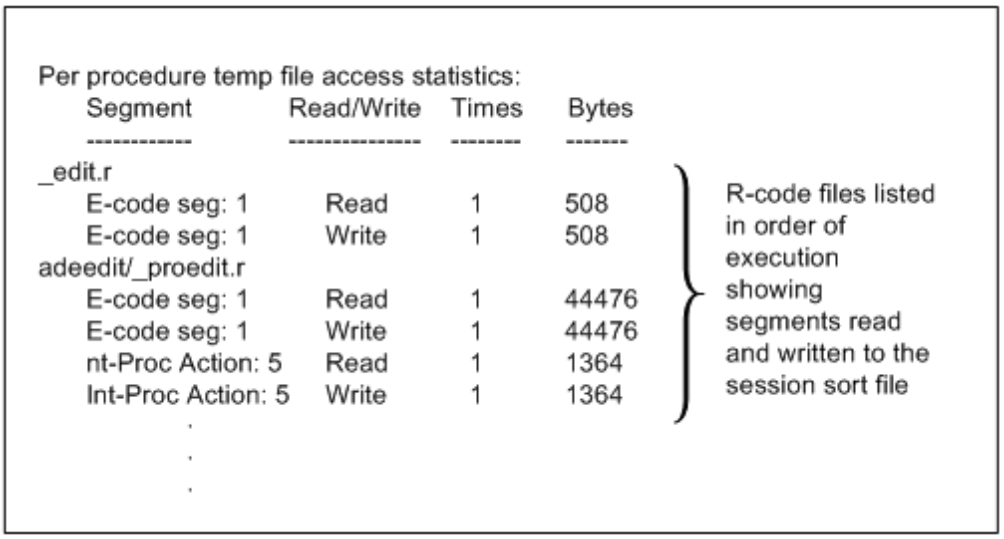

In the following image, the "Execution buffer map" section shows the order and size of procedures loaded into the execution buffer.

**Figure 18: Execution buffer map for –yd**



In the following image, the "Per procedure temp file access statistics" section lists each r-code segment that has been read or written to the r-code swap file (`.rcd`). Each segment is listed under its r-code file by segment type ("Int-Proc Action"), number (5), and size (1364 bytes).

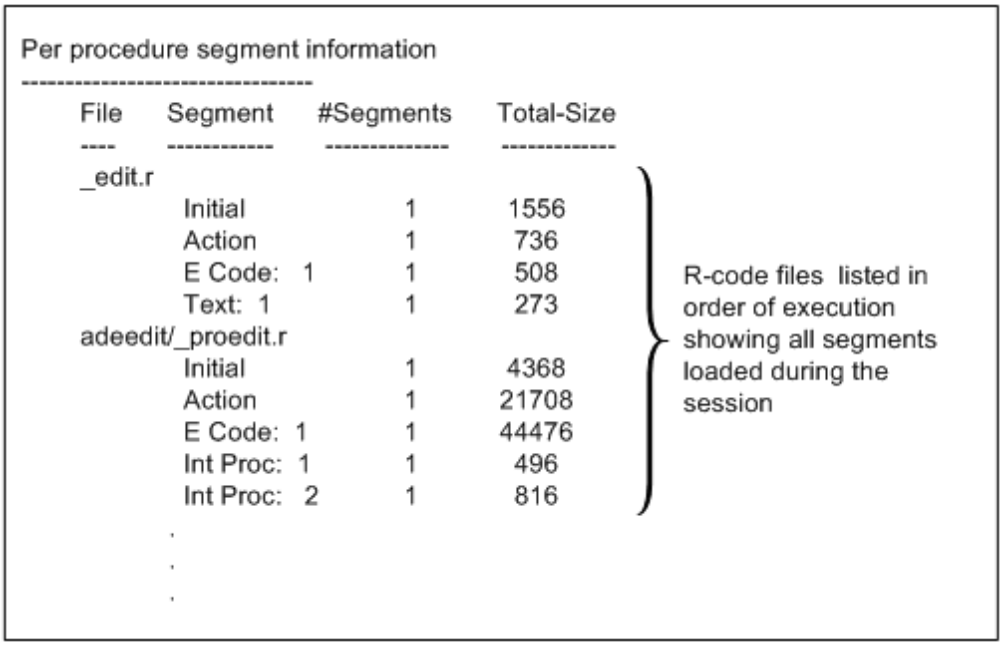
**Figure 19: Accessing the r-code swap file for –yd**




In this example, all segments shown have been read and written once. A large number of segments read or written a large number of times indicates a likely need for more memory.

In the following image, the "Per procedure segment information" section lists all the r-code segments loaded during the session. Each segment is listed under its r-code file by segment type ("Int-Proc"), number (2), and size (816 bytes).

**Figure 20: Procedure segment information for –yd (Part 1)**




Thus, if there are three internal procedure action segments in `appedit/_proedit.r`, they are listed in order (Int-Proc: 1 through 3). Likewise, multiple main action code segments are listed in order (A-Code: 1 and 2). The number of segments for each entry is always one. Note that the "Initial" segment has no segment number, because there is never more than one of this segment type per r-code file.

In the following image, the listed sections provide memory and segment usage summaries. The `-y` startup parameter also generates this information.

**Table 31: Procedure segment information for –yd (Part 2)**

```
----------------------------------------
Program access statistics:    Times    Bytes
                    .
                    .
                    .
Memory usage summary:       Current    Max Used       Limit (Bytes)
Stack usage (-s):                60        7248       40960
Local buffer usage:             864       14704
R-code Execution Buffer:     530025      710609      710656
Segment Descriptors Usage: (numbers)
Max Used:      508      Limit:      720
-----------------------------------------------
```

The "R-code Execution Buffer" statistics show how far your application pushes the execution buffer ceiling. The "Segment Descriptors Usage" statistics shows how close your application is to running out of segment descriptors, and thus, whether you need to optimize the number of r-code segments in your application.

# R-code portability

You can often port the r-code without recompiling. However, you must recompile if one of the following changes:

- The display architecture
- The database type
- The r-code version

## Display architectures

The two display architectures supported by OpenEdge are graphical and character. For information about deploying web applications, see *Develop Web Clients*.

Code that does not contain user-interface statements (specifically, code that does not create frames, either explicitly or implicitly) does not belong to any display architecture, and so does not involve a change of display architectures. If a procedure contains no user interface code, its r-code can run across user interfaces without change. This is typical, for example, of database schema trigger procedures. Another example of such code is a batch program.

## Database types

Database types are OpenEdge, ORACLE, and MS-SQL server. Applications access non-OpenEdge databases through the appropriate OpenEdge DataServer products.

Code that does not access any OpenEdge or non-OpenEdge database does not belong to any database type, and so does not involve a change of database types. An example of such code is a date-conversion procedure.

## R-code version

Porting across r-code versions sometimes requires recompiling. The r-code version always changes between major releases. It might or might not change between minor point releases depending on the added functionality.

If you port to:

- A lower or higher major release, you must recompile.
- A higher point release within a major release, you might or might not need to recompile, depending on the new functionality in the point release.
- A lower point release within a major release, you might or might not need to recompile. However, it is highly recommended that you recompile.

## R-code portability and operating system-specific statements

If you want your r-code to be portable, avoid OpenEdge statements that are operating-system specific. For example, the `DDE INITIATE` statement is specific to Windows.

## Byte order of integers in R-code

R-code, whether on disk or in memory, always stores integers in byte-swapped order, even on machines that store integers in byte-stream format. On such machines, OpenEdge converts integers to byte-stream format at run time.

## Examples of portable and nonportable r-code

Not all r-code is portable. You can usually port r-code between clients as long as you do not change display architectures, database types, platform classes or major r-code versions. For example:

- If you port a Windows application to character-mode, you must recompile, because the display architecture has changed.
- If you port a character application compiled against an ORACLE DataServer on a SUN workstation to a character application accessing an ORACLE DataServer on a Hewlett-Packard (HP) workstation, you do not have to recompile (assuming that the ORACLE release level does not change and both platforms are 32-bit or 64-bit, respectively).
- If you port a character application compiled against the DataServer for ORACLE on a SUN workstation to a character application accessing the DataServer for Microsoft SQL Server on an HP workstation, you must recompile because the database type has changed.
- If you migrate an application from one major OpenEdge release to another you must recompile it. You can upgrade directly to the latest release without upgrading to each intermediate version.

# Code page compatibility

The Internal Code Page (`-cpinternal`) startup parameter determines the internal code page that OpenEdge uses in memory. The code page in which r-code is compiled and the internal code page of the session in which the r-code runs must be compatible. That is, the r-code code page must be either the internal code page, undefined, or convertible to the internal code page.

If the code page for r-code, from either an operating system file, a memory-mapped procedure library, or a standard procedure library, is not the same as the session's internal code page, OpenEdge performs an in-memory conversion of the r-code text segments to the session's internal code page.

---

**Note:** If you use the R-code In Code Page (`-cprcodein`) startup parameter to specify a code page for reading r-code text segments, OpenEdge reads the text segments as if they were written in that code page, even if the text segments were written in a different code page.

---

When executing r-code from a standard procedure library, the ABL Virtual Machine (AVM) accesses and executes the r-code segments in the execution buffer in local memory. The AVM does not swap the r-code segments to the r-code swap file unless you specify the PROLIB Swap (-pls) startup parameter. By default, the AVM reloads segments from the open library in local memory.

Codepage-converted text segments from memory-mapped and standard procedure libraries are swapped in and out of the r-code swap file, preserving any code page conversions that occurred during the initial load of the text segment.

For more information about the Internal Code Page (`-cpinternal`) and R-code In Code Page (`-cprcodein`) startup parameters, see *Startup Command and Parameter Reference*.

# Database CRCs and time stamps

At run time, OpenEdge must ensure that r-code files and the database(s) that they access are compatible. Otherwise, if the schema has changed since the code was compiled, running the code might damage the database. OpenEdge supports the cyclic redundancy check (CRC) validation technique for checking this compatibility. This technique prevents you from running unauthorized or data-incompatible procedures against a particular database environment.

## CRC validation

For each table, OpenEdge computes a CRC value (*`database`* CRC) from selected elements of the table metaschema. When compiling a procedure, OpenEdge inserts the database CRC for each database table the procedure accesses. The database CRC for each table is stored in the metaschema `_File` record `_CRC` field for the table. A matching CRC ensures that the schema referenced by the r-code is compatible with the table schema.

CRCs help maintain database integrity. CRCs change only when certain schema elements critical to field or record definitions change. As long as a table is structurally compatible with the r-code that references it, the CRCs match and the r-code can execute. It does not matter when or where the table's schema was created or updated.

## CRC advantage

The main advantage of using CRC validation is that you can run the same r-code against different databases as long as the databases have sufficiently similar schemas. This allows you to deploy code and database updates while avoiding either of the following effects:

- Forcing the user to dump and reload their data into a new database that you supply with new r-code.
- Forcing the user to compile new source code (possibly encrypted) that you supply with new data definitions to update their database schema.

Depending on the schema changes, the user still might have to dump and reload some data, but you can always supply r-code for their updated database.

## R-code execution with CRCs

When executing a procedure using CRC validation, OpenEdge follows these steps:

1. For each table accessed by the r-code, check the time stamp. If it matches, execute the procedure. Otherwise, go to Step 2.
2. Check the CRC. If it matches, execute the procedure. Otherwise, reject the procedure.

   Thus, if the time stamps match, OpenEdge assumes that the database schema and r-code must be compatible. Otherwise, the CRCs determine the outcome.

# CRC calculation

The following table lists the metaschema fields that are involved in each CRC calculation.

**Table 32: Metaschema fields in CRC calculation**

| Metaschema table | | | |
|---|---|---|---|
| **_File** | **_Field** | **_Index** | **_Index–Field** |
| `_File-Name`<br>`_DB-lang` | `_Field-Name`<br>`_Data-Type`<br>`_dtype`<br>`_sys-field`<br>`_field-rpos`<br>`_Decimals`<br>`_Order`<br>`_Extent`<br>`_Fld-stdtype`<br>`_Fld-stlen`<br>`_Fld-stoff`<br>`_Fld-case` | `_Index-Name`<br>`_Unique`<br>`_num-comp` | `_Field-Name`<br>`_Ascending`<br>`_Abbreviate`<br>`_Unsorted` |

### Notes

- The `_Fld-stlen` is not involved in the CRC calculation for BLOB and CLOB fields.
- The `_Field–Name` for index fields is referenced in the `_Field` table using `_Field–recid` in `_Index–Field`.

- A value of Unknown (?) or 0 in any integer field in the above table results in the same CRC value.
- This list is for informational purposes only. For CRC checking, only `_File._CRC` needs to be checked.

## CRC calculation for tables

All of the listed metaschema fields participate in the CRC calculation for each database table. The resulting CRC is stored in the `_CRC` field of the `_File` record for each table. A change to any of these fields automatically changes the value of `_CRC`.

## Database changes that affect CRCs

You must recompile procedures that reference a database table in which you have made any of the following changes:

- Deleted the table
- Changed the table name
- Changed the database language or authorization key
- Added or deleted a field in the table
- Changed the name or order of a field

---

**Note:**

Changes in order or position of the fields in tables of the dataserver database do not require recompilation of R-code.

The order in which indexes are defined has no effect on database CRCs.

---

In addition to the schema changes listed above, you must recompile procedures that reference a database table in which you have made the following changes to a field:

- The data type or extent (array size)
- The number of decimals
- The case sensitivity

Although you do not have to recompile procedures when you make other schema changes, such changes do not apply to procedures that you do not recompile. For example, changes to the following features appear only when you recompile:

- **Field appearance** — Format, label, column label, and decimal
- **Data entry** — Initial value, mandatory value, case sensitivity, validation expression, delete validation, and security
- **User information** — Help messages, validation messages, and description

## Database CRC changes that do not prevent r-code execution

Under certain circumstances, database modifications can change the database CRC value but will not require you to recompile existing r-code. You can run r-code without recompiling if:

- You add new field to a table with a `_Field-rpos` value greater than any other field in the table. In other words, the new field cannot be inserted into an existing `_Field-rpos` sequence.
- You make changes to existing fields that **do not** affect the values of `_Field-name`, `_dtype`, `_Field-rpos`, `_Extent`.

**Note:** The above exceptions do not apply to DataServer tables. However, changes in field positions in tables of the DataServer database do not require recompilation of r-code.

### CRC and time stamp availability

During compilation, OpenEdge always inserts both database time stamps and CRCs in the r-code. OpenEdge marks the r-code to check the CRC if the time stamp check fails.

## CRC-based deployment

Using CRC validation, if you deploy r-code, you only have to compile the procedures against a database with the same basic structure as the end-user database. It does not matter when or where the database was created. If you make schema changes to an existing database, you can distribute the newly compiled r-code to end users, along with a data definition files to install the schema changes.

The flexibility of CRC-based deployment makes it easier to distribute a new version of an existing application.

To deploy an application update based on CRC validation:

1. Install a copy of the production database from the target site in your development environment.
2. Create an incremental data definition file that captures the difference between your development database and the production copy. For information about creating an incremental data definition file, see *Manage the OpenEdge Database*.
3. Apply the incremental data definition file to your copy of the production database.
4. Recompile all procedures affected by the schema changes against your copy of the production database.
5. Apply the incremental data definition file to the original production database (on site). The CRC for the original production database should now be identical to the production copy, but probably not identical to your development database.
6. Distribute the new r-code files (from Step 4) to the updated production site.

   The steps for CRC-based deployment are essentially the same as those for time stamp-based deployment, but you gain these advantages:

   - You are not required to encrypt and give end users source code.
   - End users do not have to compile your source code.
   - You do not have to send a copy of a new database to end users.
   - End users do not have to dump and reload all their data into your new database.

## R-code access authorization

One possible drawback of using CRC validation is that anyone having an OpenEdge development environment can create a counterfeit database (a database with the same structure as your database). The user can then write a program, compile it, and run it against your database.

However, you can combine CRC validation with additional security to prevent unauthorized r-code access. You can either turn on run-time permission checking or use the PROUTIL utility's DBAUTHKEY qualifier. For details on how to turn on run-time permission checking, see Maintain Application Security on page 41.

The DBAUTHKEY option of the PROUTIL utility allows you to set an authorization key for your database. When you compile your source code, OpenEdge includes the value of this authorization key in your r-code. You can also use the RCODEKEY option of PROUTIL to insert the authorization key in existing r-code. Any r-code that does not include the correct authorization key cannot run against your database. For more information about using PROUTIL to create and set database authorization keys, see *OpenEdge Data Management: Database Administration*.

# R-code CRCs and procedure integrity

When OpenEdge compiles a procedure, it calculates a special CRC based on the procedure name and code content, and stores it in the r-code. This *r-code CRC* (as distinguished from database CRC) is useful to ensure the integrity and security of ABL procedures, especially for schema triggers. In addition, you can use the r-code CRC to determine whether you must recompile a procedure file after a database change or between different versions of your application.

If you choose to have CRCs checked for a schema trigger, the r-code CRC of the trigger procedure definition is stored in the trigger schema. The trigger procedure cannot run unless it has a matching r-code CRC. This prevents a trigger procedure with the same name, but different ABL code, from being improperly substituted for the original trigger procedure. Such a substitution can cause damage to your database or override your security.

For other application r-code files, you can use the RCODE-INFO handle to build a procedure security table that contains the name and r-code CRC of each r-code file in your application (except the startup procedure). Before running a procedure, your application can use the RCODE-INFO handle to validate the r-code CRC of its r-code file against the entry established for it in the procedure security table.

---

**Note:** If there is no r-code for the procedure, any source (.p) procedure returns an Unknown (?) CRC value.

---

## Assign CRCs to schema triggers

When you create a schema trigger in the Data Dictionary, you can specify CRC checking. Then, when you save the trigger procedure, the Data Dictionary calculates its r-code CRC and stores it in the trigger metaschema record (_File-Trig for table triggers and _Field-Trig for field triggers).

If you want CRC checking for all your schema triggers, you must specify it for each schema trigger in your database. For more information, see *OpenEdge Development: Basic Development Tools* (Character only) and, in graphical interfaces, the on-line help for the Data Dictionary.

# Validate CRCs for schema triggers

When a database event occurs in your application (such as creating a record or assigning a field), OpenEdge checks whether the CRC of the corresponding trigger procedure matches the CRC in the trigger metaschema record. If it matches, OpenEdge executes the procedure. Otherwise, OpenEdge returns a run-time error.

Trigger CRC validation works for both r-code and source versions of a trigger procedure. For source versions, OpenEdge calculates the CRC during the session compile.

# RCODE-INFO handle

The `RCODE-INFO` system handle lets you read the r-code CRC from an r-code file. You can use this value to:

- Build a procedure security table, and then to verify the integrity of your application r-code against it
- Automatically install database schema trigger definitions in a deployment procedure that you run in a secure context
- Determine if you need to recompile procedure files after a database change
- Determine if procedure files have changed between different versions of your application

## Get the r-code CRC

To read the r-code CRC from an r-code file, first set the `FILE-NAME` attribute of the `RCODE-INFO` handle to the pathname of your r-code file. Then read the value of the `CRC-VALUE` attribute, as shown:

```
DEFINE VARIABLE rCRC AS INTEGER NO-UNDO.
ASSIGN
  RCODE-INFO:FILE-NAME = "sports2020/crcust.r"
  rCRC                 = RCODE-INFO:CRC-VALUE.
```

**Note:** The `RCODE-INFO` handle cannot read the r-code CRC from a session compile. For source (`.p`) procedures, the `CRC-VALUE` attribute returns the `Unknown value (?)`.

## Example: Verify application r-code integrity

Be sure to verify the integrity of your application's r-code.

To provide r-code integrity and security in your application:

1. Build the procedure security table, RcodeSecurity, with these fields:
   - **Filename** — `CHARACTER` field for the pathname of each r-code file
   - **CRC** — `INTEGER` field for the r-code CRC of the specified r-code file
2. Construct a text file, `crctable.dat`, that contains a list of the pathnames, relative to the working directory, for all the secure procedures called by your application.
3. Compile and save the r-code for all the secure procedures in your application.

4. Run a procedure that contains code to build the RcodeSecurity table. For example:

```
DEFINE VARIABLE cProcName AS CHARACTER NO-UNDO FORMAT "x(32)".
DEFINE VARIABLE ix        AS INTEGER   NO-UNDO.
INPUT FROM "crctable.dat". /* List of r-code file pathnames */
REPEAT:
  SET cProcName.
  FIND RcodeSecurity WHERE RcodeSecurity.Filename = cProcName NO-ERROR.
  IF NOT AVAILABLE(RcodeSecurity) THEN
    CREATE RcodeSecurity.
  ASSIGN
    RCODE-INFO:FILE-NAME   = cProcName.
    RcodeSecurity.Filename = cProcName
    RcodeSecurity.Crc      = RCODE-INFO:CRC-VALUE
    ix                     = ix + 1.
END.
INPUT CLOSE.
MESSAGE ix "procedure security records created".
```

5. At each point where you call a secure procedure in your application, insert this code:

```
FIND RcodeSecurity WHERE RcodeSecurity.Filename = "secret.r".
RCODE-INFO:FILE-NAME = "secret.r".
IF RcodeSecurity.Crc = RCODE-INFO:CRC-VALUE THEN
  RUN secret.
ELSE DO:
  MESSAGE "Procedure secret.r is invalid.".
  QUIT.
END.
```

## Example: Deploy schema triggers

The `trload.p` procedure installs new schema trigger definitions in an existing database. It reads dump files that contain the new data for table and field metaschema trigger records and updates these records with the new trigger procedure names and CRCs.

### trload.p

```
/* trload.p */
DEFINE VARIABLE event      AS CHARACTER NO-UNDO FORMAT "x(6)".
DEFINE VARIABLE field-name AS CHARACTER NO-UNDO FORMAT "x(32)".
DEFINE VARIABLE iCRC       AS INTEGER   NO-UNDO.
DEFINE VARIABLE ix         AS INTEGER   NO-UNDO.
DEFINE VARIABLE proc-name  AS CHARACTER NO-UNDO FORMAT "x(32)".
DEFINE VARIABLE table-name AS CHARACTER NO-UNDO FORMAT "x(32)".
INPUT FROM "_file-tr.dat". /* Table trigger data */
_fl-loop:
REPEAT:
  SET table-name event proc-name.
  ASSIGN
    RCODE-INFO:FILE-NAME = proc-name
    iCRC                 = RCODE-INFO:CRC-VALUE.
  FIND _file WHERE _file._file-name = table-name.
  FIND _file-trig WHERE _file-trig._file-recid = RECID(_file)
    AND _file-trig._event = event NO-ERROR.
  IF AVAILABLE _file-trig THEN DO:
    IF  _file-trig._proc-name = proc-name
```

```
      AND _file-trig._trig-crc  = iCRC THEN NEXT _fl-loop.
    ELSE DO:
    /* ABL doesn't let you modify a trigger record, so delete and recreate. */
      DELETE _file-trig.
      CREATE _file-trig.
      ASSIGN _file-trig._file-recid = RECID(_file)
             _file-trig._event      = event
             _file-trig._override   = TRUE
             _file-trig._proc-name  = proc-name
             _file-trig._trig-crc   = iCRC
             ix                     = ix + 1.
    END.
  END.
END.
INPUT CLOSE.
MESSAGE ix "_file-trig records updated.".

INPUT CLOSE.
MESSAGE ix "_file-trig records updated.".
INPUT FROM "_field-t.dat". /* Field trigger data */
_fld-loop:
REPEAT:
  SET table-name field-name event proc-name.
  RCODE-INFO:FILE-NAME = proc-name.
  iCRC = RCODE-INFO:CRC-VALUE.
  FIND _file WHERE _file._file-name = table-name.
  FIND _field WHERE _field._file-recid = RECID(_file) AND
                    _field._field-name = field-name.
  FIND _field-trig WHERE _field-trig._file-recid = RECID(_file) AND
                         _field-trig._field-recid = RECID(_field) AND
                         _event = event NO-ERROR.
  IF AVAILABLE _field-trig
    AND _field-trig._proc-name = proc-name
    AND _field-trig._trig-crc = iCRC THEN NEXT _fld-loop.
  ELSE DO:
    DELETE _field-trig.
    CREATE _field-trig.
    ASSIGN
      _field-trig._file-recid  = RECID(_file)
      _field-trig._field-recid = RECID(_field)
      _field-trig._event       = event
      _field-trig._override    = TRUE
      _field-trig._proc-name   = proc-name
      _field-trig._trig-crc    = iCRC
      ix                       = ix + 1.
  END.
END.
INPUT CLOSE.
MESSAGE ix "_field-trig records updated.".
```

**Note:** As this example shows, you must use the `RECID` function rather than the `ROWID` function to reference metaschema table record locations.

## Example: Determine which files are affected by a database change

The following procedure demonstrates how you can use the RCODE-INFO system handle with the TABLE-LIST and TABLE-CRC-LIST attributes to help determine which files you need to recompile based upon a database change. TABLE-LIST generates a list of all the database tables that are referenced in the procedure file. TABLE-CRC-LIST generates a list of the corresponding **table** CRC values stored in the **compiled** procedure file. This example procedure then compares the CRC values in the procedure file with those stored in the database. If any of the values differ, you get a message stating that the procedure needs to be recompiled, as shown:

```
DEFINE VARIABLE crclst AS CHARACTER NO-UNDO.
DEFINE VARAIBLE hBuff  AS HANDLE    NO-UNDO.
DEFINE VARIABLE ix     AS INTEGER   NO-UNDO.
DEFINE VARIABLE tbllst AS CHARACTER NO-UNDO.
ASSIGN
  RCODE-INFO:FILE-NAME = "main.r"
  tbllst               = RCODE-INFO:TABLE-LIST
  crclst               = RCODE-INFO:TABLE-CRC-LIST.
REPEAT ix = 1 TO NUM-ENTRIES(tbllst)
  CREATE BUFFER hBuff FOR TABLE ENTRY(ix, tbllst).
  IF hBuff:CRC-VALUE = INTEGER(ENTRY(ix, crclst)) THEN
    MESSAGE "main.r does not need to be recompiled".
  ELSE
    MESSAGE "main.r needs to be recompiled".
  DELETE OBJECT hBuff.
END.
```

This procedure does not generate any warnings or error messages. If the r-code file was not compiled with any tables, then the attribute returns the empty string. If the file is not found or is corrupted, the attribute returns the Unknown value (?).

## Example: Determine which files differ between application versions

The signature value is a unique key that is stored within a compiled procedure. Changing one character in a procedure file results in a different signature value. The following example demonstrates how you can use the RCODE-INFO system handle with the SIGNATURE-VALUE attribute to help determine which r-code files need to be replaced in your application between versions.

```
DEFINE VARIABLE signatureVal AS CHARACTER NO-UNDO.

RCODE-INFO:FILE-NAME = "main.r".
signatureVal = RCODE-INFO:SIGNATURE-VALUE.
MESSAGE "Signature value of main.r: " signatureVal.
```

This code results in the following output:

```
Signature value of main.r: zaaJAOedxIiFQfhOSZK+lcYbOEia/oF2YUOLQPCOiUM=
```

You could create a program that runs this code for two versions of the same procedure file and then compare the resulting output. If they are the same, you know the contents of the procedure file has not changed between the two versions.

# C

# OpenEdge Application Limits

The hardware and operating system version on which applications run often determines the limits for applications. This appendix lists the limits you must consider when developing an application.

For information about database limits, see *Manage the OpenEdge Database*.

For details, see the following topics:

- Input/output limits
- Sort limits
- Name limits
- Compiler limits

## Input/output limits

The following table lists input and output limitations for terminals, printers, files, and streams.

**Table 33: Input/output limits**

| Device | Operating system | Limit |
|---|---|---|
| Terminal line width | UNIX | 80 to 132 columns |
| | Windows | 80 columns |

| Device | Operating system | Limit |
|---|---|---|
| Printer line width | All | 1 to 255 columns |
| Export file | All | 1 to 3,000 characters per field; 32K bytes per record |
| Import file | All | 1 to 3,000 characters per field; 32K bytes per record |
| Input file | All | At least 2GB, and up to $2^{63}$ bytes if the operating system allows |
| Output file | All | At least 2GB, and up to $2^{63}$ bytes if the operating system allows |
| Streams | All | 1 to 50 streams per procedure |

**Note:** Windows batch files limit you to no more than nine input parameters. This is a Windows limitation; actual executables handle more than nine.

# Sort limits

The following table lists the limits for sorting data (unless otherwise specified).

**Table 34: Sorting limits**

| Category | Limit |
|---|---|
| Levels | 1 to 16 columns or expressions. |
| Size | When executing a query with a sort (BY clause), there is a size limit on the number of sort bytes the query can handle. The number of sort bytes is the number of bytes contained in all the indexes that are involved in the query for a single result-list entry. This limit is roughly 1970 bytes. The exact size limit depends on the number of columns and expressions involved in the sort. |

**Example of size limitation**

```
define temp-table tt
  field f1 as character
  field f2 as character
  index idx1 f1 f2.

create tt.
f1 = fill("1",985).
f2 = fill("2",984).  /* works as is, but increasing to 985
                        results in max key size error */

for each tt by f1 by f2:

end.
```

# Name limits

The following table lists the maximum number of characters you can use in names (unless otherwise specified).

**Table 35: Name limits**

| Name type | Operating system | Limit |
|---|---|---|
| External procedure | UNIX | 1 to 58 characters, plus a 2 character extension. |
| | Windows | 1 to 255 characters, plus a 2 character extension. |
| Pathnames | All | 1 to 255 characters. |
| Table Field Field-level widget Index | All | 1 to 32 characters; can consist of any combination of letters (a-z or A-Z), numbers (0-9), and these special characters: # $ - _ % & Names must begin with a letter. |
| Local variable of a routine Variable data member of a class Property of a class Run-time routine parameter | All | 1 to 128 characters; can consist of any combination of letters (a-z or A-Z), numbers (0-9), and these special characters: # $ - _ % & Names must begin with a letter. |
| Internal procedure Block label Query Frame widget Browse widget Menu widget Submenu widget Menu item widget | All | No set limit; can consist of any combination of letters (a-z or A-Z), numbers (0-9), and these special characters: # $ - _ % & Names must begin with a letter. |
| Stream | All | 1 to 12 characters; can consist of any combination of letters (a-z or A-Z), numbers (0-9), and these special characters: # $ - _ % & Names must begin with a letter. |
| Tables in the convmap file: Attribute table Collation table Conversion table Case table | All | 1 to 20 characters; can consist of any combination of letters (a-z or A-Z), numbers (0-9), and the hyphen character (-).Names must begin with a letter. |

# Compiler limits

The following table lists the limits for each element of the Compiler (unless otherwise specified).

[2] A routine includes a method of a class, a property accessor, a procedure, or a user-defined function.

**Table 36: Compiler limits**

| Element | Limit |
|---|---|
| Variables | 32,000 bytes for UNDO and NO-UNDO variables per external procedure. 32,000 bytes for local UNDO and local NO-UNDO variables per internal procedure or trigger block. |
| Statements | 1 to 2147483647 characters per statement. Use the Input Characters (-inp) startup parameter to limit the number of characters allowed in a single statement. The number of tokens allowed per statement is limited only by the available system resources. Each word or special character, such as a parenthesis, aplus sign, and a minus sign, counts as one token. Use the Token (-tok) startup parameter to limit the number of tokens allowed in a single statement. |
| Frames | 1 to 650 columns and rows.[3] |
| Widgets | 1 to 320 columns and rows. A compiler error will occur if the combination of a widget's position (COLUMN, ROW) and size (WIDTH-CHARS, HEIGHT-CHARS) causes any portion of the widget to be positioned past 320 columns or rows. [4] |
| Nested blocks | 20 to 20000 blocks, including called procedures. Use the Nested Blocks (-nb) startup parameter to limit the number of nested blocks allowed in a procedure. |

For more information about the Input Characters (-inp), Token (-tok), and Nested Blocks (-nb) startup parameters, see *Startup Command and Parameter Reference*.

[3] The run-time limit is 131,072.
[4] The run-time limit is 131,072.

# D

# Deployment Utilities and Scripts

This appendix provides reference information for the OpenEdge deployment utilities and scripts.

For details, see the following topics:


- Templates
- Utilities summary
- DBRSTRCT utility
- MKDUMP utility
- XCODE utility
- _tlr Module


## Templates

You can use the templates provided with OpenEdge, tailor them to the needs of your application, and supply them with your application. The following templates are located in the*install-dir*/toolkit/samplesdirectory:

- **runmenu** — Starts a single-user OpenEdge session
- **multmenu** — Starts a multi-user OpenEdge session
- **runbatch** — Starts a single-user batch OpenEdge session
- **multbat** — Starts a multi-user batch OpenEdge session

- **newdb** — Makes a copy of a basic application database
- **strtsrvr** — Starts a multi-user OpenEdge server
- **stopsrvr** (supplied on UNIX only) — Stops a multi-user OpenEdge server
- **deldb** — Deletes a database
- **dumpdb** — Dumps an application database
- **reloaddb** — Loads an application database
- **trimlog** — Discards old information from the database log file
- **upgrade** — Upgrades an existing application with new data definitions and/or procedures

# Utilities summary

The following table provides a summary of the different utilities provided with OpenEdge.

**Table 37: Deployment utilities**

| Utility | Description |
|---|---|
| DBRSTRCT | Defines the type of access that all users, including you, have to your application |
| MKDUMP | Creates procedures a user runs to dump and reload your database |
| XCODE | Encrypts source code for shipment to customer sites |
| _tlr | Lets you tailor the environment variables used on UNIX scripts |

# DBRSTRCT utility

Defines the access that all users, including you, have to your application database.

## Syntax

```
dbrstrct database-name
```

*database-name*

The name of the database for which you want to restrict access.

## Notes

- Before you define database access, it is very important that you make a copy of your application database and precompile all of your application procedures against that database. For example, suppose you do not

precompile a procedure that updates the database and then you deny update access to the database. You will be unable to compile that procedure against the newly restricted database.

- Keeping a copy of the unrestricted database also lets you redefine the database restrictions at a later time. To redefine database restrictions, dump the data from the restricted database, make a copy of the unrestricted database, define restrictions on that database copy, and reload the data into it.

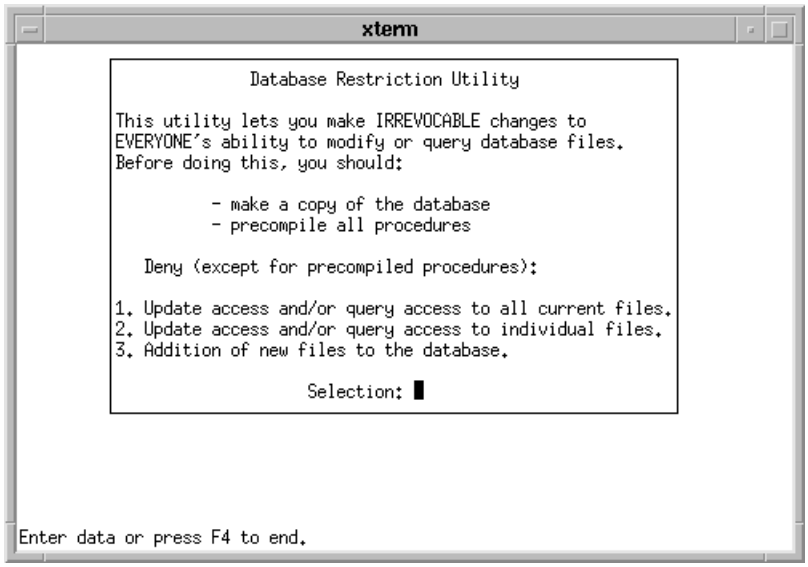
### Example

Sample DBSTRCT command:

```
dbrstrct mydb
```

As you can see from the options listed in the following image, you can define access globally, for all files, or you can define access on a file-by-file basis. Any restrictions you define affect all users, including yourself.

**Figure 21: Database Restriction Utility**




If you choose option 1 and deny update access but permit query access, no users, including yourself, will have update access to files or fields in the database, unless that update is being done by a procedure that was precompiled against the database before the database was restricted. However, all users will be able to write procedures that query the database.

# MKDUMP utility

Creates a set of file dump and file load procedures for a database.

### Syntax

```
mkdumpc database-name
```

*database-name*

The name of the database for which you want to create dump and load procedures.

### Note

The `filedump.p` and `fileload.p` procedures created by `mkdump` are meant to run from an application menu inside OpenEdge. If you plan to have end users run these procedures directly from the operating system level, you must first modify `filedump` and `fileload`. Comments in the `dumpdb` and `reloaddb` scripts or batch files explain these modifications.

### Example

Sample `MKDUMP` command:

```
mkdump mydb
```

This command creates two main ABL (Advanced Business Language) procedures: `filedump.p` and `fileload.p`. In addition, it creates two subdirectories: `dmpprocs` and `ldprocs`. The `dmpprocs` subdirectory contains a single dump procedure for each file in the database; the `ldprocs` subdirectory contains a single load procedure for each file in the database.

An end user runs the `filedump.p` procedure to dump the database. That procedure runs the procedures in the `dmpprocs` subdirectory. To load the database, the user runs `fileload.p`, which runs the procedures in the `ldprocs` subdirectory.

# XCODE utility

Encrypts ABL procedures and include files using either the default or a specified encryption key.

### Syntax

```
xcode [ -k key ][ -d directory ]{files | - }
```

*key*

A character string up to eight characters long. On UNIX, *key* is case sensitive. If you do not specify *key*, XCODE uses a default key. When OpenEdge is started with the Encrypted Compiler Mode (`-rx`) startup parameter, ABL automatically uses this default key, unless you specify the `XCODE` option on the `COMILE` statement or set the `XCODE-SESSION-KEY` attribute on the `SESSION-POLICY` handle. (The `XCODE` option takes precedence over the `XCODE-SESSION-KEY` attribute if both are in effect for a compile operation.)

The XCODE utility uses the default codepage of the operating system where it runs. To avoid possible conflicts from automatic codepage conversions, key values should use only US-ASCII characters. These characters are included in all codepages and can be located below code point 128 in the codepage.

Note that keys longer than eight characters do not generate warning or compile errors. Both the XCODE utility and the `COMPILE` statement ignore extra characters if present.

*directory*

The directory where the encrypted *files* are placed. The specified *directory* must be different from the source directory, because each encrypted file retains the name of its original source file. Existing files in *directory* are overwritten only if they are encrypted.

*files*

The pathnames, relative to the root source directory, of files to be encrypted. The pathnames supplied are appended to *directory*. Therefore, you should build a directory structure exactly parallel to the source directory structure, move to the source root, and specify relative pathnames.

- SYS$INPUT

Indicates that source filenames are to be read from standard input.

### Example

```
cd /applr001
xcode -k key1 -d applx001 *.p
```

```
find applf002/*.p | xcode -k key2 -d applx002 -
```

### Notes

- You must create the full directory structure desired for your encrypted files before running XCODE; XCODE does not create any directories implied by *directory* or *files*.
- The encryption algorithm is based on known techniques; therefore, the code is breakable. If your source code is highly sensitive, consider additional security methods.
- Encrypted include files must use the same *key* as any procedure that includes them.
- Compile encrypted procedures with the XCODE option on the COMPILE statement. (The XCODE option is not required if the procedures were encrypted with the default key or if the key is provided at the session-level by the XCODE-SESSION-KEY attribute of the SECURITY-POLICY handle.) Whatever the source, the key used by the COMPILE statement must match the key used with the XCODE utility. The *ABL Reference* describes the COMPILE statement in detail.

# _tlr Module

Changes the default values of environment variables as defined in various scripts.

## Syntax

```
_tlr var-namereplace-valuefile-name . . .
```

```
_tlr var-namereplace-value -< file-list
```

The first syntax format processes one file at a time. The second processes a list of files read from a file.

*var-name*

A constant character string that identifies the environment variable whose value you want to modify.

*replace-value*

A constant character string that identifies the new default value of the environment variable.

*file-name*

The name of the file in which you want to modify the default value of the environment variable.

*file-list*

The name of a file containing a list of filenames in which you want to modify the value of the environment variable.

## Example

Several of the scripts provided with OpenEdge name the DLC environment variable, as follows:

```
DLC=${DLC-/usr/dlc}
```

In this example, if the value of the DLC environment variable has been defined, the script uses the value of that variable. Otherwise, it uses /usr/dlc as the value of DLC.

To change the default value of the DLC variable to /tmp/dlc in a script named test.dat, use this command:

```
_tlr DLC /tmp/dlc test.dat
```

This command changes the environment variable line in test.dat from:

```
DLC=${DLC-/usr/dlc}
```

To:

```
DLC=${DLC-/tmp/dlc}
```

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