Progress®



OpenEdge® Development:
Web Services

OpenEdge®

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Preface

For details, see the following topics:

- Purpose
- Audience
- Organization
- Use ABL documentation
- Typographical conventions
- Examples of syntax descriptions
- OpenEdge messages

Purpose

This manual describes how OpenEdge supports both SOAP and REST Web services. It describes the technology for exposing AppServer™ application services as Web services and how to access them from client applications. It also describes Data Object Services, a type of REST Web services that provide access to OpenEdge data and business logic for mobile and Web apps with support for complex transaction management.

This manual also provides a brief overview of SOAP and REST Web services architecture in OpenEdge. For a complete description of SOAP Web services architecture for the OpenEdge AppServer, including all components and how they work together, see *OpenEdge Getting Started: Application and Integration Services*.

This manual describes the general procedures and facilities for building OpenEdge Web services, as well as specific client requirements. For additional information on Web service development, deployment, and administration, see the following documentation:

- **Web service development:**

- *OpenEdge Application Server: Developing AppServer Applications*
- *OpenEdge Development: Open Client Introduction and Programming*
- Progress Developer Studio for OpenEdge online help, the *Progress Developer Studio for OpenEdge Guide*

- **Web service deployment and administration:**
  - *OpenEdge Application Server: Administrator*
  - *OpenEdge Management or OpenEdge Explorer* online help
  - *OpenEdge Development: Messaging and ESB* (for deploying and managing OpenEdge Web services for the Sonic ESB using the Sonic ESB Adapter)

Note: For information on development, deployment, and administration of Web services for the Progress Application Server for OpenEdge, see the documentation set for this OpenEdge application server.

Audience

This manual is intended for experienced ABL developers who want to either expose their AppServer-enabled applications as Web services or consume Web services in their ABL applications.

Organization

Introduction

Web Services in OpenEdge on page 27

Describes the alternatives (SOAP and REST) for implementing Web services in OpenEdge®

Overview of REST Web services in OpenEdge on page 31

Describes how OpenEdge supports REST-based Web services.

Overview of SOAP Web services in OpenEdge on page 39

Describes how OpenEdge supports a SOAP Web services.

Creating OpenEdge REST Web Services

REST Applications on page 57

Contains technical details about OpenEdge REST applications.

REST Application Security on page 75

Contains general security information with regard to OpenEdge REST applications.

Data Object Services on page 81

Provides an overview and requirements for building Data Object Services, a type of REST Web service, with additional information, that allows mobile and web clients to access a set of standard CRUD operations, as well as custom ABL business logic, on a single OpenEdge data resource (Data Object).

Creating OpenEdge SOAP Web Services

Exposing AppServer Applications as OpenEdge SOAP Web Services on page 111

Describes the initial decisions that you need to make when you transform an AppServer-enabled application into an OpenEdge Web service. This includes discussions of SOAP formats and session models.

Building Clients for OpenEdge SOAP Web services on page 119

Discusses how to build a client that consumes your OpenEdge Web service. This includes discussions of how SOAP formats, session models, and the structure of your ABL application impact the programming of the client.

Sample Code with SOAP Messages for OpenEdge Web Services on page 143

Details the techniques for consuming OpenEdge Web service operations in a non-ABL client, showing the types of SOAP messages that are generated for various types of SOAP requests.

Test and debug OpenEdge SOAP Web Services on page 165

Describes how to test and debug OpenEdge Web services using log files, SOAP viewers, and basic SOAP fault handling techniques.

Creating ABL Clients to Consume OpenEdge SOAP Web Services

Create an ABL Client from WSDL on page 181

Describes how to access a Web service from an ABL application. This includes using the WSDL Analyzer to generate sample ABL code for connecting to the Web service and calling its operations. The chapter also describes how OpenEdge maps ABL data types to the XML Schema data types interpreted by Web services.

Connecting to OpenEdge SOAP Web Services from ABL on page 205

Describes how to connect to and manage connections to a Web service from ABL.

Invoking OpenEdge SOAP Web Service Operations from ABL on page 213

Describes how to invoke and manage Web service operations from ABL. This includes information on managing both simple and complex data in parameters and managing asynchronous requests.

Handling SOAP Message Headers in ABL on page 225

Describes how to manage SOAP message headers in ABL for Web service operations that are configured for SOAP header management. This includes a detailed description of ABL techniques for accessing, manipulating, creating, and managing all elements of a SOAP message header.

Handling Errors in ABL Requests to OpenEdge SOAP Web Services on page 255

Describes how to manage errors from ABL requests to Web services in general and for SOAP faults in particular. This includes a detailed description of ABL techniques for accessing all elements of a SOAP fault message.

Appendices

Developing a .NET Client to Consume OpenEdge SOAP Web Services on page 271

Describes a sample scenario in which a .NET client application is developed to access a OpenEdge Web service.

Develop a Java Client to Consume OpenEdge SOAP Web Services on page 295

Describes a sample scenario in which a Java™ client application is developed to access a OpenEdge Web service.

ABL Elements to Consume SOAP Web Services on page 323

Provides a quick reference to the basic ABL elements provided by OpenEdge to access Web services.

Data Type Conversion Rules for ABL Calls to SOAP Web Services on page 337

Describes in detail the key rules used to transform data for Web service operation parameters between alternative mappings of ABL data types and XML Schema data types.

WSDL Details on page 355

Provides a closer look at how certain ABL features are defined in the WSDL file that ProxyGen creates.

The WSDL Analyzer on page 373

Describes the syntax for commands and utilities documented in this manual. If this manual provides the primary documentation for a command or utility, the syntax for that command or utility appears in this appendix.

Use ABL documentation

OpenEdge provides a special purpose programming language for building business applications. In the documentation, the formal name for this language is *ABL (Advanced Business Language)*. With few exceptions, all keywords of the language appear in all UPPERCASE, using a font that is appropriate to the context. All other alphabetic language content appears in mixed case.

For the latest documentation updates go to https://docs.progress.com.

References to ABL compiler and run-time features

ABL is both a compiled and an interpreted language that executes in a run-time engine. The documentation refers to this run-time engine as the *ABL Virtual Machine (AVM)*. When the documentation refers to ABL source code compilation, it specifies *ABL* or *the compiler* as the actor that manages compile-time features of the language. When the documentation refers to run-time behavior in an executing ABL program, it specifies *the AVM* as the actor that manages the specified run-time behavior in the program.

For example, these sentences refer to the ABL compiler's allowance for parameter passing and the AVM's possible response to that parameter passing at run time: "ABL allows you to pass a dynamic temp-table handle as a static temp-table parameter of a method. However, if at run time the passed dynamic temp-table schema does not match the schema of the static temp-table parameter, the AVM raises an error." The following sentence refers to run-time actions that the AVM can perform using a particular ABL feature: "The ABL socket object handle allows the AVM to connect with other ABL and non-ABL sessions using TCP/IP sockets."

References to ABL data types

ABL provides built-in data types, built-in class data types, and user-defined class data types. References to built-in data types follow these rules:

- Like most other keywords, references to specific built-in data types appear in all UPPERCASE, using a font that is appropriate to the context. No uppercase reference ever includes or implies any data type other than itself.
- Wherever *integer* appears, this is a reference to the `INTEGER` or `INT64` data type.
- Wherever *character* appears, this is a reference to the `CHARACTER`, `LONGCHAR`, or `CLOB` data type.
- Wherever *decimal* appears, this is a reference to the `DECIMAL` data type.
- Wherever *numeric* appears, this is a reference to the `INTEGER`, `INT64`, or `DECIMAL` data type.

References to built-in class data types appear in mixed case with initial caps, for example, `Progress.Lang.Object`. References to user-defined class data types appear in mixed case, as specified for a given application example.

Typographical conventions

This documentation uses the following typographical and syntax conventions:

Convention	Description
Bold	Bold typeface indicates commands or characters the user types, provides emphasis, or the names of user interface elements.
Italic	Italic typeface indicates the title of a document, or signifies new terms.
SMALL, BOLD CAPITAL LETTERS	Small, bold capital letters indicate OpenEdge key functions and generic keyboard keys; for example, **GET** and **CTRL**.
KEY1+KEY2	A plus sign between key names indicates a **simultaneous** key sequence: you press and hold down the first key while pressing the second key. For example, **CTRL+X**.
KEY1 KEY2	A space between key names indicates a **sequential** key sequence: you press and release the first key, then press another key. For example, **ESCAPE H**.
Syntax:	
`Fixed width`	A fixed-width font is used in syntax, code examples, system output, and file names.
`Fixed-width italics`	Fixed-width italics indicate variables in syntax.
`Fixed-width bold`	Fixed-width bold italic indicates variables in syntax with special emphasis.
`UPPERCASE fixed width`	ABL keywords in syntax and code examples are almost always shown in upper case. Although shown in uppercase, you can type ABL keywords in either uppercase or lowercase in a procedure or class.
Period (.) or colon (:)	All statements except `DO`, `FOR`, `FUNCTION`, `PROCEDURE`, and `REPEAT` end with a period. `DO`, `FOR`, `FUNCTION`, `PROCEDURE`, and `REPEAT` statements can end with either a period or a colon.
[ ]	Large brackets indicate the items within them are optional.
[ ]	Small brackets are part of ABL.
{ }	Large braces indicate the items within them are required. They are used to simplify complex syntax diagrams.
{ }	Small braces are part of ABL. For example, a called external procedure must use braces when referencing arguments passed by a calling procedure.

Convention	Description
|	A vertical bar indicates a choice.
. . .	Ellipses indicate repetition: you can choose one or more of the preceding items.

Examples of syntax descriptions

In this example, ACCUM is a keyword, and *aggregate* and *expression* are variables:

Syntax

```
ACCUM aggregate expression
```

FOR is one of the statements that can end with either a period or a colon, as in this example:

```
FOR EACH Customer NO-LOCK:
  DISPLAY Customer.Name.
END.
```

In this example, STREAM *stream*, UNLESS-HIDDEN, and NO-ERROR are optional:

Syntax

```
DISPLAY [ STREAM stream ] [ UNLESS-HIDDEN ] [ NO-ERROR ]
```

In this example, the outer (small) brackets are part of the language, and the inner (large) brackets denote an optional item:

Syntax

```
INITIAL [ constant [ , constant ] ]
```

A called external procedure must use braces when referencing compile-time arguments passed by a calling procedure, as shown in this example:

Syntax

```
{ &argument-name }
```

In this example, EACH, FIRST, and LAST are optional, but you can choose only one of them:

Syntax

```
PRESELECT [ EACH | FIRST | LAST ] record-phrase
```

In this example, you must include two expressions, and optionally you can include more. Multiple expressions are separated by commas:

Syntax

```
MAXIMUM ( expression , expression [ , expression ] ... )
```

In this example, you must specify MESSAGE and at least one *expression* or SKIP [(*n*)], and any number of additional *expression* or SKIP [(*n*)] is allowed:

Syntax

```
MESSAGE { expression | SKIP [ ( n ) ] } ...
```

In this example, you must specify {*include-file*, then optionally any number of *argument* or &*argument-name* = "*argument-value*", and then terminate with }:

Syntax

```
{ include-file
    [ argument | &argument-name = "argument-value" ] ... }
```

Long syntax descriptions split across lines

Some syntax descriptions are too long to fit on one line. When syntax descriptions are split across multiple lines, groups of optional and groups of required items are kept together in the required order.

In this example, WITH is followed by six optional items:

Syntax

```
WITH [ ACCUM max-length ] [ expression DOWN ]
  [ CENTERED ] [ n COLUMNS ] [ SIDE-LABELS ]
  [ STREAM-IO ]
```

Complex syntax descriptions with both required and optional elements

Some syntax descriptions are too complex to distinguish required and optional elements by bracketing only the optional elements. For such syntax, the descriptions include both braces (for required elements) and brackets (for optional elements).

In this example, ASSIGN requires either one or more *field* entries or one *record*. Options available with *field* or *record* are grouped with braces and brackets:

Syntax

```
ASSIGN   { [ FRAME frame ] { field [ = expression ] }
           [ WHEN expression ] } ...
       | { record [ EXCEPT field ... ] }
```

OpenEdge messages

OpenEdge displays several types of messages to inform you of routine and unusual occurrences:

- **Execution messages** inform you of errors encountered while OpenEdge is running a procedure; for example, if OpenEdge cannot find a record with a specified index field value.
- **Compile messages** inform you of errors found while OpenEdge is reading and analyzing a procedure before running it; for example, if a procedure references a table name that is not defined in the database.
- **Startup messages** inform you of unusual conditions detected while OpenEdge is getting ready to execute; for example, if you entered an invalid startup parameter.

After displaying a message, OpenEdge proceeds in one of several ways:

- Continues execution, subject to the error-processing actions that you specify or that are assumed as part of the procedure. This is the most common action taken after execution messages.
- Returns to the Procedure Editor, so you can correct an error in a procedure. This is the usual action taken after compiler messages.
- Halts processing of a procedure and returns immediately to the Procedure Editor. This does not happen often.
- Terminates the current session.

OpenEdge messages end with a message number in parentheses. In this example, the message number is 200:

```
** Unknown table name table. (200)
```

If you encounter an error that terminates OpenEdge, note the message number before restarting.

Obtain more information about OpenEdge messages

In Windows platforms, use OpenEdge online help to obtain more information about OpenEdge messages. Many OpenEdge tools include the following Help menu options to provide information about messages:

- Choose **Help** > **Recent Messages** to display detailed descriptions of the most recent OpenEdge message and all other messages returned in the current session.
- Choose **Help** > **Messages** and then type the message number to display a description of a specific OpenEdge message.
- In the Procedure Editor, press the **HELP** key or **F1**.

On UNIX platforms, use the OpenEdge `pro` command to start a single-user mode character OpenEdge client session and view a brief description of a message by providing its number.

To use the pro command to obtain a message description by message number:

1. Start the Procedure Editor:

```
OpenEdge-install-dir/bin/pro
```

2. Press **F3** to access the menu bar, then choose **Help** > **Messages**.
3. Type the message number and press **ENTER**. Details about that message number appear.
4. Press **F4** to close the message, press **F3** to access the Procedure Editor menu, and choose **File** > **Exit**.

I

Introduction

For details, see the following topics:

- Web Services in OpenEdge
- Overview of REST Web services in OpenEdge
- Overview of SOAP Web services in OpenEdge

1

Web Services in OpenEdge

This chapter describes the alternatives (SOAP and REST) for implementing Web services in OpenEdge®.

For details, see the following topics:

- Web services
- Comparing OpenEdge support for SOAP WSA and REST Web services
- Choosing between SOAP and REST in OpenEdge

Web services

A *Web service* is an application that can be accessed and used over the Internet (or an intranet) using industry-standard protocols. In OpenEdge, a Web service is usually an AppServer™ application that is accessible to a client application through a Web server.

In OpenEdge, you can:

- Create new Web services that you build as ABL (Advanced Business Language) applications and deploy on an AppServer.
- Expose existing AppServer applications as Web services.
- Create an interface to your Web services and deploy it on a Web server.
- Create the client-side applications that interact with your Web services.

OpenEdge includes support for Web services that are based either on SOAP, or on REST.

SOAP (Simple Object Access Protocol) uses XML messages to exchange information between client-side applications and Web services. WSDL files publicize and describe the public interface to Web services. The XML Schema standard describes both simple and complex data types in WSDL files. SOAP uses HTTP only as a transport protocol. In OpenEdge, you deploy SOAP Web services on a Web Services Adapter (WSA) which runs in a Java Servlet Container on a Web server.

REST (Representation State Transfer) uses HTTP more extensively than SOAP. REST uses URIs to identify resources and employs HTTP verbs (GET, PUT, POST, DELETE) as methods to act upon resources. In OpenEdge, JSON is used as the data-interchange format. In OpenEdge, you deploy REST Web services in Web Application Archive files which run in a Java Servlet Container on a Web server.

Both SOAP and REST are industry standards, but there are many variations on how they are implemented. If you do a Web search, you will find a wealth of information on the standards and the variety of their implementation. For a high-level view of how they are implemented in OpenEdge, see Overview of REST Web services in OpenEdge on page 31 and Overview of SOAP Web services in OpenEdge on page 39.

Comparing OpenEdge support for SOAP WSA and REST Web services

The following table summarizes SOAP WSA and REST application support in OpenEdge.

Table 1: WSA and REST support in OpenEdge

	WSA	REST
OpenEdge Components deployed on the Web server	• Web Services Adapter (WSA) • Web service property file • Web Service Application Descriptor (WSAD) file • Web Services Description Language (WSDL) file	• Web Application Archive (WAR) files • REST Management Agent (optional)
Web service development tools	• ProxyGen, • WSDL Analyzer (bprowsdldoc)	• Progress Developer Studio for OpenEdge (PDSOE) • RESTGEN
Management tools	• OpenEdge Management/ OpenEdge Explorer • WSA Management Utility (WSAMAN)	• OpenEdge Management/ OpenEdge Explorer, • REST Management Utility (RESTMAN)

	WSA	REST
Supported AppServer session models	• Session-managed • Session-free	• Session-free
Supported AppServer operating modes	• State-free (recommended) • Stateless • State-aware • State-reset	• State-free (preferred) • Stateless (limited functionality)

Choosing between SOAP and REST in OpenEdge

Before you implement Web services in OpenEdge, you must decide whether your Web services will be accessed through the SOAP (WSA or through REST applications. Consider the following before you make your decision:

- REST application development in OpenEdge is supported by Progress Developer Studio for OpenEdge (PDSOE). PDSOE is an individual OpenEdge product that you must install before beginning REST application development. If you do not have access to PDSOE, WSA is a better choice.

  Note: PDSOE support for REST application development is available only on Windows platforms.

- REST in OpenEdge is limited to HTTP/HTTPS as a transport protocol. SOAP can use other transport protocols, such as FTP and JMS. Therefore, WSA is necessary if you must use a protocol other than HTTP/HTTPS.
- Both WSA and REST applications are more efficient with AppServers running in state-free mode. REST supports limited functionality with stateless AppServers and is incompatible with AppServers running in state-reset or state-aware modes. If you must connect to a stateless, state-reset, or state-aware AppServer, you cannot use REST.
- REST is considered to be simpler by many because it uses basic HTTP methods (GET, POST, etc.) and URIs rather than APIs to interact with Web services. WSA requires generation of a Web service client from a WSDL file for each platform you intend to support, whereas OpenEdge REST applications are accesible to any client on any platform as long as the client supports HTTP 1.1 and can parse JSON data types.
- REST is necessary if you intend to develop mobile or Web apps that access OpenEdge data using Data Objects. The WSA does not support Data Objects.

  Note: A Data Object Service is a type of REST Web service that avoids the need for mobile or Web apps to access REST resources directly and offers support for complex data transactions. Developing Data Object Services in PDSOE requires a separate project type from developing REST Web services. For more information, see Data Object Services on page 81.

2

Overview of REST Web services in OpenEdge

This chapter describes how OpenEdge supports REST-based Web services.

For details, see the following topics:

- Standards supported by OpenEdge REST Web Services
- REST Web service architecture in OpenEdge
- Tools for REST application development and management
- Creating OpenEdge REST applications
- Clients for OpenEdge REST Web services

Standards supported by OpenEdge REST Web Services

OpenEdge REST Web services employ industry standards described in the following sections:

- HTTP on page 31
- JSON on page 32

HTTP

OpenEdge REST Web services employs HTTP for accessing and manipulating resources. In general, HTTP is the defacto standard for REST.

OpenEdge REST uses HTTP methods (GET, POST, PUT, DELETE for example) to interact with resources that are mapped to URIs. (Compare with the SOAP-based OpenEdge WSA, which only uses HTTP as a transport protocol, and uses complicated WSDL mappings to provide access to procedures.)

For the latest specification on HTTP, visit the following Web site:

```
http://tools.ietf.org/html/rfc2616
```

JSON

JSON is data-interchange language formatted as text, that is language independent. OpenEdge REST Web services use JSON objects to exchange data in requests from clients and in responses from resources.

For more information about JSON, visit the following Web site:

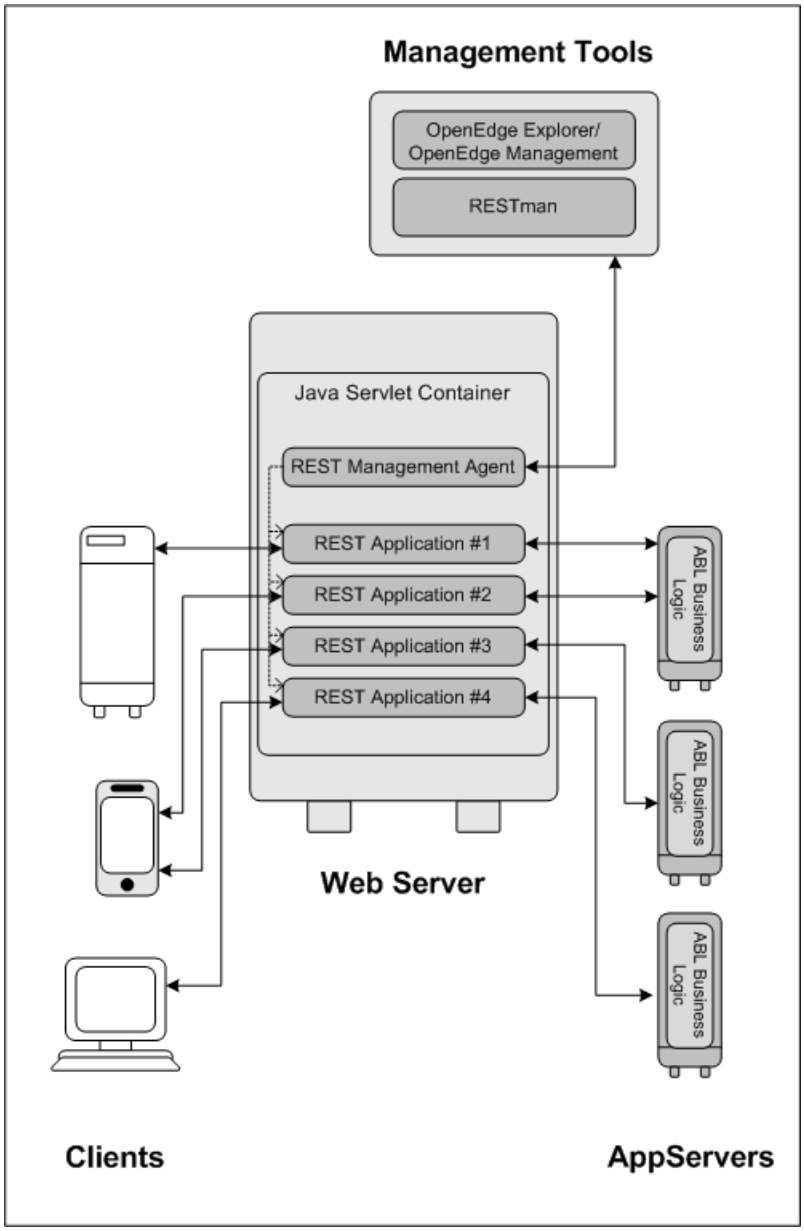
```
http://www.json.org/
```

For information about JSON support in OpenEdge, see *OpenEdge Development: Working with JSON* and *OpenEdge Development: ABL Reference*.

REST Web service architecture in OpenEdge

The following figure is a general illustration of the components in an implementation of OpenEdge REST Web services.

Figure 1: OpenEdge REST Web services architecture



As illustrated in the above figure, the components of an OpenEdge REST application deployment can be grouped in four distinct functional areas:

- **AppServers** — The ABL business logic that is accessed by OpenEdge REST applications resides on one or more AppServers.
- **Web Server** — OpenEdge REST applications are Web Application Archive (WAR) files that reside in a Java Servlet Container on a Web server. OpenEdge REST applications interpret incoming HTTP requests from REST client applications and return results from ABL business logic executed by AppServers.

The Web server's Java Servlet Container is also the host of the OpenEdge REST Management Agent, which is an OpenEdge REST application that you can optionally install. It enables the management of other of the OpenEdge REST applications through OpenEdge utilities.

- **Management Tools** — The interfaces to the REST Management Agent on the Web server are the command line utility, RESTMAN, and the browser-based OpenEdge Explorer/OpenEdge Management tools.
- **Clients** — OpenEdge REST clients can reside on a variety of devices, including servers, desktop, and mobile devices (especially using Data Object Services).

Tools for REST application development and management

This section contains a brief description of the tools that support REST application development in OpenEdge.

Progress Developer Studio for OpenEdge

Progress Developer Studio is an Eclipse-based integrated development environment that supports a number of ABL project types. For ABL REST applications, Progress Developer Studio support includes:

- A REST project type that is specialized for developing and deploying ABL REST applications
- A Define Service Interface wizard for annotating the ABL procedures and class files that will be REST services
- A New REST Service dialog for creating the invocation files that describe the procedure and class files that comprise REST services
- A REST Expose Editor for mapping the resources in REST services to HTTP pathnames
- An Export as REST Application wizard to package REST application WAR files
- An Apache Tomcat Web server which provides a Java container for running and testing REST applications
- A dialog for associating or disassociating the REST application with a REST Manager (which enables configuration and management using OEM/OEE or RESTMAN)
- Functionality for publishing, with a variety of options, to multiple Web servers

See the *Progress Developer Studio for OpenEdge Guide*, which is the online help volume for Progress Developer Studio, for more information on REST application development.

Also see Creating OpenEdge REST applications on page 35 for an overview of REST application development in OpenEdge.

OpenEdge Management (OEM) and OpenEdge Explorer (OEE)

If an OpenEdge REST Manager is installed in the Java Servlet Container, you can use OEM/OEE to configure and manage OpenEdge REST applications deployed on a Web server. The tasks you can perform include:

- Defining connections to the OpenEdge REST Manager
- Viewing the status of the OpenEdge REST Manager
- Configuring OpenEdge REST Manager properties
- Viewing a list of deployed OpenEdge REST applications
- Viewing log files

- Viewing runtime statistics
- Setting up monitoring plans and rules
- Deploying OpenEdge REST applications
- Viewing OpenEdge REST application status
- Configuring OpenEdge REST application properties
- Viewing OpenEdge REST application statistics

See *OpenEdge Management and OpenEdge Explorer: Configuration* for more information about configuring and managing OpenEdge REST applications.

RESTMAN

The RESTMAN utility is a command-line utility for configuring and managing OpenEdge REST applications deployed on a Web server. The configuration and management support provided by the RESTMAN utility duplicates the functionality provided by OEM/OEE. Like OEM/OEE, depends on the installation of an OpenEdge REST Manager in the Java Servlet Container.

See *OpenEdge Application Server: Administration* for more information about RESTMAN.

Creating OpenEdge REST applications

This section is an overview of REST application development in OpenEdge. It also points to sources for more information on various topics and tasks.

Developing an OpenEdge REST application requires these steps:

1. Planning on page 35
2. Configuring an AppServer on page 36
3. Creating a REST project on page 36
4. Creating an AppServer REST service interface on page 37
5. Creating REST Web services on page 37
6. Adding static resources to your project on page 37
7. Generating an OpenEdge REST application on page 38
8. Testing the REST application on an Apache Tomcat Web server on page 38
9. Deploying the REST application on page 38

Planning

Before you begin developing OpenEdge REST applications, you should make some decisions regarding:

- The AppServer or AppServers that will run the ABL business logic required by your REST application. AppServers running in the state-free mode are recommended.
- The Web server or servers where you intend to deploy your REST application. OpenEdge REST applications must be deployed in a Java Servlet container on a Web server.
- The new or existing AppServer procedures and classes that you need to implement REST services for your application. You also need to determine the input and output parameters that you will map as REST resources.

- The structure of the URI namespace that you will create to expose REST resources

Configuring an AppServer

OpenEdge REST applications communicate with an AppServer running the ABL business logic required by your application. Note that the REST application WAR file deployed on a Web server can optionally contain other static or dynamic resources (HTML files, graphics files, etc.).

For OpenEdge REST applications, an AppServer running in the state-free operating mode is recommended. This mode supports a connectionless and context-free interaction between the REST application on the Web server and the ABL application on the AppServer. By definition, a REST application contains all state information in the request and response messages. No state is saved on the server.

OpenEdge REST applications are designed to act as typical Web applications that transparently pass the Web server's authenticated user-id (in the form of an ABL Client-Principal) and session-id (in the form of a CCID) to the AppServer on each request. The AppServer can access that identity information at any time during the execution of the remote request, including the AppServer Activate and Deactivate procedures.

It is possible, however, to access an AppServer running in the stateless operating mode. However, when a REST application accesses a stateless AppServer it disconnects after each HTTP request. You cannot establish a bound connection between a REST client and a stateless AppServer agent. Without a bound connection, your application cannot use the stateless mode's CONNECT/DISCONNECT procedures for login sessions, and it cannot use the ABL SESSION system handle's SERVER-CONTEXT-ID or SERVER-CONTEXT-STRING attributes.

Note that AppServer state-reset and state-aware modes are not appropriate for REST applications and are not supported.

For more information about AppServer configuration and operating modes, see *OpenEdge Application Server: Administration* and *OpenEdge Application Server: Developing AppServer Applications.*

Creating a REST project

Use Progress Developer's Studio for OpenEdge to create a Server project that is automatically configured for OpenEdge REST application development. Other OpenEdge application development tools are not enabled to support REST application development. While it is possible to create REST applications using other editing and command line tools, the functionality embedded in PSDOE is necessary for building a deployable OpenEdge REST applications.

REST is a transport that you choose when creating an OpenEdge Server project in Progress Developer Studio, which is an Eclipse-based development environment for all types of OpenEdge applications. The REST transport option includes project facets for REST application development support. For example, for a Classic Server project, the REST transport includes an AppServer facet, which allows you to expose AppServer procedures and create a service interface. In addition, when you choose the REST transport, a built-in Web server is configured to deploy and test the applications your are building.

If you have an existing project in Progress Developer Studio, you can extend it for Classic REST application development by adding the AppServer, JavaScript, Progress Adapters, and REST facets to the project's properties.

The online help for Progress Developer Studio has specific information on using Progress Developer Studio for OpenEdge REST application development.

Creating an AppServer REST service interface

An AppServer REST service interface exposes the AppServer procedures, user-defined functions, and class methods that you want to specify as REST resources. You edit ABL code to include the annotations that define the service interface. Then, you generate a Progress Interface Definition Language (`.pidl`) file, which enables communication between the REST application on a Web server and a procedure on an AppServer.

Note: You may have defined service interfaces and generated `.pidl` files for other clients (WSA, for example). You should not attempt to reuse those service interface definitions for REST.

The Define Service Interface Wizard in Progress Developer Studio facilitates the process of creating a service interface tailored for REST. Progress Developer Studio also supports the automatic generation of `.pidl` files whenever a project build occurs. See the Progress Developer Studio online help for more information.

Also see REST annotations in ABL code on page 57.

Creating REST Web services

Each OpenEdge REST application includes at least one REST service. Multiple REST services can be included when generating a REST application, or can be included later as add-ons.

To create a REST service in OpenEdge:

1. Specify a unique name for the REST service.
2. Specify a root URI for the REST service.

   Any resources added to the REST service will be specified relative to the root URI. (Note that the root URI does not specify a domain name, since an individual REST service could be deployed on any number of Web servers.)

3. Map addresses to the resources exposed by the REST service interface.

   Addresses specify the path to a resource relative to the root URI and can contain HTTP methods (GET, PUT, POST, DELETE, INVOKE).

   Note that in REST, anything that must be accessible must be mapped with a unique URI. This includes input and output parameters. (Compare with WSA and other SOAP architectures, where you generate APIs for parameters rather than treating them as resources.

Creating REST Web services is fully supported by wizards and editors in Progress Developer Studio. For more information about Progress Developer Studio tools, see the online help volume, *Progress Developer Studio for OpenEdge Guide*.

Also see REST services in OpenEdge on page 60.

Adding static resources to your project

In Progress Developer Studio, you can add static files (HTML pages, graphics, JavaScript, etc.) to your project. These static files can be added to the OpenEdge REST application that is deployed on a Web server. Deploying the static files on the Web server is more efficient than dynamically generating them from the AppServer in response to a client request.

Generating an OpenEdge REST application

After you have created one or more REST Web services and included any static files in your Progress Developer Studio REST project, you can generate an OpenEdge REST application. OpenEdge REST applications are packaged as a Java Web application Archive (WAR) file.

Testing the REST application on an Apache Tomcat Web server

The Progress Developer Studio for OpenEdge provides Apache Tomcat as a default Web server to deploy your REST services and REST applications for testing. The Apache Tomcat web server can be installed and configured from the OpenEdge installation kit. It provides a basic Java Servlet container where you can deploy your REST application. The Apache Tomcat server is available in your OpenEdge installation directory, `$DLC/servers/tomcat`.

Deploying the REST application

To deploy an OpenEdge REST application to a Web server, you use the publish functionality in the Servers view of Progress Developer Studio.

Before you publish, you can use Progress Developer Studio to deploy a REST Manager to the target Web server. Publish a REST Manager only if you intend to use RESTMAN or OEM/OEE to manage your OpenEdge REST applications. For security reasons, you can do without the REST Manager deployment. For example, you probably would not deploy REST Manager on a Web server running in a network's DMZ.

Clients for OpenEdge REST Web services

A client for OpenEdge REST Web services can be any application that can communicate with an OpenEdge REST application on a Web sever. The only requirements are that the client is enabled to support HTTP 1.1 and that the client can parse JSON data.

If you intend to develop a client that runs on a mobile device, you will find development support in Progress Developer Studio for providing access to OpenEdge data and ABL business logic. For more information, see Data Object Services on page 81.

3

Overview of SOAP Web services in OpenEdge

This chapter describes how OpenEdge supports a SOAP Web services.

For details, see the following topics:

- Standards supported by OpenEdge SOAP Web services
- SOAP Web service architecture in OpenEdge
- Creating OpenEdge SOAP Web services
- Creating ABL clients to consume SOAP Web services
- Sample of consuming a SOAP Web service

Standards supported by OpenEdge SOAP Web services

To implement SOAP Web services, OpenEdge supports the industry standards described in the following sections:

- WSDL files on page 40
- SOAP on page 40
- XML Schema on page 41

WSDL files

Most SOAP Web services publicize and describe the public interface to their Web services using WSDL. The WSDL file describes the Web service interface, including how to call Web service operations and the binding requirements to access the Web service. OpenEdge uses this standard, whether you are producing an OpenEdge Web service or consuming a Web service with an ABL client.

Accessing many Web services requires little, if any, knowledge of WSDL. For complex Web services, such as those requiring the use of SOAP headers, you should have a basic understanding of WSDL to make full use of the Web service and to access its data appropriately.

A WSDL file describes Web services in sections that define features of the Web service interfaces, from data and operations to the binding information needed to access the Web services on the network. Each section has a corresponding WSDL element:

- **Definitions** — Defines the Web service.
- **Types** — Defines the XML Schema for each Web service object and SOAP fault.
- **Messages** — Defines the request and response messages.
- **Port types** — Defines the signatures for all the Web service's operations.
- **Bindings** — Defines the SOAP bindings for all the Web service objects. The bindings describe how operations in a port type are mapped to the SOAP protocol.
- **Services** — Defines the deployed locations of all the Web service objects.

Note: Not all Web services use these elements in exactly the same manner. For more information on WSDL files for OpenEdge Web services, see Web service objects and the WSDL file on page 112.

WSDL is a standard defined by the W3C. For more information, visit the following Web site:

```
http://www.w3.org/TR/wsdl
```

SOAP

SOAP is a protocol used to format message exchanges between Web service clients and Web services. The industry currently considers many scenarios for Web services communications (described at http://www.w3.org/TR/ws-arch-scenarios/). OpenEdge supports the request-response scenario.

In the request-response scenario, a client (Web service client) sends a SOAP request message to invoke a Web service operation on the Web service provider and the provider sends a response back to the client in the form of a SOAP response message (for a successful invocation) or in the form of a SOAP fault message (for an invocation that results in an error).

Given the automated resources available for producing and consuming Web services, you might not need to understand much about SOAP messages. The following sections give a brief overview of SOAP messages.

SOAP message formats

SOAP messages can be formatted using different SOAP message styles and encoding combinations. The *style* indicates how the SOAP message is structured. The *encoding* describes how data values are represented. The following table lists the SOAP message formats that OpenEdge supports.

Table 2: SOAP message formats

Format	Notes
Document/Literal (Doc/Lit)	This is the recommended format for OpenEdge Web services. It works well for ABL and .NET clients. This includes the wrapped document literal (Wrapped Doc/Lit) convention (developed by Microsoft). Wrapped Doc/Lit is a convention using Doc/Lit that wraps all request parameters for an operation into one input XML complex type and wraps all response parameters into a separate output XML complex type.
RPC/Literal	Use this format for clients that do not support Doc/Lit.
RPC/Encoded	An earlier standard. The Web Services Interoperability Organization recommends against this format in their *Basic Profile Version 1.0*.

SOAP message document structure

SOAP messages have a common XML document structure that consists of the following ordered elements:

- The envelope is a mandatory element containing the optional header element and mandatory body element. It defines all the *namespaces* used in the document. Namespaces are identifiers that provide a way to define XML elements without name conflicts.
- The header is an optional element containing application-specific information, such as context and standard attributes that describe the operation.
- The body is a mandatory element containing data (for a request or response) or error information (for a fault).

SOAP is a standard defined by the W3C. OpenEdge supports SOAP Versions 1.1 and 1.2. For more information on these SOAP versions, visit the following Web site:

```
http://www.w3.org/TR/SOAP
```

XML Schema

SOAP Web services generally use XML Schema to describe both simple and complex data for their applications. OpenEdge Web services use the XML Schema standard to describe both simple data types (scalar parameters) and complex data types (array, temp-table, and ProDataSet parameters) in the WSDL file. An ABL Web service client maps XML Schema constructs into both simple and complex ABL data types.

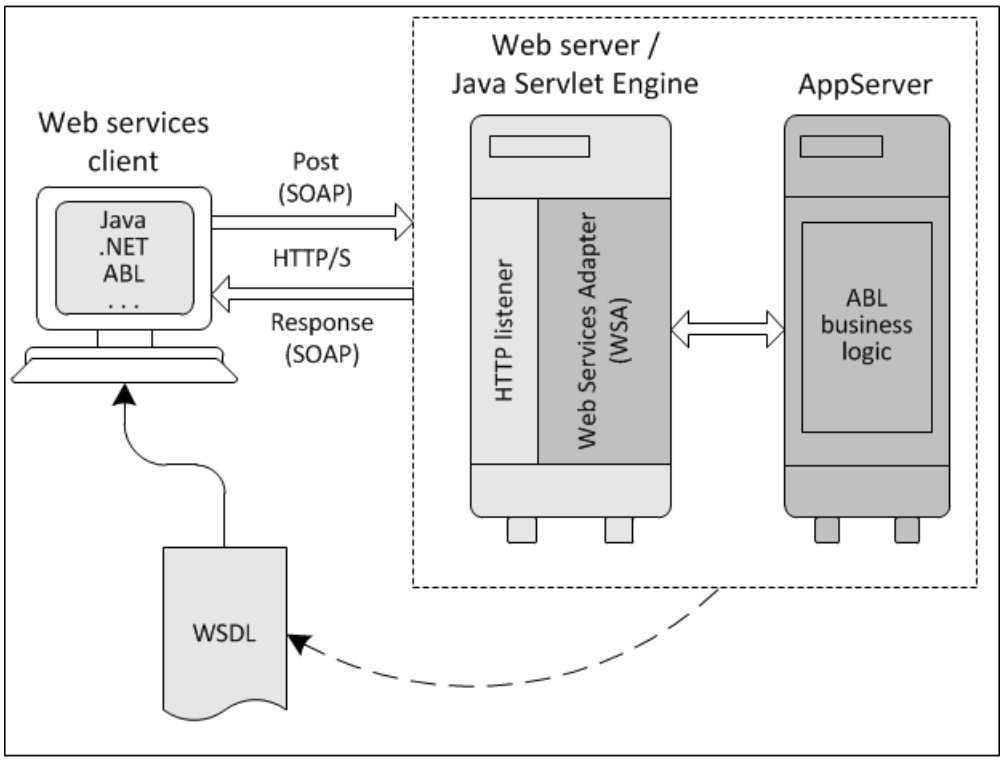
For an introduction to XML Schema, visit the following Web site:

```
http://www.w3.org/TR/xmlschema-0/
```

SOAP Web service architecture in OpenEdge

The following figure shows the basic Web services architecture, highlighting the specific OpenEdge elements used to produce a Web service.

Figure 2: OpenEdge SOAP Web services architecture



As the above figure shows, producing an OpenEdge SOAP Web service only requires deploying an interface for an AppServer-enabled ABL application on the WSA. Both your application and the expected clients affect how you define that interface.

Creating OpenEdge SOAP Web services

OpenEdge SOAP Web services are one of the interface types produced by the OpenEdge Open Client Toolkit. The Open Client Toolkit allows you to generate an interface that encapsulates remote ABL procedures and functions supported on an AppServer. A client application, either ABL or non-ABL, can then access these AppServer procedures and functions through the methods of the generated Open Client interface.

To produce an OpenEdge SOAP Web service with the Open Client Toolkit, you create a definition of your Web service in ProxyGen, which then generates a client interface definition, the Web Service Mapping file (WSM). Using the WSM file, you can deploy your Web service on an OpenEdge Web Services Adapter (WSA).

A typical set of tasks to create an OpenEdge SOAP Web service include:

1. Defining requirements on page 43
2. Defining the Web service in ProxyGen on page 44
3. Deploying a SOAP Web service on page 44
4. Putting the SOAP Web service into production on page 46

Defining requirements

The first step in creating a SOAP Web service is considering the requirements of the application and its intended clients. Knowing these requirements can decide certain details of a Web service design and implementation. Some important requirements are the session model, the SOAP message format, and the security options that the Web service uses.

Session models

The *session model* of your Web service matches the session model of the AppServer-enabled application. There are two session models:

- **Session-free** — This connectionless model uses an AppServer running in state-free mode. This is the recommended model for Web services.
- **Session-managed** — This connection-oriented model uses AppServers running in stateless, state-aware, or state-reset operating modes. This model should only be used when the application must maintain a private, persistent connection with a client.

The *session-free* model supports a connectionless and context-free interaction between the client and Web service application. This session-free model is far more scalable than the session-managed model because the AppServer accepts client requests from all clients as fast as it can execute them, and executes them in no particular order. No AppServer resource (memory or process) is reserved for indefinite use by a single client, as is the case with the session-managed model. With this model, the AppServer application must be written to be context-free, and all mechanisms otherwise available for context management on the AppServer are not supported.

The *session-managed* model provides varying types of support for maintaining and managing session context across client requests, throughout the life of the client connection. With this model, the type of context management supported depends on the actual operating mode of the AppServer, and the AppServer application must be written to maintain session context accordingly. The AppServer handles all requests from a single client sequentially in this model, completing each request before accepting another, which allows an orderly maintenance of context from one request to the next. To achieve this sequential handling, your Web service and its clients must use object IDs and SOAP headers to maintain context. Handling these elements increases the complexity of programming for a session-managed model. For more information on object IDs and SOAP headers, see Retrieving and sending object IDs: handling SOAP headers on page 128.

For information on configuring and programming AppServers, see *OpenEdge Application Server: Administration* and *OpenEdge Application Server: Developing AppServer Applications*. For more information on choosing a session model for your OpenEdge SOAP Web service, see Session Models and object IDs on page 113.

SOAP message formats

As described in SOAP on page 40, OpenEdge supports the following SOAP message formats:

- Document/Literal (Doc/Lit)
- RPC/Literal
- RPC/Encoded

In general, you can use the same application code to create Web services for clients that support any of these formats. Each Web service instance can only accept a single SOAP format within each target namespace. You must generate and deploy a separate Web service for each format. When you deploy the same Web service definition for multiple SOAP formats, Progress Software Corporation recommends that you specify a unique target namespace to deploy each format on the single WSA instance.

Note: Alternately, you might deploy the Web services for each SOAP format with the same target namespace, but on different WSA instances. However, reusing target namespaces can cause unexpected problems.

For more information on SOAP messages, see SOAP message formats on page 115 and SOAP format impact on generated client interfaces on page 122.

WSA and server security options

OpenEdge supports a variety of security options for the WSA that can be used to control access to its various administrative and run-time functions. Generally, these security options include:

- Requiring authorization to access WSA administration functions
- Restricting WSA instance administration to a selection of authorized functions
- Requiring authorization to retrieve WSDL files
- Requiring authorization for clients to access Web services
- Enabling or disabling access to WSA administration
- Enabling or disabling client access to Web services
- Securing the data connection between a Web service and the AppServer using TLS tunneling

For more information on security options for managing WSA configuration and administration and on managing access control for Web services, see *OpenEdge Application Server: Administration*. For more information on how OpenEdge supports security for OpenEdge Web services, see *OpenEdge Getting Started: Core Business Services - Security and Auditing.*

Defining the Web service in ProxyGen

After you have built the AppServer application and compiled its r-code, you can use ProxyGen to prepare the application for deployment as a SOAP Web service. As you define the Web service, your knowledge of the application and client requirements helps to decide how best to organize and include the procedures of your application as Open Client objects and methods. ProxyGen saves information needed to create the Web service definition as a WSM file.

For information on how to use ProxyGen to define the Web service, see *OpenEdge Development: Open Client Introduction and Programming.*

Deploying a SOAP Web service

Use OpenEdge Management or OpenEdge Explorer or `WSAMAN` to deploy SOAP Web services to a particular Web Service Adapter (WSA) instance and to manage deployed Web services at run time. The WSA is a Java servlet running on a Web server or stand-alone Java Servlet Engine (JSE). Situated between the client and AppServer, this Java servlet understands how to pass communications at run time between a Web service client and the AppServer. Each deployed Web service behaves according to a predefined set of run-time properties. These properties are initially set to default values for all Web services deployed to a WSA instance. You can set and reset their values for each Web service individually, under prescribed run-time conditions.

Caution: You can update a deployed Web service to change its deployment information and object definitions. However, you should not update a Web service that is enabled for live access by production clients. Instead, create a new version of the Web service with the intended updates and deprecate the old version of the Web service once all clients have moved to the new version.

For more information on deploying and managing a deployed Web service, see *OpenEdge Application Server: Administration*. For information on configuring a WSA instance, see Configure a Web Service Adapter instance on page 116.

Writing a client and testing a SOAP Web service

Before enabling your Web service for public access, you should test it by building test clients to access it. To begin writing a client, you need the WSDL file. When you define an OpenEdge Web service in ProxyGen, you can select an option to have ProxyGen generate a test WSDL file. You should build your initial test clients using only the information provided in the WSDL. Starting from this information enables you to identify what other documentation users who are building clients without intimate knowledge of your application might need.

Here are three common examples of how client toolkits work:

- **Microsoft® Visual Studio** — Adds a Web Reference that points to the WSDL to your .NET project. Visual Studio creates proxy code from the WSDL and stores the proxies in a `References` file. When you reference the Web service in your code, Visual Studio offers these proxy objects as appropriate. See Developing a .NET Client to Consume OpenEdge SOAP Web Services on page 271 for detailed information on creating .NET for OpenEdge Web services.
- **Apache® Axis** — Runs the `WSDL2Java` command on the WSDL. The command generates the proxy code in several packages in the current directory. See Develop a Java Client to Consume OpenEdge SOAP Web Services on page 295 for detailed information on creating Java clients for OpenEdge Web services.
- **OpenEdge** — Uses the WSDL Analyzer. The WSDL Analyzer outputs a series of HTML pages with sample code for invoking the Web service's operations.

Caution: You should test a Web service by deploying it to a WSA instance that is isolated from the intended client domain. This allows you to enable the Web service for access by clients doing preproduction testing without making it visible and "live" to production clients. Once testing is complete, you can redeploy or import the Web service to the context of the production WSA instance.

For more information on writing client applications for an OpenEdge Web service, see Building Clients for OpenEdge SOAP Web services on page 119. For more information on testing and debugging Web services, see Test and debug OpenEdge SOAP Web Services on page 165.

Documenting client programming requirements

You might find that your SOAP Web service interface can benefit from additional client programmer documentation along with the WSDL file to aid in easily building a client. This information describes any special requirements for Web service operation parameters and other requirements for Web service binding and programming. The requirements for most parameters and their data types are based on standards supported in the WSDL file, and most Web service client toolkits support them without additional programming.

However, there are some unique features of OpenEdge support for building Web services that it might be helpful or necessary for client programmers to know:

- **Open Client object model** — The Open Client object model supports certain built-in object management methods whose availability and use depends on the session model of the Web service application and the particular type of Open Client object in use. For example, in a session-managed application, the instantiation of each object returns a unique ID that identifies that object and must be maintained and supplied in all method calls on that object. In general, client programmers need to understand when they can and should use these built-in methods on an object and how to use them.
- **SOAP format** — All Web service client platforms support a limited choice of SOAP formats, often fewer than the three supported by OpenEdge. Client programmers need to know the SOAP format that a particular Web service uses in order to know whether their client platform supports it. This information is certainly

available in the WSDL, but it might be helpful to know before downloading the WSDL. Also, you might provide versions of the Web service for each supported SOAP format and identify them accordingly.

- **Relational data** — OpenEdge allows you to build Web services that pass complex data types as input and output parameters, thus supporting the exchange of relational data (such as ABL temp-tables and ProDataSets). For many OpenEdge SOAP Web services, the WSDL supplies all the schema information required to access these relational data, particularly for static temp-tables and ProDataSets. However, for Web services that pass dynamic temp-tables and ProDataSets, where the schema is not defined at compile-time, the client programmer needs additional documentation on the schema required to pass dynamic temp-tables and ProDataSets as input parameters.
- **SOAP faults** — Client programmers need to understand the format of error messages that are returned from OpenEdge Web services.

For more information on all these requirements (and more) for programming client applications to access OpenEdge SOAP Web services, see , "Creating OpenEdge SOAP Web services."

Putting the SOAP Web service into production

When you initially deploy an OpenEdge Web service, it is disabled from access by clients over the network. You can adjust Web service property values and perform other administrative tasks before making it visible and accessible to the intended network clients. When the Web service is ready for production, you can enable it for client access through OpenEdge Management or OpenEdge Explorer or the `WSAMAN` utility.

Tuning the Web service and its WSA instance

After your Web service is in production, you can monitor various run-time statistics accumulated for both the WSA instance and the deployed Web service. Using these, you should adjust WSA instance and Web service property values to yield the best performance metrics.

Note: Remember also to monitor and tune the AppServer configurations that support your Web services along with monitoring and tuning the Web services themselves.

For information on enabling and disabling Web services for client access and on monitoring and tuning AppServer configurations, WSA instances, the Web services that are deployed to WSA instances, see *OpenEdge Application Server: Administration*.

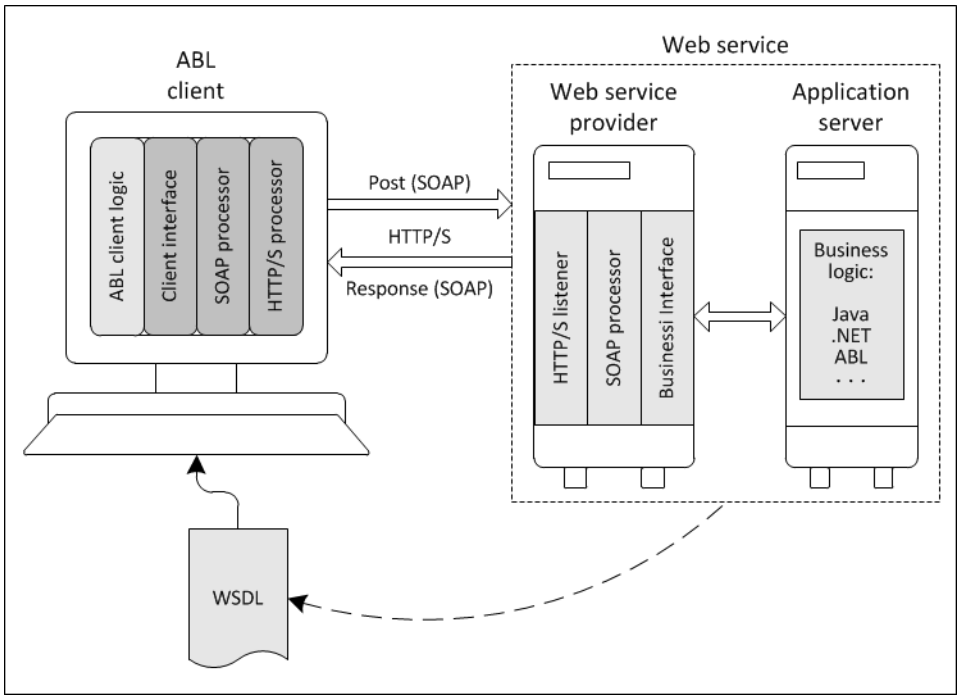
Creating ABL clients to consume SOAP Web services

An ABL client requires the target SOAP Web service's WSDL file, both at design time and at run time. OpenEdge provides a utility, the WSDL Analyzer, that reads the WSDL file and generates documentation and sample code for invoking and managing the Web service's operations in ABL. OpenEdge uses the WSDL file at run time to interpret ABL calls to Web service operations and to manage the exchange of data between the ABL client and the Web service.

ABL views a Web service much like an application service accessed through an AppServer. In addition to the ABL elements used in any AppServer-enabled application, ABL includes some elements specifically designed to manage calls to Web services. In general, all ABL network deployment models support inherent access to Web services.

The following figure shows the basic industry standard Web services architecture and how an ABL client application communicates with a Web service.

Figure 3: ABL clients consuming SOAP Web services



The darker gray components are the additional pieces that the ABL client uses for consuming Web services. OpenEdge has a built-in SOAP processor to convert ABL-like procedure invocations into SOAP messages. OpenEdge supports both nonsecure HTTP and TLS using its HTTP/S processor to manage the transport of these SOAP messages across the wire.

Using this interface, you can use ABL code to interact with a Web service in a similar manner to how you interact with an AppServer-enabled application. A typical set of tasks to create an ABL client for a Web service includes:

1. Obtain the Web service's WSDL and documentation on page 47
2. Run the WSDL Analyzer on page 48
3. Build your client on page 49
4. Test your client on page 50

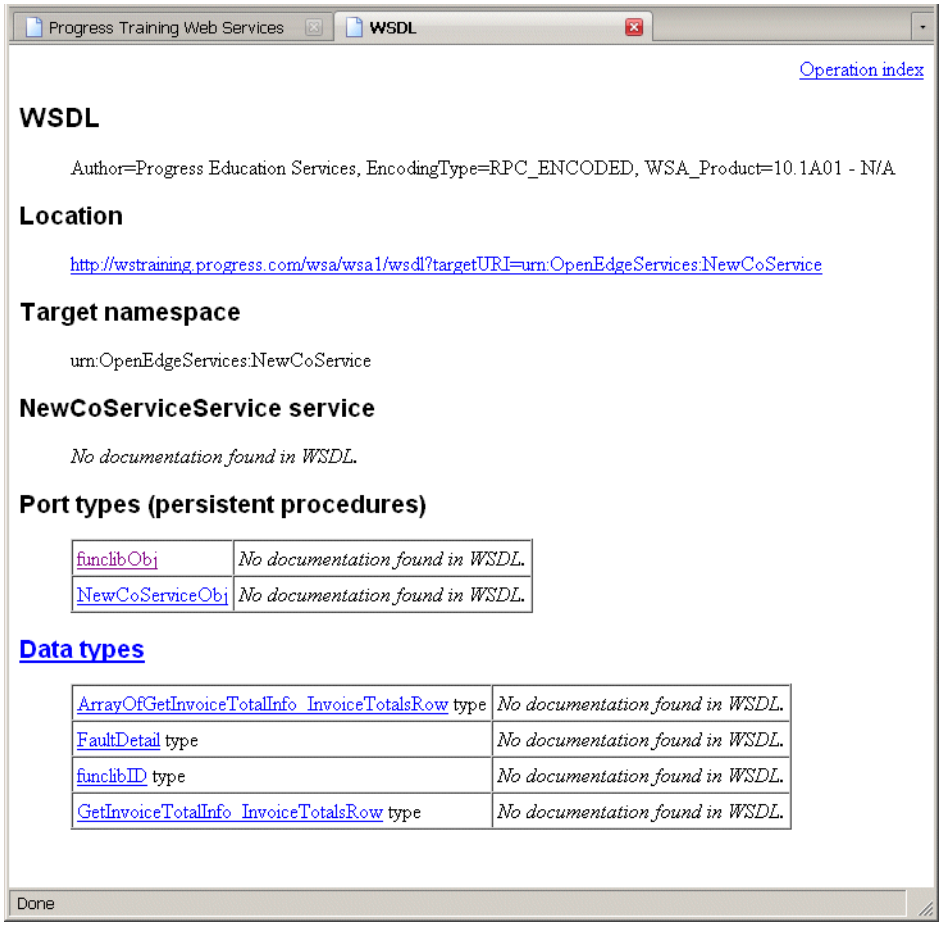
Obtain the Web service's WSDL and documentation

The first step in building a client to access a Web service is to obtain the WSDL and any other documentation the Web service's producer makes available. You need the WSDL to describe the Web service's API and connection requirements. An ABL client requires the WSDL, both at design time and run time. The Web service's producer might make other documentation available to describe exactly how you should use the API described in the WSDL. Make sure that the Web service uses one of the SOAP formats that OpenEdge supports.

Run the WSDL Analyzer

After obtaining the WSDL file, run the WSDL Analyzer on it. The WSDL Analyzer makes accessing Web services from ABL much easier by reading the WSDL file and producing a reference guide that documents how to use ABL to access the Web service. This guide is a series of linked HTML documents that define the Web service operations and their ABL interfaces, including how complex data types are represented in the WSDL. It also provides the binding information necessary to access the Web service on the Internet. Finally, it includes any internal WSDL file comments as documentation from the Web service provider.

For example, the WSDL Analyzer outputs the following index page when run on the WSDL for the NewCo Web service discussed in Consuming SOAP Web service example on page 50:



All of the information for writing the example code in Consuming SOAP Web service example on page 50 is found in the WSDL file. When you run the WSDL Analyzer on the WSDL file it generates interface documentation that contains information on how to connect to and invoke operations in the Web service, such as the:

- Connection parameters for the `CONNECT( )` method
- Name of a Web service port type
- Prototypes for ABL procedures and user-defined functions used to invoke Web service operations for a given port type
- Any complex types defined for use in Web service operation parameters
- Other information required to use the Web service, such as what Web service errors (SOAP faults) might be returned to the client

For more information on running the WSDL Analyzer and the documentation that it generates, see Create an ABL Client from WSDL on page 181.

Build your client

The output from the WSDL Analyzer provides the starting point to build your client. The output gives you the code to connect to the Web service and call its operations. You need to create the logic to provide data to the Web service and manipulate the data the Web service provides to complete your client.

The general procedure for accessing a Web service to invoke its operations is similar to accessing a AppServer and invoking its remote procedures and user-defined functions. For information on accessing a AppServer, see *OpenEdge Application Server: Developing AppServer Applications.*

Comparing access to AppServers and Web services

The following table lists and compares ABL elements used for session-free AppServer access and Web service access, listed in rough order of use.

Table 3: AppServer and Web service access compared

Session-free AppServer clients use the . . .	Web service clients use the . . .
Server object handle to access the AppServer application service.	Server object handle to access the Web service.
`CONNECT( )` method on the server handle to logically connect (bind) the server object to the application service.	`CONNECT( )` method on the server handle to logically connect (bind) the server object to the Web service.
`RUN` statement to instantiate a remote persistent procedure on an AppServer and map it to a proxy persistent procedure handle.	`RUN` statement to access a port type in the Web service and map it to a Web service proxy procedure handle. **Note:** While the syntax to access a port type is similar to the instantiation of a persistent procedure, it does not instantiate anything persistently.
`RUN` statement and the proxy persistent procedure handle to execute an internal procedure of the remote persistent procedure.	`RUN` statement and the Web service proxy procedure handle (Web service procedure object) to invoke an operation of the port type as a remote internal procedure. **Note:** All Web service operations can be invoked as remote internal procedures, allowing them to be invoked asynchronously. However, some Web service operations can also be invoked as remote user-defined functions. The documentation generated by the WSDL Analyzer includes this information.
`FUNCTION` prototype statement with the proxy procedure handle and function invocation to return the value of a remote user-defined function.	`FUNCTION` prototype statement with the Web service proxy procedure handle, and function invocation to return the value of a Web service operation that the WSDL Analyzer indicates can be invoked as a function.

Session-free AppServer clients use the . . .	Web service clients use the . . .
NO-ERROR option and the ERROR-STATUS system handle to trap ABL statement errors. Alternatively, use a CATCH block to trap any error of a type occurring in a block. ABL system errors are represented by a class-based error object derived from Progress.Lang.SysError. If a statement uses the NO-ERROR option in a block with CATCH blocks, the NO-ERROR option takes precedence and the error will not be handled by a compatible CATCH block.	NO-ERROR option and the ERROR-STATUS system handle to trap ABL statement errors and Web service SOAP faults. Alternatively, use a CATCH block to trap any error of a type occurring in a block. ABL SOAP errors are represented by a class-based error object derived from Progress.Lang.SoapFaultError, which is a subclass of Progress.Lang.SysError. If a statement uses the NO-ERROR option in a block with CATCH blocks, the NO-ERROR option takes precedence and the error will not be handled by a compatible CATCH block.
Asynchronous request object handle to manage asynchronous execution of remote ABL procedures.	Asynchronous request object handle to manage asynchronous invocation of Web service operations.
DISCONNECT( ) method on the server handle to logically disconnect (unbind) the server object from the application service.	DISCONNECT( ) method on the server handle to logically disconnect (unbind) the server object from the Web service.
DELETE object statement to delete object handles that are no longer needed.	DELETE object statement to delete object handles that are no longer needed.

Test your client

As with all applications, you need to test your Web service client. Before using your client, create some realistic test cases and make sure the client and Web service behave as expected. In addition to the normal OpenEdge tools for debugging applications, the ProSOAPView utility can be useful in testing your client. It provides a way to view SOAP messages. For more information on testing clients, see Test and debug OpenEdge SOAP Web Services on page 165 and Examples of ABL accessing a SOAP fault on page 261.

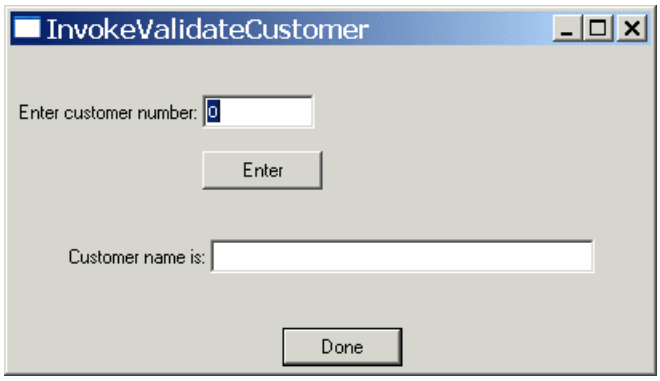
Consuming SOAP Web service example

The Progress eLearning Community maintains a Web service for a fictional company, NewCo. The Web service enables users to look up customers, place orders, and receive invoices. The application runs off the Sports2000 database. The WSDL file for the Web service is available at the following address:

```
http://wstraining.progress.com/index.html
```

Sample of consuming a SOAP Web service

One of the operations available from NewCo Web service enables you to get the customer name for a given customer number. The Progress eLearning Community Web page includes a link to a program, InvokeValideCustomer.w, that uses that operation:



The following excerpts from `InvokeValideCustomer` illustrate how to consume a Web service from ABL. In the main block, the application first creates a server and connects to the Web service by specifying the location of the WSDL file for run-time access and the name of a port type (persistent procedure) on the server:

```
CREATE SERVER hServer.
lReturn = hServer:CONNECT("-WSDL http://wstraining.progress.com/wsa/wsa1/
  wsdl?targetURI=urn:OpenEdgeServices:NewCoService
  -Port NewCoServiceObj").

IF lReturn = NO THEN DO:
  MESSAGE
  "Could not connect to WebService server"
  VIEW-AS ALERT-BOX INFO BUTTONS OK.
  APPLY "CLOSE":U TO THIS-PROCEDURE.
  RETURN.
END.
```

Note: You only need to specify `-Port` when the WSDL file contains more than one valid service and port. For information on the full range of binding options for Web services, see Connecting to OpenEdge SOAP Web Services from ABL on page 205.

If the server connects successfully, the application uses the `RUN` statement syntax to create the Web service proxy procedure object and map it to the port type (NewCoServiceObj) that defines the ValidateCustomer operation for the Web service:

```
RUN NewCoServiceObj SET hPortType ON SERVER hServer.

IF NOT VALID-HANDLE(hPortType) THEN DO:
  MESSAGE
    "Could not establish portType"
  VIEW-AS ALERT-BOX INFO BUTTONS OK.
  APPLY "CLOSE":U TO THIS-PROCEDURE.
  RETURN.
END.
```

When you click **Enter**, the application invokes the `ValidateCustomer` operation, passing in the value in the customer number field and displaying the return value in the customer name field:

```
ON CHOOSE OF bDoWork IN FRAME DEFAULT-FRAME
DO:
  ASSIGN iCustNum.

  /* Invoke ValidateCustomer */
  RUN ValidateCustomer IN hPortType (INPUT iCustNum, OUTPUT cCustName)
    NO-ERROR.

  /* this procedure checks for errors in the previous call */
  RUN ErrorInfo (OUTPUT lerr).

  IF NOT lerr THEN DO:
    DISPLAY cCustName WITH FRAME default-frame.
  END.
END.
```

For more information on mapping Web service port types and invoking operations on them, see Invoking OpenEdge SOAP Web Service Operations from ABL on page 213.

When you click **Done**, the application deletes the `hPortType` procedure object, unbinds the Web service from the server, and then deletes the server object:

```
  DELETE PROCEDURE hPortType.
  hServer:DISCONNECT().
  DELETE OBJECT hServer.
```

For more information on managing Web service bindings, see Connecting to OpenEdge SOAP Web Services from ABL on page 205.

This sample shows the similarity between basic AppServer and Web service access using synchronous interaction with the client. Another common feature between client interaction with an AppServer and client interaction with a Web service is the ability to invoke procedures asynchronously. For information on when and what you need to do to invoke Web service requests asynchronously, see Managing asynchronous requests on page 222.

Note: This sample is not available on the Documentation and Samples (`doc_samples`) directory of the OpenEdge product DVD or the Progress Documentation Web site.

Sample SOAP Web service applications

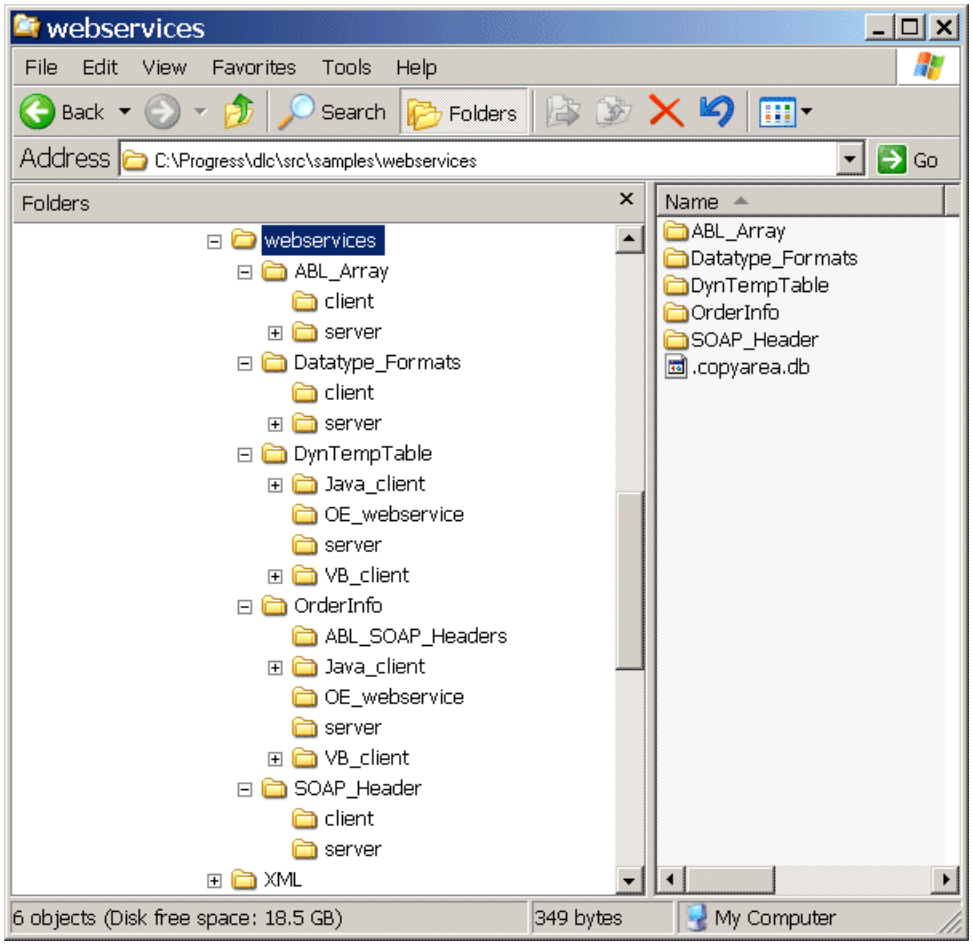
Sample Web service applications are located in a directory on the Documentation and Samples (`doc_samples`) directory of the OpenEdge product DVD and the Progress Documentation Web site. For more information on accessing this directory, see the *Example Procedures*. This samples directory contains both sample OpenEdge Web services and sample ABL client applications accessing Web services. The directory contains separate subdirectories for different sets of samples and support files. Each sample subdirectory contains a `readme.txt` file with instructions on building and running the sample. You must install these samples before accessing them.

This book references some samples on the Documentation and Samples (`doc_samples`) directory of the OpenEdge product DVD, but also contains many code samples and examples that are not available on this DVD.

Sample application directory structure

After you install the samples, you can find three sample OpenEdge Web services and several related sample client applications written using the Microsoft .NET and Java Axis client platforms. The following figure shows the directory structure as it might appear if you install the samples into the OpenEdge installation directory (`C:\Progress\dlc\` in the figure).

Figure 4: OpenEdge Web services sample applications



Thus, the Web service samples include the following:

- **AppService** — The three Web services, including the ProxyGen project files to generate the Web service definitions. These samples include one Web service that passes a dynamic temp-table.
- **Java-Axis** — Java Axis client samples, including applications for sample session-free and session-managed Web services, and in several choices of SOAP format. Also included with these samples are sample Java helper classes for managing object IDs and dynamic temp-table schema and data.
- **Microsoft** — .NET client samples, including a C#.NET application for a session-free Web service and VB.NET application for session-free and session-managed Web services. These samples include the Web-services-tools-supported SOAP format choices that are also supported by .NET.

Using the sample applications

For information on how to access and use these samples, see the `README` files provided in the `Java-Axis` and `Microsoft` folders for the respective client platforms. For an introduction to the available Java helper classes, see Developing the Axis client application on page 305.

II

Creating OpenEdge REST Web Services

For details, see the following topics:

- REST Applications
- REST Application Security
- Data Object Services

4

REST Applications

This chapter contains technical details about OpenEdge REST applications.

For details, see the following topics:

- REST annotations in ABL code
- REST services in OpenEdge
- Parameter mapping
- JSON input and output message formats
- The structure of REST application WAR files
- Manually Adding Additional Services to a REST Application
- Errors and exceptions

REST annotations in ABL code

This section describes the syntax of the annotations that you add to ABL source files in order to expose class methods, procedures, and user-defined functions as REST resources.

If the ABL source file is an external procedure that you want to expose as a REST resource, you add a main REST annotation with `executionMode` set to `EXTERNAL` at the beginning of the file.

If the ABL source file contains multiple internal procedures or user-defined functions, you add a main REST annotation with `executionMode` set to `SINGLE-RUN` or `SINGLETON`. Then you add an internal REST annotation before every internal procedure and user-defined function that you want to expose as a REST resource.

Usually, you use the Define Service Interface wizard in PDSOE REST projects for annotating ABL source files. See the PDSOE online help, *Progress Developer Studio for OpenEdge Guide* for more information.

Note: You can add annotations to class files only if the PDSOE project includes Data Object facets. Also any ABL files annotated to implement Business Entities for Data Objects can include the `executionMode` set to `SINGLETON` only. See the *Progress Developer Studio for OpenEdge Guide* in the PDSOE online help for more information.

Main REST annotations

The main REST annotation must be located at the beginning of a file, preceding any ABL statements.

Syntax

```
@openapi.openedge.export FILE (
TYPE="REST"
executionMode={ "EXTERNAL" | "SINGLE-RUN" | "SINGLETON" },
[ , useReturnValue={ "TRUE" | "FALSE" }]
[ , writeDataSetBeforeImage={ "TRUE" | "FALSE"}] ).
```

`FILE`

Specifies that the annotation applies to the entire file.

`TYPE`

The value of this attribute is a comma separated list of types. If you are annotating an ABL source file for use in a REST service, the value of this attribute must include "REST".

`executionMode`

A value of `"EXTERNAL"` specifies that the ABL source file is an external source file. That is, it contains a single procedure or user-defined function. There is no need to add any other annotations when `executionMode` is set to `"EXTERNAL"`

A value of `"SINGLE-RUN"` or `"SINGLETON"` allows you to call internal procedures and user-defined functions in an ABL source file. If you specify one of these values, the top level procedure cannot contain any parameters. Also note that no state information can be preserved by internal procedures or user-defined functions.

Note: In single-run mode, the external procedure is deleted when the internal procedure or user-defined function completes execution. In singleton mode, the external procedure remains instantiated after its internal procedure or user-defined function completes execution.

`useReturnValue`

If `"TRUE"`, specifies that a return string is used for procedures. If this option is not specified or if the value is `"FALSE"` , there will be no return string

`writeDataSetBeforeImage`

Not supported in this release. Attribute should be removed or set to `"FALSE"`.

Internal REST annotations

To make an internal procedure or user-defined function a REST resource, you must add an internal procedure annotation before the `PROCEDURE` or `FUNCTION` statement. Before you create an internal annotation, you must add a main REST annotation at the beginning of the source file in which you set the `executionMode` attribute to `"SINGLE-RUN"` or `"SINGLETON"`

The only syntactical difference between REST internal annotations and REST external annotations is that internal annotations do not include the `FILE` and `executionMode` attributes.

```
@openapi.openedge.export (
TYPE="REST"
[ , useReturnValue={ "TRUE" | "FALSE" }]
[ , writeDataSetBeforeImage={ "TRUE" | "FALSE"}] ).
```

`TYPE`

The value of this attribute is a comma separated list of types. If you are annotating an external procedure for use in REST service, the value of this attribute must include "REST".

`useReturnValue`

If `"TRUE"`, specifies that a return string is used for procedures. If this option is not specified or if the value is `"FALSE"` , there will be no return string

`writeDataSetBeforeImage`

Not supported in this release. Attribute should be removed or set to `"FALSE"`

Also see Main REST annotations on page 58 for more information.

Annotation examples

The examples in this section show the annotations to expose both external and internal procedures as REST resources.

External Procedure

The bold code in the following code sample shows the annotation of `getOrder`, which is an external procedure.

```
/* getOrder.p */
@openapi.openedge.export FILE (TYPE="REST",
executionMode="EXTERNAL").
.
.
.
DEFINE INPUT PARAM customerNumber AS INT.
DEFINE INPUT PARAM orderNumber AS INT.
DEFINE OUTPUT PARAM DATASET FOR dsOrder.
.
.
.
```

Internal procedure

The bold code in the following code sample shows the annotations when `getOrder` is an internal procedure of `orders.p`:

```
/* orders.p */
@openapi.openedge.export FILE (TYPE="REST",
executionMode="SINGLE-RUN").
.
.
.
@openapi.openedge.export(TYPE="REST").
PROCEDURE getOrder.
DEFINE INPUT PARAM customerNumber AS INT.
DEFINE INPUT PARAM orderNumber AS INT.
DEFINE OUTPUT PARAM DATASET FOR dsOrder.
.
.
.
```

REST services in OpenEdge

OpenEdge REST applications include at least one REST service. A REST service in is a collection of resources, which are ABL procedures and user-defined functions that run on an AppServer.

When developing an OpenEdge REST application, you first create the services required by the application. To create a REST service, you define a URI space where the parent node is the service name and child nodes are mappings to resources exposed in annotated ABL files (see REST annotations in ABL code on page 57). The URI space is essentially the API to access REST resources.

Progress Developer Studio supports the design and implementation of OpenEdge REST services. For information on creating REST services see the online help volume, *Progress Developer Studio for OpenEdge Guide*.

For an overview of the entire REST application development process, see Creating OpenEdge REST applications on page 35.

Planning the URI structure of a REST service

Before you begin creating a REST service, you should plan the URI space that provides access to REST resources. You must determine a logical structure that makes sense in the context of your REST applications. But keep in mind that each resource must have a unique URI.

The general form of an OpenEdge REST resource URI is shown in the following figure.

Figure 5: Anatomy of a REST URI



As suggested in the above figure, the elements of the REST URI are established during three different stages of Web application development:

- Create services on page 61

- Export WAR on page 61
- Deploy application on page 61

All three stages of OpenEdge REST application development are supported in the tools included with Progress Developer Studio. For more detailed information on how to perform these tasks, see the online help volume, *Progress Developer Studio for OpenEdge Guide*.

Create services

First, you create one or more services, each with a unique *service_name*. You also define the URIs for all the resources relative to the service. *REST_resource* is a path that can branch to multiple levels of parent-child nodes. But each individual *REST_resource* uniquely identifies a single REST resource. See Adding REST resources to a service on page 61 for more information.

Note that the parent node `/rest`, in the URI structure. It is included to illustrate that you can define a relative URI path structure to suit your needs. When the service name follows the `/rest` path element, it distinguishes the AppServer hosted resources from the static HTML, JSON, and JavaScript resources that may also be deployed as part of the application.

Also see The service-relative URI on page 61.

Export WAR

You specify *webapp_name* when you export the REST Web application. The process of exporting involves specifying all of the services you intend to include in the application and naming a WAR as the destination. The name of the WAR file becomes the Web application name, *webapp_name*.

Note that when you export an application file in Progress Developer Studio, all the necessary files (including default runtime library files, configuration files and static files) are included in the WAR file in addition to the references to REST resources.

Deploy application

The scheme (`http` or `https`) and domain (*host*[*:port*] are established when you deploy the REST application to a Java Servlet Container on a Web server. In Progress Developer Studio, you create an OE Web Server on a local or remote Web server and publish the WAR file to the specified OE Web Server. When the WAR file is expanded, the application is deployed.

Adding REST resources to a service

After you have defined a REST service, you can add REST resources to the service. (Typically, you use the REST Expose Editor in Progress Developer Studio to add resources to the service.)

REST resources are uniquely defined by a combination of the following:

- The service-relative URI on page 61 for the resource.

  Optionally, the REST resource URI can include input parameters such as Path parameters on page 62 and Query parameters on page 62.

- HTTP verbs on page 62 allowed for the resource (GET, POST, PUT, DELETE).
- A media type. Currently in OpenEdge, the only supported media type is `application/json`.

The service-relative URI

The service-relative URI must begin with a forward slash (`/`) followed by a unique service name.

Following the service name, you complete the path with a resource name that you will eventually map to a procedure or user-defined function. Choose a name that makes logical sense in the context of the service.

A developer's responsibility is to define the relative URI space for ease of use, extensibility, and versioning. You should not introduce elements of the AppServer procedure path and parameters when designing URIs.

Path parameters

Path parameters are used to identify entities, to represent hierarchies or to provide data to a resource. Curly braces ({}) identify path parameter values and multiple path parameters are separated by a forward slash (/).

For example, if you intend to pass a customer id number to a customer query, the resource URI might be `/customer/{custnum}`. If you were passing the id of the sales representative and zip code to the query, the resource URI might be `/customer/{salesrep}/{zip}`.

When specifying path parameters, consider the number of input parameters required by the ABL procedure that you will map to.

Data types are specified when you map path parameters to input parameters of ABL procedures or user-defined functions. The REST Expose Editor is the recommended tool for data type mapping.

see Parameter mapping on page 63 and JSON input and output message formats on page 66 for more information.

Query parameters

Query parameters define search criteria and restrict results like a filter. A query parameter starts with a question mark (?). Multiple query parameters are separated by an ampersand (&).

For example, a query parameter to limit the result of a query by customer name to a specified zip code might be `/customer/{custName}/info?zip=cust-zip`.

Note: Path parameters always precede query parameters in a resource URI. Any path parameter specified after a query parameter will be handled as a query parameter.

HTTP verbs

The four HTTP verbs supported by OpenEdge REST are associated with the four basic database CRUD operations, as shown in the following table.

Table 4: HTTP Verbs supported in OpenEdge REST URIs

HTTP Verb	CRUD Operation	Description
POST	Create	Create new item
GET	Read	Read existing item
PUT	Update	Add new item
DELETE	Delete	Remove existing item

The REST Expose Editor allows you to specify one or more HTTP methods for each URI resource name. After specifying the HTTP verb, you can associate the verb with a particular ABL procedure or user-defined function.

See Procedure mapping examples on page 63 for more information

Procedure mapping examples

Each AppServer service interface API you expose as a REST resource has a mapping to a unique combination of a relative URI, an HTTP verb, parameters, and media type. (Note that only JSON is currently supported as a media type in OpenEdge.

The implication is that a relative URI could be mapped to a number of different AppServer procedures using different combinations of HTTP verbs and parameters. The following table illustrates three different mappings for the resource URI `/customer`.

Table 5: Procedure mappings

Relative URI	HTTP verb	Procedure
`/customer`	`GET`	`Proc1`
`/customer`	`PUT`	`Proc2`
`/customer/{custname}`	`GET`	`Proc3`

OpenEdge developers have broad scope in determining how best to expose AppServer procedures as REST resources. You should define the relative URI space for ease of use, extensibility, and versioning. In addition, your design should hide the elements of the AppServer procedure path and ABL parameters.

Parameter mapping

To implement an OpenEdge REST application, you must map HTTP requests to input parameters of ABL procedures or user-defined functions, and you must map output parameters to HTTP responses.

Usually, you use the mapping functionality provided by the REST Expose Editor in PDSOE. See the *Progress Developer Studio for OpenEdge Guide* in the PDSOE online help for more information.

Input parameter mapping

In OpenEdge REST applications, input parameters of a procedure or user-defined function are mapped to elements of an HTTP request.

HTTP requests can contain the following elements:

- Request line, including an HTTP method (GET, POST, etc.), URI, query information, and protocol version
- Request headers, including host, cookies, and media types
- Request body

Since the request line and request headers of an HTTP request are text, mapping each request element to an input parameter is equivalent to mapping from text to a target ABL data type. see Supported input parameter mappings on page 64 for more information.

A JSON request body can be mapped to an input parameter in two ways:

- You can map a JSON request body directly to ProDataSet (DATASET and DATASET-HANDLE) or temp table (TABLE and TABLE-HANDLE) input parameter.
- You can map the JSON request body to a CHARACTER or LONGCHAR input parameter.

In either case, the request body needs to be formatted as described in *OpenEdge Development: Working with JSON*. Also see JSON input and output message formats on page 66.

Runtime errors occur if a mapping is not supported. see Errors and exceptions on page 73 for more information.

Supported input parameter mappings

The following table indicates the supported input parameter mappings between HTTP request elements and ABL data types. Y and N indicate whether a mapping is supported or not. Assume any mapping not mentioned in these tables is not supported.

Table 6: Supported mappings between HTTP request elements and ABL data types (input)

ABL Data Types	HTTP Request Elements						
	Path	***Query***	***Form*** [1]	***Header***	***Cookie***	***Body***	***Full URL***
CHARACTER	Y	Y	Y	Y	Y	Y	Y
LONGCHAR	Y	Y	Y	Y	Y	Y	Y
INTEGER	Y	Y	Y	Y	Y	N	N
DECIMAL	Y	Y	Y	Y	Y	N	N
DATE	Y	Y	Y	Y	Y	N	N
DATETIME	Y	Y	Y	Y	Y	N	N
DATETIME-TZ	Y	Y	Y	Y	Y	N	N
INT64	Y	Y	Y	Y	Y	N	N
LOGICAL	Y	Y	Y	Y	Y	N	N
MEMPTR[2]	N	N	N	N	N	Y	N
ROWID	Y	Y	Y	Y	Y	N	N
TABLE	N	N	N	N	N	Y	N
DATASET	N	N	N	N	N	Y	N

Note: ABL arrays (ABL variables defined with the EXTENT option) are encoded as JSON objects. see JSON input and output message formats on page 66 for more information.

[1] **You can map individual form fields to input parameters if the request is a POST with standard form fields.**
[2] Mapping supported as Base64 encoded strings.

Output parameter mapping

Output parameters from a procedure or function are mapped to an HTTP response. Elements of an HTTP response include:

- Status code
- Response headers (including cookies and location)
- Response body

Since the status code and response headers of an HTTP response are text, the mapping of an ABL output parameter to a response element is equivalent to mapping from the source ABL data type to text. See Supported output parameter mappings on page 65 for more information.

A JSON response body in can be mapped to an output parameter in two ways:

- You can map an output parameter that is a ProDataSet (`DATASET` and `DATASET-HANDLE`) or temp table (`TABLE` and `TABLE-HANDLE`) to a JSON response body. In this case, the request body is formatted as described in *OpenEdge Development: Working with JSON*. Also see JSON input and output message formats on page 66.
- You can map a single CHARACTER or LONGCHAR parameter to a JSON response body. In this case the formatting must conform to the JSON media type.

Runtime errors occur if a mapping is not supported. see Errors and exceptions on page 73 for more information.

Supported output parameter mappings

The following table indicates the supported output parameter mappings between HTTP response elements and ABL data types. `Y` and `N` indicate whether a mapping is supported or not. Assume any mapping not mentioned in these tables is not supported.

Table 7: Supported mappings between an HTTP response elements and ABL data types (output)

ABL Data Types	HTTP Response		
	Status Code	***Response Header (including cookie and location)***	***Response Body***
`CHARACTER`	N	Y	Y
`LONGCHAR`	N	Y	Y
`INTEGER`	Y	Y	Y
`DECIMAL`	Y	Y	Y
`DATE`	N	Y	Y
`DATETIME`	N	Y	Y
`DATETIME-TZ`	N	Y	Y
`INT64`	N	Y	Y

ABL Data Types	HTTP Response		
	Status Code	*Response Header (including cookie and location)*	*Response Body*
LOGICAL	N	Y	Y
MEMPTR	N	Y	Y
RAW	N	N	N
RECID	N	N	N
ROWID	N	Y	Y
WIDGET-HANDLE	N	N	N
TABLE	N	N	Y
DATASET	N	N	Y

Note: ABL arrays (ABL variables defined with the EXTENT option) are encoded as JSON objects. see JSON input and output message formats on page 66 for more information.

JSON input and output message formats

OpenEdge REST applications have the ability to map components of an input message to individual AppServer parameters as well as compose an output message derived from multiple output parameters. These input/output messages are JSON objects formatted as described in the following sections.

JSON input (request) messages

Input messages are JSON objects named "request". This object contains properties that are mapped to ABL parameters defined as INPUT and INPUT-OUTPUT. The property names are identical to the parameter names they are being mapped to.

All ABL parameters types that are supported by OpenEdge REST applications and that can be represented as JSON objects are supported. This includes datasets and temp-tables. See the Input parameter mapping on page 63 for more information about supported ABL parameter types.

The following is an example of an input message:

```
{"request":
  {"Param1":"String param",
   "Param2":true
   "Param3": [{
    "Country": "United Kingdom",
    "Name": "Just Joggers Limited",
     "Address": "Fairwind Trading Est",
     "Address2": "Shoe Lane",
     "City": "Ramsbottom",
     "State": "Sussex",
     "PostalCode": "BL0 9ND",
     "Contact": "George Lacey",
     "Phone": "070 682 2887",
     "SalesRep": "SLS",
     "CreditLimit": 22000.00,
     "Balance": 1222.11,
     "Terms": "Net30",
     "Discount": 20,
     "Comments": "This is a modified record",
     "Fax": "",
     "EmailAddress": ""
    }]
   }
}
```

In the above example, the `REQUEST_BODY` of the incoming message contains 3 parameters. They are a `CHARACTER` parameter with the name `Param1`, a `LOGICAL` parameter with the name `Param2`, and a `DATASET` parameter with the name `Param3`. To access these parameters, the AppServer procedure must have these parameters declared.

JSON output (response) messages

Output messages are JSON objects named `"response"`. This object contains properties that are mapped to ABL parameters defined as `OUTPUT`, `INPUT-OUTPUT`, and *`return-value`* parameters. The property names are identical to the parameter names that are mapped to the `RESPONSE_BODY`. The return value is named `"_retVal"`

All ABL parameters types that are supported by OpenEdge REST applications, and that can be represented as JSON objects are supported. This includes datasets and temp-tables. See the Output parameter mapping on page 65 for more information about supported ABL parameter types.

The following is an example of an output message:

```
{"response":
  {"Param1":"String param",
   "Param2":true
   "Param3": [{
     "Country": "United Kingdom",
     "Name": "Just Joggers Limited",
     "Address": "Fairwind Trading Est",
     "Address2": "Shoe Lane",
     "City": "Ramsbottom",
     "State": "Sussex",
     "PostalCode": "BL0 9ND",
     "Contact": "George Lacey",
     "Phone": "070 682 2887",
     "SalesRep": "SLS",
     "CreditLimit": 22000.00,
     "Balance": 1222.11,
     "Terms": "Net30",
     "Discount": 20,
     "Comments": "This is a modified record",
     "Fax": "",
     "EmailAddress": ""
    }],
    "_retVal":"Some return string"
  }
}
```

If there is no return value because you are calling an external procedure or internal procedure and the `useReturnValue` attribute is set to `"FALSE"` in the annotation, there will be no `_retVal` property in the response message. If the parameter is `UNKNOWN`, it will have a value of null in the message.

The structure of REST application WAR files

The following table describes the directory structure of an OpenEdge REST application WAR file and indicates what content you can add to or modify.

Table 8: OpenEdge REST application WAR file structure

Folders/Files	Description
/Web_app_name	The REST application root directory. All the other files and folders described in this table are children of this directory. You can add any files or sub-directories to the root directory. **Note:** Application security configuration files (`/WEB-INF/appSecurity-`*`xxxx`*`.xml`) control access to */Web_app_name*.
`/index.html`	A template for an application's welcome page.
`/META-INF/MANIFEST.MF`	The `META-INF` folderis a standard component of JAVA Web applications. and it contains the `MANIFEST.MF` file. `MANIFEST.MF` contains context information about the environment in which the web application runs and is inserted as a standard addition to any WAR file generation. It can be used on the production deployment site to tailor some of the Web application context information.
`/static/`	Contains static files (HTML pages, graphics, JavaScript, etc.). It contains the default files and folders supplied. Application developers may add any files and sub-directories to this folder. **Note:** Application security configuration files (`/WEB-INF/appSecurity-`*`xxxx`*`.xml`) control access to this folder.
`/static/home.html`	A template for a page that appears after successful login and logout operations. It is the default referred to in: `/WEB-INF/appSecurity-form-local.xml` **Note:** For client access to hosted Data Object Services, this page is not displayed, but used as a target for mobile and Web app login using HTTP Basic or Form Authentication.
`/static/auth/`	Contains the HTML files used for logging into and out of a REST application.

Folders/Files	Description

`/static/auth/login.html`
`/static/auth/logout.html`
`/static/auth/loginfail.html`
	The files `login.html`, `logout.html`, and `loginfail.html` are templates that support HTTP form-based authentication, which is implemented in:
	`/WEB-INF/appSecurity-form-local.xml`
	Application developers and administrators may edit or extend these files.

`/static/error/`
`/static/error/error401.html`
`/static/error/error403.html`
`/static/error/error404.html`
`/static/error/error503.html`
	Contains templates for customizing HTTP error messages.
	The `error`*`xxx`*`. html` files override the Java container's default error pages and provide a consistent output for all Java containers.
	Application developers may add to or modify the error pages in this folder. New error pages must be defined in the `/WEB-INF/web.xml` deployment descriptor file.

`/static/error/error401.html`
`/static/error/error403.html`
`/static/error/error404.html`
`/static/error/error503.html`
	The `error`*`xxx`*`. html` files override the Java container's default error pages and provide a consistent output for all Java containers.
	Application developers may add to or modify these error pages.

`/static/`	(Data Object Services only) Contains Data Service Catalog (.json) files that define Data Object Services hosted by the Web application. Application developers can add other HTML, JavaScript (.js) or JSON data files for client upload in this folder. This can include entire web apps and their libraries that access the Data Object Services hosted by the Web application.
`/WEB-INF/`	Contains configuration files (at the top level and in sub-directories) for the Web application.

`/WEB-INF`
`  /appSecurity-anonymous.xml`
`  /appSecurity-basic-local.xml`
`  /appSecurity-container.xml`
`  /appSecurity-form-local.xml`
	Spring Framework security configuration templates for common authentication models. Only one of these models can be declared as active in the `web.xml` Web application deployment description file.
	In addition, these files set the role-based access to URI resources, and set the authentication provider.
	Application developers and administrators may edit or extend these files.

`/WEB-INF/mvc-dispatch-context.xml`	Configuration file that instantiates the Spring Framework enhancements, which extend the Web application framework. It is referenced in the Web application deployment descriptor, `web.xml`. Application developers and administrators may edit or extend this file.

Folders/Files	Description
`/WEB-INF/users.properties`	Defines test user accounts and is referenced by the `/WEB-INF/appSecurity-`*`xxxx`*`.xml` files as the default authentication provider. The test user accounts should be deleted from a production deployment and replaced with more secure account storage.
`/WEB-INF/web.xml`	The Web application deployment descriptor that references the objects for managing security, dynamic content, static content, and AppServer data services. An application developer must modify `web.xml` to set the user authentication model. If the application is used by a mobile or Web app to access a hosted Data Object Service, the authentication model needs to match the mobile or Web app's authentication model. An application administrator can modify `web.xml` to change the user authentication model.
`/WEB-INF/adapters/`	Contains application properties, mapping, and log files. Do not modify, or add to the contents of this folder.
`/WEB-INF/adapters/`*`AppName`* `/`*`AppName`*`.paar`	Contains the service definition (`.paar`) file, which defines the Web application, *`AppName`*. There can be multiple *`AppName`* folders in /WEB-INF/adapters but each folder can contain only one *`AppName`*`.paar` file. PAAR files include all of the mappings (procedures, datasources and parameters) and other artifacts that define a service. They are created in the process of defining REST services in Progress Developers Studio. If there are multiple PAAR files, each must have its own unique URI space. You should not manually edit *`AppName`*`.paar` files. You can add additional *AppName* folders after deployment, however. see Manually Adding Additional Services to a REST Application on page 72 for more information.
`/WEB-INF/adapters/runtime.props`	An XML file containing the runtime properties for connecting to an AppServer. This file is created at deployment time by the REST Management Agent using its default application properties.
`/WEB-INF/adapters/logs`	Contains Web application log files. Do not modify, or add to the contents of this folder, except for the `.log` files that require periodic maintenance.

Folders/Files	Description
`/WEB-INF/classes/`	Contains individual Java class files that can be loaded by a Web application. Application developers add additional class files in this folder. A production administrator will find the log4j.properties file here and control the logging for security, the 1pAdapters framework, and gateway to the AppServer Java client.
`/WEB-INF/classes/log4j.properties`	A properties file that controls the logging for security, the 1pAdapters framework, and the gateway to the AppServer Java client. Application administrators modify this file to facilitate debugging.
`/WEB-INF/lib/`	Contains the runtime library files. An application developer may add JAR files to support any dynamic JSP content generation or to extend the Spring Security framework functionality.

Manually Adding Additional Services to a REST Application

When you create an OpenEdge REST application using Progress Developers Studio, you generate one or more PAAR (*AppName*.paar) files that contain service definitions for your Web application. These PAAR files are included when a OpenEdge REST application is deployed.

You can add additional service definitions to a deployed Web application by manually copying a PAAR file to the Java Servlet Container on the Web server where the application is running:

1. In Progress Developers Studio, generate an *AppName*.paar file. The URIs in the PAAR file cannot match any entries in the PAAR files that are already deployed.
2. In the deployed application on the Web server, add the folder *AppName* to the directory `/WEB-INF/adapters/`, where *AppName* is identical to the root name of the PAAR file.
3. Copy *AppName*.paar to `/WEB-INF/adapters/`*AppName*.
4. Edit `/WEB-INF/web.xml` in your deployed application to add the new PAAR file to the context parameter `archiveFiles`. This parameter contains a comma separated list of archive files for example:

```
<context-param>
  <param-name>archiveFiles</param-name>
 <param-value>CustomerSvc.paar,OrderSvc.paar, AppName.paar</param-value>
</context-param>
```

5. Restart the Java Servlet Container on the Web server. If there is no conflict with the URI spaces defined in other PAAR files, the additional services will be available in your application.

Errors and exceptions

OpenEdge REST applications can encounter exceptions, especially when attempting to communicate with the AppServer. The following table lists the exceptions and the corresponding HTTP errors that is returned by the application in each case.

Table 9: REST Application exceptions and corresponding HTTP errors

Exception	HTTP Status
java.lang.Exception	500 Internal Error
com.progress.common.exception.ProException	500 Internal Error
com.progress.open4gl.Open4GLException	500 Internal Error
com.progress.open4gl.BusySessionException	503 Service Unavailable
com.progress.open4gl.ConnectException	500 Internal Error
com.progress.open4gl.BadURLException	500 Internal Error
com.progress.open4gl.ConnectFailedException	500 Internal Error
com.progress.open4gl.HostUnknownException	500 Internal Error
com.progress.open4gl.InvalidNameServerPortException	500 Internal Error
com.progress.open4gl.MsgVersionInvalidException	502 Bad Gateway
com.progress.open4gl.NameServerCommunicationsException	502 Bad Gateway
com.progress.open4gl.NameServerInterruptException	504 Gateway Timeout
com.progress.open4gl.NameServerMessageFormatException	502 Bad Gateway
com.progress.open4gl.NoSuchAppServiceException	500 Internal Error
com.progress.open4gl.OutputSetException	500 Internal Error
com.progress.open4gl.RunTime4GLException	500 Internal Error
com.progress.open4gl.RunTime4GLErrorException	500 Internal Error
com.progress.open4gl.RunTime4GLQuitException	504 Gateway Timeout
com.progress.open4gl.RunTime4GLStopException	504 Gateway Timeout
com.progress.open4gl.SystemErrorException	500 Internal Error

5

REST Application Security

This chapter contains general security information with regard to OpenEdge REST applications.

For more detailed information on security, see *OpenEdge Application Server: Administration* and *OpenEdge Management and OpenEdge Explorer: Configuration*.

For details, see the following topics:

- Security considerations
- Java Servlet Container managed security
- REST application managed security
- AppServer application managed security
- Data-in-transit network security
- REST Manager security

Security considerations

The security issues with regard to OpenEdge REST applications are the same as is found in any Web application: user authentication, session management, authorization to REST resources, and data-in-transit security. REST application deployment will often be performed in hostile unprotected networks like the Internet. Without the Web application's authentication, authorization, data integrity, and privacy being performed at the web server level you increase the risk of exposing business data to data miners and hackers.

The REST application and REST Manager employ Web application security best practices by employing the security mechanisms commonly provided by the Web server and a built-in Spring Security layer within the applications themselves. These common security layers supply Web applications with proven industry standard user authentication, authorization, and data privacy controls such as TLS before the backend data services (i.e. AppServer) can be attacked. The backend data services may then employ their own application level security without the need to be aware of the Web server environment they operate in. Additionally, because the REST applications employ common Web application security features and technologies, they will support a wider variety of REST clients without the requirements for customizations specifically for OpenEdge.

The security strategy for REST support is composed of these optional components:

- Web server (Java container) or REST application authentication using built-in services
- Internal REST application authorization to HTTP resources
- Using an AppServer as the web application's user authentication service
- Data-in-transit security provided by the TLS for web application's client to web server, and from REST application to an AppServer

The goal is to provide a production administrator with the ability to configure REST application security using standard web application security best practices in a layered and scalable manner that can range from simple to complex as is necessary.

A secondary goal is to divest an OpenEdge REST application developer from needing to incorporate highly technical security features that conform to security best practices in a Web environment. The developer's responsibility is twofold:

- To integrate with the web server's secure environment via OpenEdge supplied integration features
- To apply AppServer level access controls to application resources.

The following sections describe some of the options available for securing a REST Web application.

Java Servlet Container managed security

All Web servers and Java Servlet Containers provide a security infrastructure that provides consistent shared identity management across all deployed Web applications. Each Web application contains a deployment descriptor file that can be edited to declare its specific security requirements to the Java container. As the Web application runs in the container, the declared policy is used to authenticate users and authorize users to the resources that make up the Web service. These security constraints can specify the type of user authentication and what user role membership is required before the container will grant access to the application's URI space.

The resulting authenticated user-id and roles are then supplied to the REST applications security layer for fine grained URI and method authorization to individual REST resources. In this way the production administrator can choose the strength of user authentication and coordinate it across all deployed Web applications.

The production administrator configures user authentication and role membership in the REST application's deployment descriptor in order to share the same user accounts and authentication mechanism across all Web applications hosted in the Java container

A template security configuration will be included in the REST manager and adapter that will simplify using Java container security. See the Java Servlet Specification and your Java container documentation for more details on implementing security for REST applications.

REST application managed security

Each OpenEdge REST application has an embedded Spring Security framework that provides a richer set of security features than is normally found in the Java Servlet Container. Additionally, it provides a common authentication and authorization configuration regardless of which type of Java container the REST application runs in. Spring Security provides access to the same forms of user authentication protocol as the Java container does, but has a richer set of user authentication system plug-ins, form login controls, and URL access controls.

The Spring Security framework may be configured to provide its own user authentication instead of using the Java container. Normally the administrator would choose the Spring Security framework for user authentication when application specific user authentication is required. Allowing the web application to perform user authentication also has the advantage of having a single location to configure all authentication, authorization, and session management. Of course, Spring Security can be configured to delegate user authentication to the Java container when needed.

The REST application and REST Manager come with built-in support for a number of authentication plug-in sources via a selection of sample configuration files, which may be configured at the production site.

The Web application's Spring Security is always where login session management and authorization to the REST resources (i.e. URIs) will be performed. The authorization is based on role memberships supplied by whichever authentication system is employed. The production administrator has a number of options to control login session management, including a built-in "remember-me" service. Other session context schemes are available where session context can be shared across multiple web servers configured in a load-balancing architecture.

The Spring Security framework has a rich set of access controls that employ powerful regular expression matching for URIs, HTTP verbs, and user role memberships. The granularity of this access control can range from coarse to fine-grained as demanded by the production site's security requirements.

The other primary task of the Spring Security framework is to bridge the REST application's authenticated user ID and session management with the AppServer. After the Web application user authentication, session management, and HTTP resource authorization completes, the Spring framework will generate a sealed Client-Principal for the login session. The resulting sealed Client-Principal will then be inserted into the Web application login context where it will be stored and transparently passed to the AppServer on each operation. Therefore, the AppServer application developer does not need to add additional parameters to each and every remote request for user-id and session-id. (If required, the AppServer and REST application may manually pass private user-id and session information as parameters for each service interface API, and configure the web application to send it to the REST client via customized data sources)

The AppServer application can accesses the Web application's sealed Client-Principal and session id via the ABL `RequestInfo` object from any activate, deactivate, or remote execution object. The `RequestInfo` object is common to all AppServer clients so that all service interfaces may share the same identity management code. Each time the AppServer runs a request the REST application will ensure the correct user Client-Principal and session ID pass are passed to it.

The types of information transparently passed to the AppServer are:

- Web login session's id via the CCID property
- Sealed Client-Principal with the information:
- Web server authenticated user-id
- Web application context name as the domain-name
- Date-time of the user login to the web server
- Roles the web user was granted access to by the web server

AppServer application managed security

Your AppServer application may add its own security layer for internal operations and data. There are a number of options recommended in *OpenEdge Application Server: Developing AppServer Applications*. In particular, a state-managed AppServer application can provide authentication and authorization using a `CONNECT` procedure. Also, any AppServer application can implement its own login/logout procedures after a connection is established.

As stated previously, the REST application's security framework passes a Client-Principal to the AppServer on each request to identify who the user is and what their login session is. The Client-Principal is available to the AppServer's activate remote procedure, and deactivate procedure via the ABL session's `RequestInfo` object. The Client-Principal can be used to set the ABL session and/or database connections in the same way, and for the same reasons, as if the REST application were any other ABL client.

Data-in-transit network security

Each deployed OpenEdge REST application acts as an intermediary between the AppServer and the clients that access its services from the Internet or an intranet. As a result, an application session involves two distinct connections, each of which is configured separately with respect to security.

The first connection is between the REST client and the OpenEdge REST application. To make this connection secure, the following conditions must be met:

- The client must use the HTTPS protocol to send requests.
- The OpenEdge REST application must be HTTPS-enabled; that is, it must be configured to accept HTTPS requests from clients (via the Java Servlet Container or the Web server).
- A private key and a Web server digital certificate must be installed on the Web server or standalone Java SErvlet Container, and must be configured for TLS support.
- In the OpenEdge REST application `web.xml` file, the `security-context` element must be changed from `NONE` to `CONFIDENTIAL`.
- In the `runtime.props` file for the application, the URI must be set to use the HTTPS protocol instead of HTTP.

The second connection is an AppServer protocol connection between the OpenEdge REST application and the AppServer. For this connection to be secure, the following conditions must be met:

- You must obtain and install public key certificates for the OpenEdge REST application's host machine (the machine hosting the Java Servlet Container). OpenEdge provides built-in keys and certificates for development. For production machines, you should obtain server certificates from an internal or public Certificate Authority (CA). See *OpenEdge Application Server: Administration* for more information about public keys.
- The service must send TLS requests to the AppServer. To configure the application to send TLS requests, you set the value of the `appServiceProtocol` property to `AppServerS` or `AppServerDCS`. You set this property, either for a specific application or as the default for REST applications deployed to a given Java Servlet Container, by using OpenEdge Explorer.
- The AppServer must be TLS-enabled, meaning that it accepts TLS requests from the OpenEdge REST applications (or other clients). You set the property `sslEnable=1` by checking the **Enable SSL Client Connections** box in the SSL General properties category in the Progress Explorer, or by manually editing the `ubroker.properties` file on the AppServer host machine. You must also obtain and install a server private key and public key certificate and set additional TLS server properties. See *OpenEdge Application Server: Administration* for more information on configuring the AppServer.

REST Manager security

If the OpenEdge REST Manager was not protected in some way, then anyone on the internet could make changes to your Java container. Therefore the REST Manager will incorporate the same Spring Security framework as described in OpenEdge REST applications. Therefore, it will have the same abilities for user authentication and authorization to URIs.

The OpenEdge REST Manager's Spring default configuration uses a user account file local to the Web application and has two default accounts. This configuration is suitable for development environments but is not adequate for deployment environments. The production administrator is encouraged to use one of the provided sample security templates to provide stronger authentication.

When configuring security in either the REST Manager or REST application service the key to success will be to manage the user account's role memberships and use those roles in Spring Security configuration's URI access controls.

In addition to configuring authentication, you may also want to use TLS requests to communicate with the REST Manager. Since the REST Manager is also a Web application similar to the deployed OpenEdge REST applications, the instructions for enabling TLS on the client-application connection also apply.

To even further restrict the access to the REST Manager, you should configure your Web server or Java Servlet Container to only accept the IP addresses of the specific client machines that will be allowed to connect.

6

Data Object Services

This chapter provides an overview of OpenEdge Data Objects, which are server-side objects that allow remote clients to access OpenEdge data and operations over the Internet using an RPC model that is both simplified and natural for the client implementation language, and provides an overview of Data Object Services, which are specially configured REST Web services that provide client access to Data Objects using either the Progress Application Server for OpenEdge (PAS for OpenEdge) or a generic Tomcat Web server with access to the classic OpenEdge AppServer. This chapter also describes the requirements for creating OpenEdge Data Objects and Services, and introduces the OpenEdge tools available to accelerate their development.

For details, see the following topics:

- Overview of Data Object Services
- Coding Business Entities to implement Data Objects
- URIs for accessing Data Object Web applications, Services, and resources

Overview of Data Object Services

An *OpenEdge Data Object* implements a single server-side resource that provides client access to a set of OpenEdge data and operations through the agency of a Data Object Service, which is a type of REST Web service with additional information about the data and operations that a client can access. You implement a Data Object resource using an OpenEdge Business Entity (the Data Object), which is typically an annotated ABL user-defined class that provides access to resource data and business logic through public methods that implement the resource operations. You can also implement a Business Entity as a persistent procedure (procedure object), with resource operations implemented as internal procedures. However, OpenEdge tools that help you create new Business Entities always create ABL classes to implement Data Objects.

A Business Entity can provide a standard set of operations to access a single *data model*—either a single temp-table or a single ProDataSet resource with one or more temp-tables—and can also provide access to custom ABL business logic as well. The operations that a Business Entity can implement include:

- **Read** — A standard operation that returns any number of records to the client according to optional server pre-processing that can include filtering of the result set, sorting of the result set, and paging of the result set (returning a fixed batch of records from the result set upon request).
- **Create, Update, or Delete (CUD)** — A set of standard operations that create, update, or delete (respectively) a single record per network request.
- **Submit** — A standard operation that can create, update, and delete multiple records per network request, providing support for complex data transactions.
- **Invoke** — A custom operation that can execute any method in the Business Entity other than the methods used to implement standard operations.

A Business Entity class must provide a separate and distinct method, with a particular signature and annotations, to implement each of the five standard CRUD and Submit operations supported by a given Data Object resource. The same Business Entity can also provide one or more methods that are annotated as custom Invoke operations, where each method can have any supported ABL signature (see Coding ABL for Data Object operations on page 88).

When a Data Object is first accessed by a client, its Business Entity is instantiated on an OpenEdge application server as a singleton class, where it can be accessed by all clients that need this Data Object resource from a given Data Object Service.

The main difference between an OpenEdge REST Service providing access to REST resources and a Data Object Service is that a Data Object Service has information that allows clients to access the data and operations of Data Object resources without having to construct the corresponding calls to REST resources. Instead, the client accesses methods of a single client-side Data Object that hides all the details of the REST resources supported by a single corresponding server-side Data Object.

Thus, an *OpenEdge Data Object Service* is a combination of an OpenEdge REST Web service and a Data Service Catalog that defines how clients can access server-side Data Object resources using corresponding client-side Data Objects. This *Data Service Catalog* is a JSON file that defines the schema of the data and the operations on the data that are supported by each Data Object resource provided by a given Data Object Service. Instead of only defining a RESTful mapping of HTTP verbs to Web URIs and header data on which these verbs operate (resulting in a *mapped RPC*), a Data Service Catalog defines these same REST resources as implementations for methods of a client-side Data Object. These client-side Data Object methods are there by defined to correspond to methods of a correspondingg server-side Data Object based on annotations in its implementing ABL Business Entity (resulting in an *annotated RPC*).

As a result, a client can access the data and operations of a server-side Data Object simply by calling the corresponding methods of the client-side Data Object in exactly the same way that it calls any object methods in the client's implementation language, and without having to code the HTTP verbs, URIs, and header information for REST requests. These client-side Data Objects also afford the client access to data processing features that mirror the capabilities of OpenEdge server-side Data Objects, such as before-imaging and the multi-table data modeling provided by OpenEdge ProDataSets, which allow the client to participate in complex transaction processing.

A given OpenEdge Data Object Service can support any number of Data Object resources as defined by its Data Service Catalog, which is generated by OpenEdge when you create the Data Object Service. You can then deploy the Data Object Service in a Web application, just like any OpenEdge REST Web service, but with the addition of its Catalog, which is deployed as a static file in the Web application.

Progress currently supports the instantiation of client-side Data Objects for JavaScript clients as part of a Cloud Data Object open source project on GitHub. Using the supported Progress Data Object libraries from this project, together with access to available OpenEdge Data Object Services and their Catalogs, a mobile or Web app developer can create instances of a JavaScript Data Object (JSDO), the client-side Data Objects, that provide access to corresponding OpenEdge Data Object resources on the server.

For more information on using client-side Data Objects to access server-side Data Objects, see the documentation on Progress Data Objects in the Cloud Data Object project on GitHub: http://clouddataobject.github.io/, or see Develop Progress Data Objects.

OpenEdge supports the development and deployment of Data Object Services for both the Progress Application Server for OpenEdge (PAS for OpenEdge), where Data Object Services are deployed directly to the PAS for OpenEdge, and the classic OpenEdge AppServer, where Data Object Services can be deployed to any generic Tomcat Web server that supports OpenEdge REST applications. Progress Developer Studio for OpenEdge provides wizards and other tools to accelerate the development of OpenEdge Data Objects and Services for both application server environments. This support includes wizards that provide automatic (default) or custom annotations to Business Entity methods that implement Data Object operations.

Progress Developer Studio for OpenEdge supports Data Object development for each of the two OpenEdge application servers (PAS for OpenEdge or the classic OpenEdge AppServer) using different and distinct types of OpenEdge Server projects. To develop Data Objects for deployment to PAS for OpenEdge with the corresponding ABL Business Entities running on PAS for OpenEdge, you must use a PAS for OpenEdge Server project to create and manage a Data Object Service with either a REST transport using a REST RPC service provider or a WEB transport using a WebSpeed (*WebHandler*) service provider. To develop Data Objects for deployment to a generic Tomcat Web server with the corresponding ABL Business Entities running on the classic OpenEdge AppServer, you must create a Classic Server project, which **only** supports Data Object Service development using the classic AppServer implementation. (An OpenEdge Server project can similarly be used to develop REST and APSV (ABL application) services on either PAS for OpenEdge and the OpenEdge AppServer.)

Note that the WebHandler service provider imposes the following limitations on the coding for any Business Entity (or other service interface) used to implement a resource for the Data Object Service:

- **No current support for ABL procedures as Business Entities** — You can only code user-defined ABL classes as Business Entities for access by the WebHandler. As a workaround, you can call into any procedure (`.p`) that was previously used as a resource service interface from the ABL class.
- **No support for `DEFINE TEMP-TABLE x LIKE y`** — A Business Entity (or other service interface) for access by the WebHandler **cannot** contain a temp-table definition as part of its schema that includes the `LIKE` option. For example:

  ```
  DEFINE TEMP-TABLE ttCustomer LIKE Customer.
  ```

  If any Business Entity is a resource of a Data Object Service defined using the WebHandler, and it contains a `TEMP-TABLE` statement with `LIKE` as part of its schema, the Read operation on that Business Entity fails and returns an error to any client app as a result.

For more information, see the topics on Data Objects and Data Object Services in the Developer Studio online help *Progress Developer Studio for OpenEdge Guide*.

Note: Some operation annotations must be added manually to the Business Entity code. For more information, see Updates to allow access by Kendo UI DataSources and Rollbase external objects on page 95

Note: The generated files for a Data Object Service created with the WebHandler service provider include a *`ServiceName`*`.json` Catalog file located in *`PASforOEInstance`*`\webapps\`*`WebApplicationName`*`\static`, exactly the same as for a REST RPC service provider. The only difference is in the relative transport URI specified in URIs for client apps to access resource operations. For more information, see Data Object URIs for testing resources from REST clients on page 105.

Note: For the WebHandler service provider, an OpenEdge *ServiceName*.gen file is generated in *PASforOEInstance*\webapps*WebApplicationName*\WEB-INF\openedge, instead of the *ServiceName*.paar file generated for REST RPC. This *ServiceName*.gen file is similar in function to the REST RPC *ServiceName*.paar file. However, *ServiceName*.gen is a readable JSON file containing the same mapping information required to map request and response messages to Data Object Service resource operations.

Coding Business Entities to implement Data Objects

Several options and requirements apply to the ABL that you write to implement Data Objects:

- The ABL routines that implement Data Object resource operations have specific coding requirements. The following sections describe these requirements.
- Only a class or procedure object that is coded and running as a singleton can implement a Data Object. The Progress Developer Studio for OpenEdge wizards for creating and updating a Business Entity ensure that the object is created for use as a singleton.

OpenEdge also provides an ABL API to send push notifications to hybrid apps running on registered devices. This API consists of the ABL OpenEdge.Mobile.PushNotificationService class and its related classes that run on an OpenEdge application server. For more information on using this server-based push notification service, see the Developer Studio online help *Progress Developer Studio for OpenEdge Online Help*.

For more information on coding Data Objects, see:

- Singleton classes and procedures as Data Object resources on page 84
- Coding ABL routines to implement a Data Object resource on page 85
- Creating an ABL class with the New Business Entity wizard on page 86
- Using existing ABL code with the Define Service Interface wizard on page 87
- Coding ABL for Data Object operations on page 88
- Sample Business Entity with before-image support on page 90
- Sample Business Entity without before-image support on page 93
- Updates to allow access by Kendo UI DataSources and Rollbase external objects on page 95

Singleton classes and procedures as Data Object resources

The ABL to implement the interface to a single Data Object resource must be coded in a single class or external procedure that can be executed as a singleton object. A singleton object is a class or external procedure that once initially instantiated, the same instance is shared by all consumers of the class or procedure no matter how many times it is instantiated in a given application server session.

When, on behalf of a mobile or web app, a Web application executes any Data Object operation in the resource running in an application server session, if the ABL class or external procedure has not yet been instantiated as a singleton object, the session instantiates it and executes the ABL routine that implements the operation. When the operation completes, the object remains instantiated for access by other client requests. When the Web application executes another operation on the same resource running in the same ABL session, the same singleton object is then used to execute the ABL routine for that operation, and so on. If another application server session executes the operation for the same Data Object resource, the same process repeats itself, instantiating the singleton if it does not exist and remaining instantiated for all additional calls to the same resource on that or another session where the same object is instantiated. Once all running application server sessions have executed an operation for that same Data Object resource, they all maintain their singleton objects as long as they continue to run. Again, the process repeats for any additional session that runs on the application server and responds to a Data Object operation request.

ABL classes are inherently coded to be instantiated as singletons. However, external procedures must meet a basic requirement to be instantiated as singletons, and that is, they cannot contain any `DEFINE PARAMETER` statements in the main block. They can contain internal procedures and user-defined functions with their own parameters, each of which can implement a Data Object operation exactly like a method of a class.

Note that the singleton coding requirement for external procedures applies only to an external procedure that implements the resource for a Data Object and its operations. Any additional procedures or classes that a singleton class or procedure accesses can be implemented like any other class or procedure that runs on an OpenEdge application server.

For more information on singleton procedures instantiated in the context of an ABL client, see the `RUN` statement in *OpenEdge Development: ABL Reference*. Although this information is for ABL clients, singleton procedure behavior and coding requirements apply for OpenEdge procedures running on an application server as well.

Coding ABL routines to implement a Data Object resource

When you create a Data Object resource in Developer Studio for OpenEdge, you can either create a new class to implement the resource using the **New Business Entity** wizard or you can use the **Define Service Interface** wizard to create the resource from an existing ABL class or external procedure coded to run as a singleton. Using either of these wizards, you can define ABL routines that implement one or more operations for a single Data Object resource. You can also create a new Business Entity by creating an Express Data Object project, which creates a fully-implemented Data Object Service containing a single Data Object that provides access to a ProDataSet with a single temp-table based on a selected OpenbEdge database table.

Note: Express Data Object Services can only be built for an OE Web Server (Tomcat) for access to a classic OpenEdge AppServer.

The two basic options that you must define for any class or procedure that implements a Data Object resource include the data model and the Data Object operations that the class or procedure supports. As described previously (see Overview of Data Object Services on page 81), a Data Object resource can support a single data model that is managed by the standard operations of a Data Object: Create, Read, Update, Delete (CRUD), and Submit. This data model can be the ABL definition for a single temp-table or a single ProDataSet that contains one or more temp-tables, including any data-relations defined for them.

If you want to use the Submit operation with a ProDataSet, the temp-tables of the ProDataSet must also define before-tables to support before-imaging; you can then take advantage of built-in ProDataSet support for managing complex data transactions. If you want to use the Submit operation with a single temp-table, there is no before-image support, and you must develop your own model for managing multi-record updates to an OpenEdge database.

In a ProDataSet resource with related (parent-child) temp-tables, you might want to define the data-relations between them using the `NESTED` option, especially if you pass this ProDataSet data as output from Invoke operations to which the client must respond. Nesting allows the data in the response from the Invoke operation to be more easily inspected and managed by the client, because the child table records are all grouped and nested under each related parent table record.

In the Developer Studio wizards, you can select the data model from any temp-tables and ProDataSets that are defined in the class or procedure file, or in another external file that you specify. Once completed, the wizard, if directed, inserts the selected data definition in the main block of the class or procedure based on the data model that you select and creates empty stubs for resource operation methods that you can use to implement the Business Entity class that is created. If you create a Business Entity class as part of an Express Data Object project (for classic OpenEdge AppServer deployments only), you select a single table from an OpenEdge database as your data model, which generates the corresponding definition for a ProDataSet with a single temp-table. In this case, OpenEdge creates an entire initial implementation for all the resource operation methods created in the Business Entity.

Creating an ABL class with the New Business Entity wizard

When you create a Business Entity class to define a Data Object resource using the **New Business Entity** wizard, it can define a resource with one of the following sets of standard Data Object operations for the selected data model:

- A single Data Object Read operation (for a read-only resource)
- A full set of Data Object CRUD operations
- A full set of Data Object CRUD operations plus the Submit operation

If the selected data model is a ProDataSet with multiple temp-tables, it also defines a separate Invoke operation for each temp-table that is intended to read the table and return its records to a mobile app as a JavaScript object.

If you choose to include the Data Object Submit operation, along with the other standard CRUD operations using a ProDataSet, the wizard requires that your Business Entity inherit the `OpenEdge.BusinessLogic.BusinessEntity` abstract class. This abstract class includes protected generic methods that perform much of the work required to implement record change operations using the before-image support available in a ProDataSet. Note that inheriting this abstract class is only useful to implement a Data Object resource that you define to support before-imaging, and the wizard automatically defines all the standard and custom Invoke operations to use a ProDataSet with the data model that you have specified.

If you choose to include the Submit operation using only a single temp-table, the wizard does not allow your Business Entity to inherit the `BusinessEntity` abstract class, because this base class only supports a Submit operation using a ProDataSet with before-imaging. If you choose to use a single temp-table, note that there can be no before-image support, and you must design your own custom data management model to handle a multi-record CUD request for this single temp-table. Note that any client JSDO that accesses this temp-table resource must also follow the same custom data management model.

For a Business Entity created using the **New Business Entity** wizard, each Data Object CRUD and Submit operation is defined by a single `VOID` ABL method whose name is based on the operation name, whose code block is created based on the starting point for generating the Business Entity, and whose parameter list is tailored to reference the selected data model. The exact parameter list for each method is prescribed by the Data Object operation that it implements. The generated name for each method is a concatenation of the operation name with the name of the resource data model instance. For example, if the data for the resource is a ProDataSet named `dsCustomer` and the read operation is being defined, the method name is created as `ReaddsCustomer( )`.

The code block of the method for each Data Object CRUD and Submit operation is generated depending on the specified Business Entity data model and whether or not it inherits the `BusinessEntity` abstract class, as follows:

- **Setting a database table as the data model** — Generates a complete code block to implement each method, **whether or not** the Business Entity inherits the `BusinessEntity` abstract class.
- **Setting a schema file as the data model for a Business Entity that inherits the `BusinessEntity` abstract class** — Generates most of the code block. You have to add code to access the data-source and specify a record field skip-list for the read operation.
- **Setting a schema file as the data model for a Business Entity that does not inherit the `BusinessEntity` abstract class** — Generates an empty code block. You have to add all of the code to implement each method.

Based on your Business Entity starting point, you must then add any additional code required to implement each Data Object CRUD and Submit operation according to OpenEdge Data Object functional requirements. Note that a resource that supports both Data Object CRUD and Submit operations **with** before-imaging has different coding requirements than one that supports only CRUD operations **without** before-imaging. For more information, see Coding ABL for Data Object operations on page 88.

Note: It is possible to define a Data Object resource with only CRUD operations that support before-imaging. However, without the use of the Submit operation to do multi-record transactions, most of the benefits of before-imaging support in the client JSDO are lost.

In addition, when the wizard is directed to generate a Data Object Service interface, both the first ABL statement in the file and each `METHOD` statement in the class are preceded by a set of annotations that start with the `'@'` character and specify how the class and each method is to be accessed and executed as a Data Object resource and operation. For example, the annotations indicate operation URIs and whether the Data Object resource supports before-imaging.

Caution: Use care when modifying any annotations in the ABL source file generated for a Business Entity. Doing so can make the resource inaccessible from clients (mobile apps) or otherwise fail to function. One case where you do need to modify these annotations in the source is for Business Entities you create for client access in the Telerik Platform using the JSDO dialect of the Kendo UI Datasource. For more information, see Updates to allow access by Kendo UI DataSources and Rollbase external objects on page 95.

Using existing ABL code with the Define Service Interface wizard

When you define a Data Object resource from an existing ABL class or procedure (using the **Define Service Interface** wizard), you select the existing class or procedure file, the data model for the new Data Object resource to support, and the existing ABL routines that you want to implement Data Object operations for the resource. In this case, you select an operation, and choose the ABL routine you want to implement it. Each ABL routine you have selected for the resource can implement **only one** operation, whether it is a standard Data Object CRUD or Submit operation or a custom Invoke operation. Once you have chosen a routine for every CRUD and Submit operation you need to implement, any remaining routines in the list can each implement an Invoke operation. (If you choose to have all the existing ABL routines implement Invoke operations, the Data Object resource then supports no CRUD or Submit operations.)

Note: A common use of this wizard is to add additional ABL methods as Invoke operations in a Business Entity that you have previously created using the **New Business Entity** wizard.

When the wizard completes, it annotates the file and the ABL routines chosen to implement Data Object operations similar to the annotations added to the class file and methods of a new Business Entity.

Note that the **Define Service Interface** wizard does **not** verify that the existing ABL routines you choose are coded properly to implement a given operation. For a Data Object CRUD or Submit operation, the wizard does not even verify that the prescribed parameter list for the operation is correct. If a Data Object CRUD or Submit operation has an incorrect parameter list, the operation will not work. So, you might have to revise any existing ABL routines that you chose to implement Data Object CRUD or Submit operations to perform the work of that operation, at least according to OpenEdge Data Object functional requirements (see Coding ABL for Data Object operations on page 88).

Coding ABL for Data Object operations

No matter how you obtain the ABL class or procedure to implement a Data Object resource, any ABL routines that you define in the source file to implement Data Object operations must conform to specific coding requirements. Otherwise, a client cannot access the data using client-side Data Objects (JSDOs). These requirements depend on the operation and the data that you want the resource to provide:

- The ABL routines that implement Data Object CRUD and Submit operations must all operate on the same data model.
- Each ABL routine that implements a standard Data Object Create, Read, Update, Delete, or Submit operation must have a prescribed parameter list, based on the data model that the Data Object resource supports. When you create a new Business Entity for a data model, the wizard generates correct parameter lists for interacting with that data model.
- For the fields of temp-tables in the data model, and for the parameter lists and return types of ABL routines that implement custom Invoke operations, you can include all supported ABL data types **except** `RAW` and `RECID`. The ABL `RAW` and `RECID` data types are not supported by OpenEdge Data Objects.
- For all standard Data Object CRUD and Submit operations, the return type for class methods must be `VOID`, and any return values from internal procedures and user-defined functions are ignored.

The following table shows a complete description of the prescribed parameter list for each standard Data Object CRUD and Submit operation. The notes in the table describe important additional requirements and limitations that you need to consider.

Table 10: Prescribed ABL parameters for standard Data Object operations

Standard operation	Prescribed ABL parameter list[3]
Create	`INPUT-OUTPUT { TABLE` *`table-name`* `| DATASET` *`dataset-name`* `| TABLE-HANDLE` *`table-hdl`* `| DATASET-HANDLE` *`dataset-hdl`* `}`[4]
Read	`INPUT` *`filter`*[5] `AS CHARACTER ,` `OUTPUT { TABLE` *`table-name`* `| DATASET` *`dataset-name`* `| TABLE-HANDLE` *`table-hdl`* `| DATASET-HANDLE` *`dataset-hdl`* `}`[4]
Update	`INPUT-OUTPUT { TABLE` *`table-name`* `| DATASET` *`dataset-name`* `| TABLE-HANDLE` *`table-hdl`* `| DATASET-HANDLE` *`dataset-hdl`* `}`[4]
Delete	`INPUT-OUTPUT { TABLE` *`table-name`* `| DATASET` *`dataset-name`* `| TABLE-HANDLE` *`table-hdl`* `| DATASET-HANDLE` *`dataset-hdl`* `}`[4]
Submit	`INPUT-OUTPUT { TABLE` *`table-name`* `| DATASET` *`dataset-name`* `| TABLE-HANDLE` *`table-hdl`* `| DATASET-HANDLE` *`dataset-hdl`* `}`[4,6]

As noted previously, when you define a Data Object resource by creating a new Business Entity class, it creates the class methods to implement the Data Object CRUD and Submit operations using the correct parameter list, and in some cases, leaves the code block for each method empty for you to complete. For this purpose, and for any revisions you might need to make to an existing class or procedure you are using to define a Data Object resource, you need to account for certain features of the client-side Data Object (JSDO):

- A JSDO has an internal data store (JSDO memory) that is structured to match the data model selected for the Data Object resource that it accesses. So, if the data model is a ProDataSet containing ten temp-tables with data-relations, JSDO memory is structured to map the data for these ten temp-tables and their data-relations.
- If your Data Object resource supports both Data Object CRUD and Submit operations on a ProDataSet, the JSDO created for it includes before-image support to work with multi-record transactions over the

[3] If the implementing ABL routine is a class method, its return type must be `VOID`. The return value of any ABL routine is ignored.

[4] Because all the standard operations of a Data Object resource must support the same schema, their implementations all must share either a TABLE, TABLE-HANDLE, DATASET, or DATASET-HANDLE parameter with exactly the same temp-table or ProDataSet schema.

[5] The *`filter`* parameter is passed as a query string or a JSON object that is intended to filter the records returned for the temp-table or ProDataSet parameter of a read operation. Your ABL routine can use this value for any purpose, or ignore the parameter entirely. Note that to allow the prescribed mapping to work between the ABL routine for the standard Read operation and the JavaScript method that calls it, you must name this parameter `filter` in the signature of the ABL routine.

[6] The implementation for a Submit operation (like the other standard operations) supports either a single ProDataSet or a single temp-table parameter, and all CRUD operations that you define for the same Data Object resource must support the same parameter type. However, note that the single temp-table parameter does not support before-imaging, and you cannot use the `OpenEdge.BusinessLogic.BusinessEntity` as a base class for the resource implementation because it only supports Submit with a single ProDataSet parameter; therefore, you must code the entire resource implementation yourself.

network. This means that the ABL routine that implements the Submit operation needs to be written to access the ProDataSet to handle these multi-record transactions using before-imaging. In addition, the ABL routines that implement the Create, Update, and Delete operations handle **single-record** transactions only, but also work with the before-image features of the ProDataSet. For example, if a record-change (CUD) operation fails on a ProDataSet, the value of the `ERROR-STRING` attribute on the associated temp-table buffer object is typically set to provide information about the error that can be returned to the JSDO on the client. As noted previously, OpenEdge provides a pre-defined ABL abstract class (`OpenEdge.BusinessLogic.BusinessEntity`) that you can use as a base class to implement these Data Object operations with before-image support.

- If your Data Object resource supports Data Object CRUD operations **without** before-image support, the JSDO created for it also does not include before-image support and only supports single-record transactions over the network. Therefore, each Data Object Create, Update, and Delete operation can only change a single record at a time, and the ABL routines that you use to implement these operations can only update a single input record per invocation on the server.

  The standard Data Object CRUD operations without before-image support interact directly with the JSDO memory accordingly. The Read operation reads a set of records from its single temp-table, or from the temp-tables of its single ProDataSet on the server and loads them into JSDO memory. The Create, Update, and Delete operations each send only a **single** record from JSDO internal memory to the server, where they, respectively, add the new record, update the existing record, or delete the existing record from the OpenEdge data source. These operations execute across the network multiple times in order to update multiple records on the server. So, if the data model is a ProDataSet with multiple tables, the ABL routine that implements the operation must query each table for which the operation applies in order to find that one record to Create in, Update in, or Delete from the data source.

  When a Data Object Create, Update, or Delete operation completes, it can only return a **single** record to JSDO memory. For example, if an update operation fails, it might return the record with the field values that currently exist in the data source, along with raising an ABL error explaining how the update failed.

- If your Data Object resource supports a Submit operation on a single temp-table, it can process multiple record changes in a single network request to the server. However, without before-image support, you must manage individual record changes using your own semantics in both client JSDO memory and in the server Data Object resource.

Sample Business Entity with before-image support

Following is a sample ABL Business Entity class (`Customer`) defined for a Data Object resource that has before-image support (with all annotations removed). This class inherits from OpenEdge-defined abstract class, `OpenEdge.BusinessLogic.BusinessEntity`, and calls several of its methods to implement the Data Object. It thus uses the following public methods to implement the standard Data Object CRUD and Submit operations on a ProDataSet named `dsCustomer`:

- **Create** — `CreatedsCustomer( )`, which calls `CreateData( )` in the super class
- **Read** — `ReaddsCustomer( )`, which calls `ReadData( )` in the super class
- **Update** — `UpdatedsCustomer( )`, which calls `UpdateData( )` in the super class
- **Delete** — `DeletedsCustomer( )`, which calls `DeletedData( )` in the super class
- **Submit** — `SubmitdsCustomer( )`, which calls `SubmitData( )` in the super class

In this case, the ProDataSet contains a single temp-table, `ttCustomer`, with a before-table, `bttCustomer`, that is defined for the `Customer` table in the `sports2000` database. The listing of the data model follows the class.

The class constructor first invokes the super class constructor to pass the handle of the instance ProDataSet to the abstract class, which sets the protected `ProDataSet` property defined in the class, then passes the required data source handles and skip lists (one each in this case) by setting the protected `ProDataSource` and `SkipList` properties that are defined in the abstract class.

Note: For the Data Object Create, Update, Delete, and Submit operations, the input side of the `INPUT-OUTPUT DATASET` parameter replaces the `dsCustomer` data left over from any prior operation. Also note that while the client JSDO invokes the Submit operation on all changed records in the JSDO, the JSDO invokes any Create, Update, or Delete operation on only one changed record at a time, similar to when a Data Object resource is defined without before-image support. However, in this case (with before-image support), before-image data is passed by the JSDO and processed for these single-record operations as well.

Table 11: Sample Business Entity class for a Data Object resource with before-image support

```
USING Progress.Lang.*.
USING OpenEdge.BusinessLogic.BusinessEntity.


BLOCK-LEVEL ON ERROR UNDO, THROW.


CLASS Customer INHERITS BusinessEntity:

  {"customer.i"}

  DEFINE DATA-SOURCE srcCustomer FOR Customer.

  CONSTRUCTOR PUBLIC Customer():

    DEFINE VAR hDataSourceArray AS HANDLE NO-UNDO EXTENT 1.
    DEFINE VAR cSkipListArray AS CHAR NO-UNDO EXTENT 1.

    SUPER(DATASET dsCustomer:HANDLE).

    /* Data Source for each table in dataset. Should be in table order
       as defined in DataSet. */
    hDataSourceArray[1] = DATA-SOURCE srcCustomer:HANDLE.

    /* Skip-list entry for each table in dataset. Should be in temp-table order
       as defined in DataSet. Each skip-list entry is a comma-separated list of
       field names, to be ignored in the ABL CREATE statement. */
    cSkipListArray[1] = "CustNum".

    THIS-OBJECT:ProDataSource = hDataSourceArray.
    THIS-OBJECT:SkipList = cSkipListArray.

  END CONSTRUCTOR.


  METHOD PUBLIC VOID ReaddsCustomer(INPUT filter AS CHARACTER, OUTPUT DATASET
dsCustomer):

    SUPER:ReadData(filter).

  END METHOD.


  METHOD PUBLIC VOID CreatedsCustomer(INPUT-OUTPUT DATASET dsCustomer):

    DEFINE VAR hDataSet AS HANDLE NO-UNDO.
    hDataSet = DATASET dsCustomer:HANDLE.

    SUPER:CreateData(DATASET-HANDLE hDataSet BY-REFERENCE).
```

```
  END METHOD.


  METHOD PUBLIC VOID UpdatedsCustomer(INPUT-OUTPUT DATASET dsCustomer):

    DEFINE VAR hDataSet AS HANDLE NO-UNDO.
    hDataSet = DATASET dsCustomer:HANDLE.

    SUPER:UpdateData(DATASET-HANDLE hDataSet BY-REFERENCE).

  END METHOD.


    METHOD PUBLIC VOID DeletedsCustomer(INPUT-OUTPUT DATASET dsCustomer):

    DEFINE VAR hDataSet AS HANDLE NO-UNDO.
    hDataSet = DATASET dsCustomer:HANDLE.

    SUPER:DeleteData(DATASET-HANDLE hDataSet BY-REFERENCE).

  END METHOD.


  METHOD PUBLIC VOID SubmitdsCustomer(INPUT-OUTPUT DATASET dsCustomer):

    DEFINE VAR hDataSet AS HANDLE NO-UNDO.
    hDataSet = DATASET dsCustomer:HANDLE.

    SUPER:SubmitData(DATASET-HANDLE hDataSet BY-REFERENCE).

  END METHOD.

END CLASS.
```

All the public methods call the corresponding super class methods to manage the business logic, such as calling `ReadData( )` to parse the filter string passed to the `ReaddsCustomer( )` method and then fill `dsCustomer` with data accordingly.

Note that the inherited `BusinessEntity` class provides alternative overloadings of the `ReadData( )` method that you can call with different options to implement `ReaddsCustomer( )` in the Business Entity. For more information, you can obtain a listing of the installed `OpenEdge.BusinessLogic.BusinessEntity` class from the following ABL source library:

```
OpenEdge_install_dir\src\OpenEdge.BusinessLogic.pl
```

Note that the inherited behavior of the public `SubmitData( )` method is to process all record changes in the transaction according to the same order defined for a default call to the `saveChanges( )` method on the client JSDO **without** using the Submit operation:

1. Apply all record deletes
2. Apply all record creates
3. Apply all record updates

Also, you can add additional processing for the respective record changes. For example following the call to a super class method, you might replace or modify the value of the `ERROR-STRING` attribute returned on each changed record buffer based on custom criteria. This attribute value is then available in the client JSDO as the value of the `_errorString` property in each record object returned with a record change error.

Note: The `Customer` class listed above is based on the Business Entity generated for an Express Data Object using the `Customer` table.

Following is the `customer.i` include file that provides the data model for the `Customer` class.

Table 12: Data model from customer.i for the Customer class

```
DEFINE TEMP-TABLE ttCustomer BEFORE-TABLE bttCustomer
  FIELD Address AS CHARACTER LABEL "Address"
  FIELD Balance AS DECIMAL INITIAL "0" LABEL "Balance"
  FIELD City AS CHARACTER LABEL "City"
  FIELD CustNum AS INTEGER INITIAL "0" LABEL "Cust Num"
  FIELD Name AS CHARACTER LABEL "Name"
  FIELD Phone AS CHARACTER LABEL "Phone"
  FIELD State AS CHARACTER LABEL "State"
  INDEX CustNum CustNum
  INDEX Name Name.

DEFINE DATASET dsCustomer FOR ttCustomer.
```

Sample Business Entity without before-image support

Following is a sample ABL class defined for a Data Object resource that has no before-image support (and with all annotations removed). It implements the standard Data Object CRUD operations for a Data Object resource defined for a ProDataSet named `dsCustomer` with the following public methods:

- **Create** — `CreatedsCustomer( )`
- **Read** — `ReaddsCustomer( )`
- **Update** — `UpdatedsCustomer( )`
- **Delete** — `DeletedsCustomer( )`

In this case, the ProDataSet contains a single temp-table, `eCustomer`, with a before-table, `beCustomer`, that is defined for the `Customer` table in the `sports2000` database. The listing of the data model follows the class.

Note: Although `eCustomer` has a before-table defined, it is not used to support JSDO before-imaging in this case, since the Data Object resource is defined without before-image support. Instead, it is used to process the appropriate Data Object operation request for the single input record in the ProDataSet, as described below.

All the public methods dispatch their function to private methods that manage the business logic, such as to interpret the filter string passed to the `ReaddsCustomer( )` method. The Create, Update, and Delete operations rely on a `commitCustomers( )` method to apply the row state from the operation method to the changed record and execute the `SAVE-ROW-CHANGES( )` method on the corresponding before-table buffer handle accordingly.

Note: For the Data Object Create, Update, and Delete operations, the input side of the `INPUT-OUTPUT DATASET` parameter replaces the `dsCustomer` data left over from any prior operation.

Table 13: Sample Business Entity class for a Data Object resource without before-image support

```
USING Progress.Lang.*.
BLOCK-LEVEL ON ERROR UNDO, THROW.
```

```
CLASS dsCustomer:
  {"dsCustomer.i"}
  DEFINE DATA-SOURCE srcCustomer FOR Customer.

  METHOD PUBLIC VOID ReaddsCustomer(
      INPUT filter AS CHARACTER,
      OUTPUT DATASET dsCustomer):
      THIS-OBJECT:applyFillMethod (INPUT filter).
  END METHOD.

  METHOD PUBLIC VOID CreatedsCustomer(INPUT-OUTPUT DATASET dsCustomer):
    THIS-OBJECT:commitCustomers(INPUT "", ROW-CREATED).
  END METHOD.

  METHOD PUBLIC VOID UpdatedsCustomer(INPUT-OUTPUT DATASET dsCustomer):
    THIS-OBJECT:commitCustomers(INPUT "", ROW-MODIFIED).
  END METHOD.

  METHOD PUBLIC VOID DeletedsCustomer(INPUT-OUTPUT DATASET dsCustomer):
    THIS-OBJECT:commitCustomers(INPUT "", ROW-DELETED).
  END METHOD.

  METHOD PRIVATE VOID commitCustomers(INPUT pcFieldMapping AS CHARACTER,
    INPUT piRowState AS INTEGER ):
    DEFINE VARIABLE skipList AS CHARACTER NO-UNDO.

    BUFFER eCustomer:ATTACH-DATA-SOURCE (DATA-SOURCE srcCustomer:HANDLE,
      pcFieldMapping).

    FOR EACH eCustomer.
      BUFFER eCustomer:MARK-ROW-STATE (piRowState).
      IF piRowState = ROW-DELETED THEN
        DELETE eCustomer.
    END.

    /* NOTE:
    ** For the ROW-CREATED case, the database has a trigger that generates
    ** the key value for the new CustNum field. The name of this field is
    ** passed to SAVE-ROW-CHANGES( ) so it will not overwrite the
    ** database-generated value with the unneeded input value.
    */

    IF piRowState = ROW-CREATED THEN
      skipList = "CustNum".

    FOR EACH beCustomer:
      BUFFER beCustomer:SAVE-ROW-CHANGES(1, skipList).
    END.

    FINALLY:
      BUFFER eCustomer:DETACH-DATA-SOURCE().
      RETURN.
    END FINALLY.
  END METHOD.

  METHOD PRIVATE VOID applyFillMethod(INPUT pcWhere AS CHARACTER):
    EMPTY TEMP-TABLE eCustomer.  /* Get rid of any existing data */
    BUFFER eCustomer:ATTACH-DATA-SOURCE(DATA-SOURCE srcCustomer:HANDLE).

    IF pcWhere NE "" AND pcWhere NE ? THEN
      DATA-SOURCE srcCustomer:FILL-WHERE-STRING = pcWhere.

    DATASET dsCustomer:FILL().

    FINALLY:
      BUFFER eCustomer:DETACH-DATA-SOURCE().
      DATA-SOURCE srcCustomer:FILL-WHERE-STRING = ?.
      RETURN.
```

```
    END FINALLY.
  END METHOD.

END CLASS.
```

Note: Although the client JSDO created for this Data Object resource has no before-image support and sends changes for only a single record at a time, the sample `commitCustomers( )` method uses, as a convenience, a `FOR EACH` statement to mark the row state of the single temp-table record sent from the client, and uses another `FOR EACH` statement to call `SAVE-ROW-CHANGES( )` on the single before-image record to create, update, or delete the record according to its row state.

Following is the `dsCustomer.i` include file that provides the data model for the `dsCustomer` class.

Table 14: Data model from dsCustomer.i for the dsCustomer class

```
DEFINE TEMP-TABLE eCustomer NO-UNDO BEFORE-TABLE beCustomer
  FIELD CustNum AS INTEGER
  FIELD Name AS CHARACTER FORMAT "X(20)"
  FIELD Address AS CHARACTER
  FIELD Phone AS CHARACTER
  FIELD SalesRep AS CHARACTER
  FIELD CreditLimit AS DECIMAL
  FIELD Balance AS DECIMAL
  FIELD State AS CHAR
  FIELD numOrders AS INT
  INDEX CustNum IS UNIQUE PRIMARY CustNum
  INDEX Name NAME.
DEFINE DATASET dsCustomer FOR eCustomer.
```

Updates to allow access by Kendo UI DataSources and Rollbase external objects

In both current and prior OpenEdge releases, the Business Entity generated for an OpenEdge Data Object assumes that the `filter` parameter of the Data Object Read operation can contain a string value of any format that is agreed upon between the developer of the client mobile app and the OpenEdge developer. For a Classic Server project using the Express setup option or a PAS for OpenEdge Server project whose Business Entity inherits the `OpenEdge.BusinessLogic.BusinessEntity` abstract class, Progress Developer Studio for OpenEdge generates Business Entity code that looks for an ABL `WHERE` string as the agreed upon value of this parameter, but otherwise leaves it up to the OpenEdge developer to provide the code required to handle a different format for the `filter` value.

If you are building a mobile or Web app using Kendo UI development tools, to allow the Kendo UI to access OpenEdge data using the server filtering, sorting, and paging features of the JSDO dialect of the Kendo UI DataSource, you must manually update the ABL code in the Business Entity to handle a new `filter` string format and add a new Data Object Count operation method. For more information on using Kendo UI to build mobile and Web apps using the JSDO dialect of the Kendo UI DataSource, see the Develop Progress Data Objects documentation.

If your Business Entity is intended to implement a *Rollbase external object* (a Rollbase object created to access an OpenEdge Data Object resource), you must provide similar updates for use by the Rollbase server to preprocess data that the Rollbase external object reads from the OpenEdge Data Object. For more information on Rollbase external objects, see the following Rollbase documentation: https://documentation.progress.com/output/rb/doc/index.html#context/rb/rb_oe.

Developer Studio for OpenEdge does not currently generate all the annotations to configure the Data Service Catalog or the behavior in a Business Entity that are required to provide OpenEdge data to a Kendo UI DataSource using its server preprocessing features, even when you build a Business Entity that inherits from `OpenEdge.BusinessLogic.BusinessEntity`. Therefore, you must manually update the Business Entity to add:

- **Annotations to handle the `filter` parameter value of the Data Object Read operation method as an OpenEdge-proprietary JSON Filter Pattern (described below).** This is required to implement the Read operation for any JSDO accessed by the Kendo UI DataSource, allowing it to use its server preprocessing options. Rollbase also relies on a similar JSON Filter Pattern to preprocess the data read by Rollbase external objects.
- **Code for a Data Object Count operation method that returns the total number of records available for access in the OpenEdge database (that is, in the result set) according to the specified JSON Filter Pattern options.** This Count operation method is required only if the DataSource uses server paging, because Kendo UI needs to know the total number of records available in the server result set for a given DataSource in order to manage server paging on the client.

  Unlike the manual annotations required to specify the JSON Filter Pattern value passed to the Read operation method's `filter` parameter, you can add the required annotations to specify a method as a Count operation method using the Define Service Interface wizard of the Developer Studio for OpenEdge. These annotations then identify the method to the client DataSource through the Data Service Catalog without the client programmer having to explicitly call it or identify it to the DataSource as the Count operation method.

For more information on updating Business Entities for access by Kendo UI DataSorces and Rollbase external objects, see:

- Understanding the JSON Filter Pattern (JFP) on page 96
- Adding the Count operation method on page 97
- Sample Read operation updated to handle JFP input and server paging on page 98

Understanding the JSON Filter Pattern (JFP)

The *JSON Filter Pattern* is a simple JSON object that contains the `ablFilter`, `id`, `orderBy`, `skip`, and `top` properties, which are intended to be used as follows:

- **`ablFilter`** — Contains the text of an ABL `WHERE` string (**not** including the `WHERE` keyword itself) on which to filter the OpenEdge database query that returns the result set, as in the following examples:
  - `"ablFilter" : "(State = 'MA') OR (State = 'GA')"`
  - `"ablFilter" : "Name BEGINS 'A'"`

  A value for this property is always specified for server filtering.

  Note: Some Kendo UI widgets (the Grid for example) can send a filter to a Kendo UI DataSource with `serverFiltering = true`. This then causes the DataSource to use the client JSDO to send a JFP expression containing `ablFilter` to the OpenEdge Data Object.

- **`id`** — Specifies a unique logical ID for data on the server, however you choose to implement it. For example, you can specify a string representing the ABL `ROWID` of a record in an OpenEdge database.

In order for the client to set this `id` property to a value the Business Entity can use to access data, you need to initially return an appropriate value (or multiple values) for each Read operation on the data. For example, you might return a value that identifies each row of data in the result set. For OpenEdge data, this can be an `id` field in each temp-table record containing the database `ROWID` of the corresponding record in the OpenEdge database.

Note: The `id` property is not currently used by the Kendo UI, but is used, for example, by Rollbase external objects.

- **`orderBy`** — A comma-delimited list of the names of fields used to sort the data in the result set (ascending order by default). After any field, `desc` can be added (case-sensitive) to indicate that sort order is descending for that field. For example:
  - `"orderBy" : "Balance, State"` — The data should be sorted ascending, first by `Balance`, then within `Balance`, by `State`.
  - `"orderBy" : "Balance desc"` — The data should be sorted by `Balance` descending.
  - `"orderBy" : "Country, State desc, City"` — The data should be sorted first by `Country` ascending, then within `Country`, by `State` descending, then within `State`, by `City` ascending.

  A value for this property is always specified for server sorting.

  Note: Some Kendo UI widgets make this setting on the Kendo UI DataSource internally.

- **`skip`** — Specifies how many records in the result set to skip before returning (up to) a page of data in the result set. A value for this property is always specified (along with `top`) for server paging. For example, if the requested page size (`top`) is 10 and the request is for the 5th page of data, the value of this property is set to 40.

  Note: The Kendo UI DataSource calculates this value for some Kendo UI widgets internally.

- **`top`** — Specifies how many records should be returned in a single page (that is, the page size) of the result set after using `skip`. A value for this property is always specified (along with `skip`) for server paging. (The final page in the result set can contain a smaller number of records than `top` specifies.)

  Note: Some Kendo UI widgets set this value on the Kendo UI DataSource internally.

Adding the Count operation method

The Count operation method you must add in order for server paging to return the total number of records in the server result set must have the following ABL method signature:

Syntax:

```
METHOD PUBLIC VOID countFnName (
  INPUT filter AS CHARACTER,
  OUTPUT numRecs AS INTEGER
)
```

Where:

countFnName

Specifies a name for the method. You annotate the method in Developer Studio for OpenEdge to identify the method with this name as the Count operation so the Kendo UI DataSource in the client app knows how to call its count function as part of invoking the Read operation with paging.

filter

Specifies a string containing the same JSON Filter Pattern value that is passed to the Read operation method.

numRecs

Specifies an integer that you assign the total number of records in the server result set identified by *filter*.

You must then ensure that the `@progress.service.resourceMapping` annotation for the Count operation method includes an `operation` attribute setting to specify the Count operation and a `URI` attribute setting to specify the `filter` input parameter for this method as a URL query parameter (similar to the `URI` annotation for the Read operation), as follows:

Syntax:

```
operation="count",
URI="/countFnName?filter=~{filter~}"
```

Where *countFnName* is the name of your ABL Count operation method. As noted previously, you can use the Define Service Interface wizard in Developer Studio for OpenEdge to specify the required annotations for your Count operation method as part of the **Invoke Annotations** tab options. Note also that you can annotate **only one** method as a Count operation method in a given Business Entity. The following sample Business Entity (see Sample Read operation updated to handle JFP input and server paging on page 98) shows an example of both a Count operation method and its required annotations.

The Kendo UI DataSource calls this Count operation method on the JSDO whenever it calls the JSDO `fill( )` method to return a page of data from the server. This method is called by the DataSource **only** when it has server paging enabled. If you need to, you can also separately call this method on the JSDO like any Invoke operation method, but this usage plays no part in fulfilling DataSource paging requirements. For more information, see the sections on Using the JSDO dialect of the Kendo UI DataSource in *Develop Progress Data Objects*.

Sample Read operation updated to handle JFP input and server paging

Following is a sample Business Entity showing the method generated to implement the Data Object Read operation, with manual annotation and code changes required both to implement a JSDO for access by the Kendo UI DataSource and to implement a Rollbase external object.

This is the include file (`customer.i`) that is referenced by the Business Entity, including a ProDataSet (`dsCustomer`) that contains a single temp-table (`ttCustomer`), with fields that you add to the fields that correspond to the existing database table fields indicated in bold, and an additional index you must also add shown in bold:

```
DEFINE TEMP-TABLE ttCustomer BEFORE-TABLE bttCustomer
FIELD id            AS CHARACTER
FIELD seq           AS INTEGER      INITIAL ?
FIELD CustNum       AS INTEGER      INITIAL "0" LABEL "Cust Num"
```

```
FIELD Name          AS CHARACTER    LABEL "Name"
FIELD Address       AS CHARACTER    LABEL "Address"
FIELD Address2      AS CHARACTER    LABEL "Address2"
FIELD Balance       AS DECIMAL      INITIAL "0" LABEL "Balance"
FIELD City          AS CHARACTER    LABEL "City"
FIELD Comments      AS CHARACTER    LABEL "Comments"
FIELD Contact       AS CHARACTER    LABEL "Contact"
FIELD Country       AS CHARACTER    INITIAL "USA" LABEL "Country"
FIELD CreditLimit   AS DECIMAL      INITIAL "1500" LABEL "Credit Limit"
FIELD Discount      AS INTEGER      INITIAL "0" LABEL "Discount"
FIELD EmailAddress  AS CHARACTER    LABEL "Email"
FIELD Fax           AS CHARACTER    LABEL "Fax"
FIELD Phone         AS CHARACTER    LABEL "Phone"
FIELD PostalCode    AS CHARACTER    LABEL "Postal Code"
FIELD SalesRep      AS CHARACTER    LABEL "Sales Rep"
FIELD State         AS CHARACTER    LABEL "State"
FIELD Terms         AS CHARACTER    INITIAL "Net30" LABEL "Terms"
INDEX seq IS PRIMARY UNIQUE seq
INDEX CustNum IS UNIQUE CustNum
.

DEFINE DATASET dsCustomer FOR ttCustomer.
```

Note: For access by a Rollbase external object, you must implement the Business Entity to provide its data as a ProDataSet with only a single temp-table, as shown in this example. For access by Kendo UI, you can implement the Business Entity to provide its data either as a single temp-table or as a ProDataSet with one or more temp-tables.

The `id` field is added to each temp-table record to support Rollbase external objects.

The `seq` field is used to guarantee the order of records in the serialized temp-table that is returned as JSON to the JSDO. To work properly, this field must be initialized with the Unknown value (?). You must also add an index on `seq` that is both `PRIMARY` and `UNIQUE`. You can also have additional indexes, which can be the same or different than those in the database, as shown for `CustNum`, but the index on `seq` **must** be the `PRIMARY` one.

Following is the class file for the Business Entity, `Customer.cls`. Manually added annotations and code are in bold, **except** in the case of added methods, where only the first and last lines of the method are in bold:

```
@program FILE(name="Customer.cls", module="AppServer").
@openapi.openedge.export FILE(type="REST", executionMode="singleton",
useReturnValue="false", writeDataSetBeforeImage="false").
@progress.service.resource FILE(name="Customer", URI="/Customer",
schemaName="dsCustomer", schemaFile="Customer/AppServer/customer.i").

USING Progress.Lang.*.

USING OpenEdge.BusinessLogic.BusinessEntity.
USING Progress.Json.ObjectModel.*.

BLOCK-LEVEL ON ERROR UNDO, THROW.

CLASS Customer INHERITS BusinessEntity:

    {"customer.i"}

    DEFINE DATA-SOURCE srcCustomer FOR Customer.

    DEFINE VARIABLE iSeq            AS INTEGER      NO-UNDO.

    CONSTRUCTOR PUBLIC Customer():
```

```
        DEFINE VAR hDataSourceArray AS HANDLE NO-UNDO EXTENT 1.
        DEFINE VAR cSkipListArray AS CHAR NO-UNDO EXTENT 1.

        SUPER (DATASET dsCustomer:HANDLE).

        /* Data Source for each table in dataset.
           Should be in table order as defined in DataSet */
        hDataSourceArray[1] =  DATA-SOURCE srcCustomer:HANDLE.

        /* Skip-list entry array for each table in DataSet.
           Should be in temp-table order as defined in DataSet */
        /* Each skip-list entry is a comma-separated list of field names
           to be ignored in the CREATE statement */

        cSkipListArray[1] = "CustNum".

        THIS-OBJECT:ProDataSource = hDataSourceArray.
        THIS-OBJECT:SkipList = cSkipListArray.

    END CONSTRUCTOR.

    @openapi.openedge.export(type="REST", useReturnValue="false",
writeDataSetBeforeImage="true").
    @progress.service.resourceMapping(type="REST", operation="read",
URI="?filter=~{filter~}", alias="", mediaType="application/json").
    @openapi.openedge.method.property (name="mappingType", value="JFP").
    @openapi.openedge.method.property (name="capabilities",
value="ablFilter,top,skip,id,orderBy").
    METHOD PUBLIC VOID ReadCustomer(
            INPUT filter AS CHARACTER,
            OUTPUT DATASET dsCustomer):

      IF filter BEGINS "~{" THEN
        THIS-OBJECT:JFPFillMethod (INPUT filter).
      ELSE DO:
        BUFFER ttCustomer:HANDLE:BATCH-SIZE = 0.
        BUFFER ttCustomer:SET-CALLBACK ("AFTER-ROW-FILL", "AddIdField").

        SUPER:ReadData(filter).
      END.
    END METHOD.

    /* Other CUD and Submit operation methods */
    . . .

    METHOD PRIVATE VOID JFPFillMethod(INPUT filter AS CHARACTER):

      DEFINE VARIABLE jsonParser     AS ObjectModelParser      NO-UNDO.
      DEFINE VARIABLE jsonObject     AS JsonObject             NO-UNDO.
      DEFINE VARIABLE cWhere         AS CHARACTER              NO-UNDO.
      DEFINE VARIABLE hQuery         AS HANDLE                 NO-UNDO.
      DEFINE VARIABLE lUseReposition AS LOGICAL                NO-UNDO.
      DEFINE VARIABLE iCount         AS INTEGER                NO-UNDO.
      DEFINE VARIABLE ablFilter      AS CHARACTER              NO-UNDO.
      DEFINE VARIABLE id             AS CHARACTER INITIAL ?    NO-UNDO.
      DEFINE VARIABLE iMaxRows       AS INTEGER   INITIAL ?    NO-UNDO.
      DEFINE VARIABLE iSkipRows      AS INTEGER   INITIAL ?    NO-UNDO.
      DEFINE VARIABLE cOrderBy       AS CHARACTER INITIAL ""   NO-UNDO.

      /* purge any existing data */
      EMPTY TEMP-TABLE ttCustomer.

      jsonParser  = NEW ObjectModelParser().
      jsonObject  = CAST(jsonParser:Parse(filter), jsonObject).
      iMaxRows    = jsonObject:GetInteger("top")  NO-ERROR.
      iSkipRows   = jsonObject:GetInteger("skip") NO-ERROR.
      ablFilter   = jsonObject:GetCharacter("ablFilter") NO-ERROR.
      id          = jsonObject:GetCharacter("id") NO-ERROR.
      cOrderBy    = jsonObject:GetCharacter("orderBy") NO-ERROR.
```

```
cWhere      = "WHERE " + ablFilter NO-ERROR.

IF cOrderBy > "" THEN DO:
  cOrderBy = REPLACE(cOrderBy, ",", " by ").
  cOrderBy = "by " + cOrderBy + " ".
  /* NOTE: id and seq fields should be removed from
     cWhere and cOrderBy */
  cOrderBy = REPLACE(cOrderBy, "by id desc", "").
  cOrderBy = REPLACE(cOrderBy, "by id ", "").
  cOrderBy = REPLACE(cOrderBy, "by seq desc", "").
  cOrderBy = REPLACE(cOrderBy, "by seq ", "").
END.

lUseReposition = iSkipRows <> ?.

IF iMaxRows <> ? AND iMaxRows > 0 THEN DO:
  BUFFER ttCustomer:HANDLE:BATCH-SIZE = iMaxRows.
END.
ELSE DO:
  IF id > "" THEN
      BUFFER ttCustomer:HANDLE:BATCH-SIZE = 1.
  ELSE
      BUFFER ttCustomer:HANDLE:BATCH-SIZE = 0.
END.

BUFFER ttCustomer:ATTACH-DATA-SOURCE(DATA-SOURCE srcCustomer:HANDLE).

IF cOrderBy = ? THEN cOrderBy = "".
cWhere = IF cWhere > "" THEN (cWhere + " " + cOrderBy)
         ELSE ("WHERE " + cOrderBy).
DATA-SOURCE srcCustomer:FILL-WHERE-STRING = cWhere.

IF lUseReposition THEN DO:
  hQuery = DATA-SOURCE srcCustomer:QUERY.
  hQuery:QUERY-OPEN.

  IF id > "" AND id <> "?" THEN DO:
    hQuery:REPOSITION-TO-ROWID(TO-ROWID(id)).
  END.
  ELSE IF iSkipRows <> ? AND iSkipRows > 0 THEN DO:
    hQuery:REPOSITION-TO-ROW(iSkipRows).
    IF NOT AVAILABLE Customer THEN
      hQuery:GET-NEXT() NO-ERROR.
  END.

  iCount = 0.
  REPEAT WHILE NOT hQuery:QUERY-OFF-END AND iCount < iMaxRows:
    hQuery:GET-NEXT () NO-ERROR.
    IF AVAILABLE Customer THEN DO:
      CREATE ttCustomer.
      BUFFER-COPY Customer TO ttCustomer.
      ASSIGN  ttCustomer.id  = STRING(ROWID(Customer))
              iSeq = iSeq + 1
              ttCustomer.seq = iSeq.
    END.
    iCount = iCount + 1.
  END.
END.
ELSE DO:
  IF id > "" THEN DATA-SOURCE srcCustomer:RESTART-ROWID(1)
                  = TO-ROWID ((id)).
  BUFFER ttCustomer:SET-CALLBACK ("AFTER-ROW-FILL", "AddIdField").
  DATASET dsCustomer:FILL().
END.

FINALLY:
  BUFFER ttCustomer:DETACH-DATA-SOURCE().
END FINALLY.
```

```
    END METHOD.

    METHOD PUBLIC VOID AddIdField (INPUT DATASET dsCustomer):
      ASSIGN  ttCustomer.id = STRING(ROWID(Customer))
              iSeq = iSeq + 1
              ttCustomer.seq = iSeq.
    END.

    @openapi.openedge.export(type="REST", useReturnValue="false",
writeDataSetBeforeImage="false").
    @progress.service.resourceMapping(type="REST", operation="count",
                                      URI="/MyCount?filter=~{filter~}",
                                      alias="", mediaType="application/json").
    METHOD PUBLIC VOID MyCount( INPUT filter AS CHARACTER, OUTPUT numRecs AS INTEGER):

        DEFINE VARIABLE jsonParser   AS ObjectModelParser   NO-UNDO.
        DEFINE VARIABLE jsonObject   AS JsonObject          NO-UNDO.
        DEFINE VARIABLE ablFilter    AS CHARACTER           NO-UNDO.
        DEFINE VARIABLE cWhere       AS CHARACTER           NO-UNDO.
        DEFINE VARIABLE qh           AS HANDLE              NO-UNDO.

        IF filter BEGINS "WHERE " THEN
            cWhere = filter.
        ELSE IF filter BEGINS "~{" THEN
        DO:
            jsonParser  = NEW ObjectModelParser().
            jsonObject  = CAST(jsonParser:Parse(filter), jsonObject).
            ablFilter   = jsonObject:GetCharacter("ablFilter") NO-ERROR.
            cWhere      = "WHERE " + ablFilter.
        END.
        ELSE IF filter NE "" THEN
        DO:
            /* Use filter as WHERE clause */
            cWhere = "WHERE " + filter.
        END.

        IF cWhere = ? OR cWhere = "?" THEN cWhere = "".
        CREATE QUERY qh.
        qh:SET-BUFFERS(BUFFER Customer:HANDLE).
        qh:QUERY-PREPARE("PRESELECT EACH Customer " + cWhere).
        qh:QUERY-OPEN ().
        numRecs = qh:NUM-RESULTS.

    END METHOD.

END CLASS.
```

Key changes to note in `Customer.cls` include the following:

- **Added statement: `USING Progress.Json.ObjectModel.*.`** — Supports access to the ABL core classes for parsing the JSON Filter Pattern object returned in the `filter` parameter of the `ReadCustomer( )` method.
- **Added `@openapi.openedge.method.property` annotations: `(name="mappingType", value="JFP")` and `(name="capabilities", value="ablFilter,top,skip,id,orderBy")`** — Causes the JSDO created from this Business Entity to intercept the value the Kendo UI DataSource passes to the `filter` parameter of `ReadCustomer( )` and convert it to a JSON Filter Pattern object. Without this annotation, the DataSource passes a value to the `filter` parameter that is a JSON duplicate of the Kendo UI-proprietary settings most recently provided by the `filter` configuration property or the `filter( )` method on the DataSource.
- **Updated statement in the `ReadCustomer( )` method: `IF filter BEGINS "~{" THEN ... ELSE ...`** — If the `filter` parameter value starts with a left brace, invokes an added method (`JFPFillMethod( )`) to handle an anticipated JSON Filter Pattern; otherwise, the `BATCH-SIZE` attribute

on the buffer handle for `ttCustomer` is set to return all records in the result set, the `AddIdField( )` method is registered as a callback for the `AFTER-ROW-FILL` event on `dsCustomer` to initialize the `id` and `seq` fields of each record in the result set, and the `filter` parameter is passed to the `ReadData( )` method of the inherited `OpenEdge.BusinessLogic.BusinessEntity` abstract class to handle another `filter` string format specified when not using Kendo UI to access the Read operation. (Note that `JFPFillMethod( )` also sets different values for `BATCH-SIZE` based on the `filter` settings before registering `AddIdField( )`.)

- **Added method: `JFPFillMethod( )`** — Parses the property values from the JSON Filter Pattern passed to the `filter` parameter, assigning any that are found to corresponding ABL variables. Any of these variables that contain appropriate values are then used to implement the filtering, sorting, and paging options that are specified. These values determine the `BATCH-SIZE` to return in the `ttCustomer` temp-table for a successful result. Thus, a successful result returns either a single record identified by `id`, a specified page of records (`iMaxRows > 0`), or the entire result set of records in the `ttCustomer` temp-table of the `DATASET dsCustomer` parameter passed as output from the `ReadCustomer( )` method. The record, or set of records, returned represent the result from the specified filtering, sorting, and paging options, if any. Note that an ABL query is used for some options, while the `FILL( )` method on `dsCustomer` is used for others to copy `Customer` data to `ttCustomer` and update the corresponding `id` and `seq` fields.
- **Added callback method: `AddIdField( )`** — With this callback registered by either `ReadCustomer( )` or `JFPFillMethod( )` in response to the `AFTER-ROW-FILL` event on `dsCustomer`, this method assigns the current sequence number (`seq`) and `ROWID` value (`id`) of the corresponding database record whose `Customer` fields have just been copied (using `FILL( )`) into the corresponding fields of the current `ttCustomer` record.
- **Added method: `MyCount( )`, added as a Data Object Count operation to return the total number of records in the server result set** — Executed as part of returning a server page to the Kendo UI DataSource, this method identifies any `WHERE` string in the `filter` parameter and adds it to a `PRESELECT` query on the target database table that it constructs and opens. (Note that it sets the string returned by `filter` to `""` if its value is otherwise unspecified and set to the Unknown value (?).) It then passes the value of the `NUM-RESULTS` attribute on the opened query to its output parameter to provide the total number of records to Kendo UI.

Note: If you do not add a method like this to the Business Entity and annotate it (in Developer Studio) as a Count operation, the JSDO throws an exception when the Kendo UI DataSource tries to reference the method as part of reading a server page.

URIs for accessing Data Object Web applications, Services, and resources

The URIs required to access Data Object Web applications, Services, and their resources depend on what type of client you use to access them, a mobile or web app using JSDOs or another REST client, such as you might use for testing and debugging Data Object resources. The following sections describe the requirements for forming these URIs:

- Data Object URIs for client app access on page 104
- Data Object URIs for testing resources from REST clients on page 105
- Using a REST client to execute a Data Object operation on page 107

Data Object URIs for client app access

For a mobile or Web app to access the Data Object Services and resources deployed in a given Web application, it needs only the relative or absolute URI of both the Web application and the Data Service Catalogs for any Data Object Services that the mobile app accesses. After logging into the Web application and loading the required Data Service Catalogs, the mobile app has only to call methods on the JSDOs created for each Data Object resource to access operations of the resource. It never needs to directly access specific URIs for the REST resources that implement each Data Object operation.

The following syntax describes the URIs that you need to log into a Web application and access its Data Object Services using a JSDO:

Syntax

```
scheme://host:port/web-app-name[/static-resource]
```

scheme`//`*host*`:`*port*

The beginning of every absolute URI:

- ***scheme*** — A URI scheme supported for OpenEdge Data Object Services, which can be either `HTTP` or `HTTPS`.
- ***host*** — The host name or IP address, which is typically `localhost` for testing Data Object Services on the same machine as both the Web browser and the web server that hosts the Data Object Services.
- ***port*** — Port where the Web server is listening for HTTP requests. The default value configured for the OE Web Server that accesses the OpenEdge AppServer is `8980`, and for the Progress Application Server for OpenEdge (PAS for OpenEdge) is `8810`.

The *host*`:`*port* can also be replaced by a Web domain (such as, `www.progress.com`) that accesses the required host and port.

/web-app-name

The relative URI for the Data Object Web application, where *web-app-name* is the name of the Web application that contains your Data Object Service or Services, and serves as the root URI for all Data Object resources provided by the Web application. By default, this is the file name of the WAR file that you use to publish or deploy the Data Object Services to your OE Web Server or PAS for OpenEdge, and it is also the name of the Web server folder in which all of the Web application's Data Object Services and Web resources (including Data Service Catalogs) are deployed.

During development, by default, Progress Developer Studio for OpenEdge publishes each Data Object Service defined for a project with the file name of its own WAR file set to name of the Data Object Service. For production deployment, you can export and deploy multiple Data Object Services in a single WAR file, which by default has the name of the Classic or PAS for OpenEdge Server project. Note that during production deployment, a Web administrator can change the file name of the WAR file and the name of the Web application to a different value.

Note: During development, you cannot change the name of the WAR file that Developer Studio publishes for each Data Object Service in a project.

If you run a Web app in a Web browser and deploy it to the same OE Web Server or PAS for OpenEdge as the Data Object Services, the Web app only needs to access this relative URI to log into the Web application and access Data Object Services.

If you install and run a hybrid app in a native device container, or deploy and run a Web app from a different Apache Tomcat Web server from where the Data Object Services are deployed, the mobile or Web app must use the absolute URI to log into the Web application.

/static-resource

The relative URI for a static file or Web page that the mobile app accesses from the Web application. For example:

- **/static/*service-name*.json** — The default relative URI of the Data Service Catalog for a Data Object Service, where *service-name* is the name of the Service. The mobile app typically loads this Catalog to access Data Object resources provided by the Service after logging into the Web application. To load the Catalog, it can use the relative URI (starting with the Web application, */web-app-name*) or the absolute URI, depending on the same conditions for using a relative or absolute URI for logging into the Web application.
- **/static/home.html** — The default relative URI of a non-UI login target available to support logging into a Web application using HTTP Basic and Form Authentication.

For more information on logging into a Web application from a mobile or Web app, see the topics on the JSDO progress.data.JSDOSession and progress.data.Session classes in *Develop Progress Data Objects*.

Data Object URIs for testing resources from REST clients

After first developing and publishing Data Object Services, you might want to test the Data Object resources they provide before you create a mobile or Web app to access them using JSDOs. You can do this using various REST clients, such as the Postman REST Client, that allow you to access Data Object operations directly as REST resources. (Remember that a single Data Object resource can encapsulate several Data Object operations, each of which is accessed by a unique REST resource.) To test these REST resources using a REST client, you need to know the exact absolute REST URI of the REST resource that accesses each Data Object operation.

When you create Data Object resources and the Data Object Services to contain them, you assign a relative URI (or use the default) for each Data Object Service and resource that you define. In addition, each operation that you define for a Data Object resource is assigned a unique relative URI as part of the resource annotations that you add to the ABL Business Entity that implements the Data Object resource.

The absolute URI to access a given Data Object operation is a concatenation of all these relative URIs with the absolute root URI of the deployed Web application, as specified using the following syntax:

Syntax

```
scheme://host:port/web-app-name/transport/service-name/resource-name [op-element]
```

scheme//host:port

The beginning of every absolute URI, as described previously (see Data Object URIs for client app access on page 104).

/web-app-name

The relative URI for the Data Object Web application, where *web-app-name* is the name of the Web application that contains your Data Object Service or Services, and serves as the root URI for all Data Object resources provided by the Web application. By default, this is the file name of the WAR file that you use to publish or deploy the Data Object Services to your OE Web Server or PAS for OpenEdge, and it is also the name of the Web server folder in which all of the Web application's Data Object Services and Web resources (including Data Service Catalogs) are deployed.

During development, by default, Progress Developer Studio for OpenEdge publishes each Data Object Service defined for a project with the file name of its own WAR file set to name of the Data Object Service. For production deployment, you can export and deploy multiple Data Object Services in a single WAR file, which by default has the name of the Classic or PAS for OpenEdge Server project. Note that during production deployment, a Web administrator can change the file name of the WAR file and the name of the Web application to a different value.

Note: During development, you cannot change the name of the WAR file that Developer Studio publishes for each Data Object Service in a project.

/transport

The relative URI for the transport, which can be one of the following, depending on the service provider:

- **/rest** — A REST transport for a Data Object Service created using an OpenEdge Server project in Developer Studio with a REST RPC service provider on PAS for OpenEdge, or on an OE Web Server or generic Tomcat server accessing the classic OpenEdge AppServer.
- **/web/pdo** — A WEB transport for a Data Object Service created using an OpenEdge Server project in Developer Studio with a WebHandler service provider on PAS for OpenEdge.

  Note: The PAS for OpenEdge WEB transport reserves /web/pdo, and Progress Software recommends that you do **not** use the /web/pdo URI in your own application URL space.

This is a literal relative URI defined by OpenEdge that identifies the root for all OpenEdge resources provided by the Data Object Web application.

Note: Unlike the /static relative URI that identifies the physical location of most static Web resources, such as Data Service Catalogs and Web pages, the */web-transport* URI does **not** represent a physical folder on the Web server, but simply identifies a dynamic point in a URI where the relative URI to a given Data Object resource begins.

/service-name

The relative URI for the Data Object Service, where *service-name* defaults to the name you assign the service when you define it in Developer Studio. You can also assign a different name for the URI at the time the Data Object Service is created.

/resource-name

The relative URI for the Data Object resource, where *resource-name* defaults to the name you assign the resource when you define it in Developer Studio. You can also assign a different name for the URI at the time the Data Object resource (Business Entity) is created.

op-element

A relative URI or a URI query parameter that is specified to identify specific Data Object resource operations, as follows:

- **?filter=*filter-string*** — For the Read operation, this URI query parameter identifies the INPUT filter parameter value passed to the implementing ABL routine, where *filter-string* is a string value you type, quoted if necessary.
- ***/routine-name*** — For an Invoke or Submit operation, where *routine-name*, by default, is the case-sensitive name of the ABL routine that implements the specified Invoke or Submit operation, or any other value that you annotate for the relative URI of an Invoke or Submit operation routine that uniquely identifies and distinguishes the routine from any other that is defined for the resource.

Note that all other INPUT (and the input side of INPUT-OUTPUT) parameters passed to the implementing ABL routines of Data Object operations are passed in the body of the HTTP request. For more information, see Using a REST client to execute a Data Object operation on page 107.

Using a REST client to execute a Data Object operation

Once you have constructed the correct URI for the REST resource that represents a given Data Object operation, you can specify it as part of the HTTP request to execute the operation from a REST client, such as Postman. However, a REST client requires four basic pieces of information to send an HTTP request:

1. **URI** — As described in the previous section
2. **Media type** — Always application/json for Data Object operations
3. **HTTP verb** — As specified for each Data Object operation:
   - **Create** — POST
   - **Read** — GET (with a query parameter in the URI—see Data Object URIs for testing resources from REST clients on page 105)
   - **Update** — PUT (with **no** *op-element* in the URI—see Data Object URIs for testing resources from REST clients on page 105)
   - **Delete** — DELETE
   - **Submit** — PUT (with an *op-element* in the URI, similar to Invoke—see Data Object URIs for testing resources from REST clients on page 105)
   - **Invoke** — PUT (for all Invoke operations, each of which is identified and distinguished from the others by the relative URI value annotated for the implementing ABL routine and specified as *op-element* in the URI—see Data Object URIs for testing resources from REST clients on page 105)
4. **Other HTTP request components** — Especially INPUT parameters to be included in the body of the HTTP request (described below)

Note that, other than the filter parameter that is passed as the *op-element* in the URI of a Data Object Read operation request (see see Data Object URIs for testing resources from REST clients on page 105), all other INPUT (and the input side of INPUT-OUTPUT) parameters passed to the implementing ABL routines for Data Object operations are passed in the body of the HTTP request. This includes the JSON object for an INPUT-OUTPUT temp-table or ProDataSet parameter that is passed for the Data Object Create, Update, Delete, and Submit operations, and a JSON object with properties for passing the values of any INPUT and INPUT-OUTPUT parameters for Data Object Invoke operations.

For the REST client, the input JSON objects specified for relational data must conform to the structure defined by OpenEdge for passing the JSON representations of temp-tables and ProDataSets, as appropriate. For more information, see *OpenEdge Development: Working with JSON*. Note that this structure is similar to the structure used to return the data for a Data Object Read operation (GET). For an Invoke operation, the property names in the simple JSON object must have the same case-sensitive names as the corresponding parameters defined in the implementing ABL routines.

Note also that for the Data Object Create, Update, and Delete operations, all of which have the same type of input JSON object for relational data, only the HTTP verb specified for the HTTP request distinguishes these Data Object operations from each other.

III

Creating OpenEdge SOAP Web Services

For details, see the following topics:

- Exposing AppServer Applications as OpenEdge SOAP Web Services
- Building Clients for OpenEdge SOAP Web services
- Sample Code with SOAP Messages for OpenEdge Web Services
- Test and debug OpenEdge SOAP Web Services

7

Exposing AppServer Applications as OpenEdge SOAP Web Services

This chapter discusses the steps to expose AppServer applications as SOAP Web services.

For details, see the following topics:

- Deciding how to expose your application
- Enabling the AppServer application
- Define and deploy a Web service definition
- Distributing your WSDL file

Deciding how to expose your application

The first step in creating a Web service is considering the requirements of the application and its intended clients. Knowing these requirements can decide certain details of a Web service design and implementation. These requirements include the session model, the SOAP message format, and how you group operations into Open Client objects.

Security considerations also have a major impact on how you expose your application. For more information on security options for managing WSA configuration and administration and on managing access control for Soap-based Web services, see *OpenEdge Application Server: Administration*. For more information on how OpenEdge supports security for OpenEdge Web services, see *OpenEdge Getting Started: Core Business Services - Security and Auditing.*

Web service objects and the WSDL file

During Web service deployment, the WSA generates a WSDL file that defines one or more *Web service objects* to describe the Web service. These Web service objects conform to the Open Client object model. There must be a single AppObject and, if appropriate, there might also be SubAppObjects and ProcObjects. The Web service objects include all operations—procedures, user-defined functions, and built-in operations for object management—that define the Web service interface. The WSDL file might also define an object identifier (*object ID*) for each Open Client object. The WSDL defines this object ID for most Open Client object types, depending on the session model.

For more information on the Open Client object model and its architecture, see *OpenEdge Development: Open Client Introduction and Programming*. For more information on how the Open Client object model supports OpenEdge SOAP Web services, see Building Clients for OpenEdge SOAP Web services.

Object representation

WSDL does not have an inherent concept of objects for encapsulating operations. However, OpenEdge Web services follow common usage in representing each Web service object within a unique namespace of the WSDL file. Typically, interface generators code each such object defined in the WSDL file as a corresponding object in the client interface. However, the interface generator on a particular client platform ultimately determines how each WSDL object is represented in the client development language.

Object binding

In addition to defining the Web service interface, the WSDL file specifies how this interface is bound to the application server executing the operations. For OpenEdge Web services, this binding information specifies how to generate and handle SOAP messages exchanged over HTTP/S between the client and the WSA instance managing the Web service. This includes information to identify the Web service and its WSA instance, as well as to format and send the SOAP messages. The Web service deployer specifies this binding and implementation information (*deployment information*) during Web service deployment.

Deployment information

This deployment information consists of the data stored in WSDL elements as follows:

- **Web service namespace** — A namespace used to uniquely identify the Web service to the WSA instance where the Web service is deployed. In the WSDL, this value is specified by the `targetNamespace` attribute of the `<definitions>` element. It is typically specified as a Universal Resource Identifier (URI), usually in the form of a Universal Resource Locator (URL) or Universal Resource Name (URN). The value can be specified in ProxyGen, during Web service definition, or in OpenEdge Management or OpenEdge Explorer, during Web service deployment.
- **WSA URL** — The URL for the WSA instance where the Web service is deployed, and that forms the root for all URLs that access the Web services it manages. In the WSDL, this is specified by the `location` attribute of the `<soap:address>` element within the `<services>` element.
- **SOAP action** — A string (if specified) that the client application must place in the SOAPAction HTTP header when it invokes operations on the Web service. In the WSDL, this value is specified using the `soapAction` attribute of the `<soap:operation>` element, and the value is included in the SOAPAction header of all HTTP messages that transport SOAP messages for the Web service.

  The SOAPAction HTTP header is normally required for all HTTP messages that carry SOAP messages and is used by intervening security servers (such as firewalls) to determine if each HTTP message is allowed to pass through to its destination. The default is a blank string, but can be any string specified at deployment that is required by the intervening security servers on the network.

- **SOAP format** — Two string values that specify the format of SOAP messages exchanged between the client and the Web service. In the WSDL, these are specified by the `style` attribute in the `<soap:binding>` and `<soap:operation>` elements, and by the `use` attribute in the `<soap:header>`, `<soap:body>`, and `<soap:fault>` elements. While these values are specified in many places within the WSDL, the same style and use values are used everywhere in the file, ensuring that all SOAP messages generated for the Web service use the same SOAP format. For more information on SOAP formats, see SOAP message formats.

For more information on specifying this deployment information in a WSDL, see *OpenEdge Development: Open Client Introduction and Programming* for the optional WSDL typically used for development testing, and see the Web service deployment chapters in *OpenEdge Application Server: Administration* for the WSDL deployed to a WSA instance. For more information on how the WSDL file specifies this information, see WSDL element overview for OpenEdge Web services.

Session Models and object IDs

The session model for an OpenEdge Web service must match the session model of the AppServer that hosts your application. If you are exposing an existing AppServer application as an OpenEdge Web service, this choice is already made for you. If you are building a new Web service application, choosing a session model for your Web service defines how you structure your application. The choice of session model affects how the AppObject for a Web service is defined in the WSDL, how the WSA manages the Web service at run time, and how the client must access the Web service objects.

Session models

The following table describes the available session models.

Table 15: Session models

Model	AppServer operating modes	How clients interact with Web service
Session managed	Stateless State-aware State-reset	Client maintains a persistent connection to the AppServer, maintaining session context between requests for a single client application. This allows a client to carry out complex transactions that span multiple requests, but often requires extra code management, on the part of the client, for each request.
Session free	State-free	Client sends requests without any connection to an AppServer. This allows more clients to simultaneously access the Web service with minimal code management, but each request returns a complete result that has no certain dependency on the results of any previous requests.

For more information on how the AppServer supports session models, see *OpenEdge Application Server: Developing AppServer Applications.*

How object IDs support session models

OpenEdge Web services use object IDs to maintain context for clients across multiple operations of a Web service. Session-free AppObjects **do not use** object IDs. All other Open Client objects use object IDs. These objects require client applications to obtain the object ID from the WSA for each such object when they create it. Each request on the object must send the object's object ID to the WSA.

Note: SubAppObjects and ProcObjects have limited utility in the session-free model and generally should not be defined for session-free Web services. see How session models affect Web service objects on page 114, for more information.

The WSA creates a unique object ID whenever it instantiates an appropriate object at the request of a client. The WSA sends this object ID back to the client in a SOAP response header. The client application must send the same object ID to the WSA in the SOAP request header for every operation that it invokes on the specified object.

How a client application retrieves object IDs from the SOAP response and sends object IDs in the SOAP request depends on the client platform. Some platforms handle SOAP header information automatically and transparently to the application program. Others require the client to explicitly obtain the object ID from the SOAP response message and send it in the next appropriate SOAP request message in a manner determined by the client platform.

For session-managed Web services, these object IDs allow each client to maintain communications with its own set of Web service objects, and thus interact with the context maintained by the AppServer for these objects. For session-free Web services, these object IDs allow the use of SubAppObjects and ProcObjects, when it is necessary to do so.

How session models affect Web service objects

A session-managed AppObject establishes a connection with a single AppServer dedicated to a single client application. This AppServer services all requests for operations invoked on that AppObject until the AppObject is released. The Web service's SubAppObjects and ProcObjects share the same connection. The connection is not freed until all the Web service objects have been released. In effect, the WSA creates copies (server instances) of these objects for each client application that accesses the same session-managed Web service, and maintains a unique object ID for each instance.

A session-free AppObject establishes no connection to an AppServer. Instead, the WSA maintains a pool of AppServer TCP/IP connections (*connection pool*) that it uses to send requests from all clients to any available AppServer. Requests from operations of all client applications invoked on a session-free AppObject are executed as the WSA receives them and resources are available to handle them. In effect, all clients of a session-free Web service share the same server instance of the AppObject. Requests sent to session-free SubAppObjects use any available AppServer connection in the Web service connection pool, but the WSA maintains a separate server instance of the SubAppObject for each client that accesses it using its own unique object ID until the client releases it. The WSA also maintains a separate server instance of any ProcObject accessed by a client for a session-free Web service, and each such ProcObject reserves a single AppServer connection from the connection pool dedicated for the sole use of its client until the client releases the ProcObject.

Thus, for session-managed Web service objects, the AppServer can maintain session context between requests, enabling the possibility of fine-grained, multi-request transactions on a server-side database. For session-free Web service AppObjects and SubAppObjects, there is no single AppServer to maintain session context, and any transactions on a server-side database must be coarse-grained so that they begin and end for each request before the AppServer returns the response to the client.

Note: SubAppObjects provide no additional functionality for a session-free Web service that is not already provided by the AppObject, except to organize Web service operations into developer-defined categories, much like using folders to organize files. The increased complexity of the client application required to manage the object IDs likely overwhelms any advantage of using SubAppObjects.

A ProcObject of a session-free Web service does maintain context on a single AppServer that can be used to manage finer-grained, multiple-request database transactions. But because a ProcObject reserves its AppServer connection until the object is released, that resource is not available for other requests on objects of the session-free Web service.

Note: Progress Software Corporation recommends that you avoid defining ProcObjects for session-free Web services. Each instantiated ProcObject degrades the performance of a session-free Web Service by taking AppServer connections out of the connection pool that might otherwise be used by all other requests to the Web service.

SOAP message formats

OpenEdge Web services use the request/response model for invoking the Web service and handling the results. The client sends a request message to the Web service, and the Web service returns a response message back to the same client.

Usually, client interfaces expose this request/response pair as a single object method. When the client executes the method, the underlying interface sends a SOAP request message containing any method input parameters and receives a SOAP response message containing any method output parameters and any return value.

SOAP formats supported by OpenEdge Web services

SOAP messages can be formatted using different SOAP message styles and encoding combinations. The *style* indicates how the SOAP message is structured. The *encoding* describes how data values are represented. The following table lists the SOAP message formats that OpenEdge supports. You should choose the format with which your intended clients work well.

Table 16: SOAP message formats

Format	Notes
Document/Literal (Doc/Lit)	The entire message is defined as a single entity and the messages are represented literally using XML Schema standards. This is the recommended format for OpenEdge Web services. It works well for ABL and .NET clients. OpenEdge Web services use the wrapped document literal (Wrapped Doc/Lit) convention (developed by Microsoft). Wrapped Doc/Lit is a convention using Doc/Lit that wraps all request parameters for an operation into one input XML complex type and wraps all response parameters into a separate output XML complex type.
RPC/Literal	Each parameter is defined as a separate entity and the formatting of the messages is represented literally using XML Schema standards. Use this format for clients that do not support Doc/Literal.
RPC/Encoded	An earlier standard. Each parameter is defined as a separate entity and the messages to be encoded are formatted according to a set of encoding rules. This format is **not** recommended. The Web Services Interoperability Organization recommends against this format in their *Basic Profile Version 1.0*.

In practical terms, there is little difference between using RPC or Document style when exchanging request/response messages. The most significant difference between the supported formats is between RPC/Encoded (SOAP encoding) and Doc/Lit. Doc/Lit messages have the advantage that they can be validated by XML Schema. While SOAP encoding allows for a simpler representation of complex, object-oriented data structures than is possible with Literal encoding, this advantage usually does not offset the increased complexity needed to handle RPC/Encoded.

Enabling the AppServer application

Once you understand the requirements of your OpenEdge Web service, you can either enable a new or an existing AppServer application as a Web service. The decisions that you made about security, session model, and the structure of Web service objects should help you decide whether to create a new or to use an existing AppServer application.

Realize that you do not have to include the complete interface of your AppServer-enabled application in your OpenEdge Web service. You might find that only enabling a few interface components of an existing application provides all the operations that you want in your WQeb service. The session model that the AppServer must support for a new application also determines the complexity of its programming.

For information on configuring and programming AppServer applications, see *OpenEdge Application Server: Administration* and *OpenEdge Application Server: Developing AppServer Applications.*

Once your application is ready, you must compile it into r-code in preparation for the next step in the process.

Define and deploy a Web service definition

After you have built and compiled the ABL r-code for the AppServer application, you use ProxyGen to assemble a definition of your Web service. That definition enables you to define WSA instances to host your Web service and to generate a WSDL file that end users can use to build clients for your Web service.

Creating Web service definitions follows the Open Client model. For instructions on creating Web service definitions, see the chapter on generating proxies and Web service definitions in *OpenEdge Development: Open Client Introduction and Programming*. For more information on working with ProxyGen, see the online help.

Once you have a definition for your OpenEdge Web service, you need to deploy it to a Web Service Adapter (WSA) instance for testing. Building Clients for OpenEdge SOAP Web services discusses how to create clients to test your Web service.

Configure a Web Service Adapter instance

The WSA is a Java servlet running on a Web server or stand-alone Java Servlet Engine (JSE). Situated between the client and AppServer, this Java servlet understands how to communicate at run time with:

- A Web service client using SOAP messages
- An AppServer using the ABL interface to the application service

The WSA generates the WSDL file needed to design a client for your Web service. The WSA maintains the status of all OpenEdge Web services that have been deployed to its Web application context. It also manages the exchange of Web service SOAP requests and generates SOAP responses between Web service clients and AppServers at run time.

Each WSA instance can support multiple Web services. But, you can define multiple WSA server instances (Java servlets), each with different properties. For example, you might create separate WSA instances to deploy the same Web service using different SOAP message formats. For more information on WSA configuration and administration and on WSA deployment and Web service run-time support, see *OpenEdge Application Server: Administration*.

At any time in the cycle of Web service design and development, you can create and configure a WSA instance on which to deploy your Web service. When you do, think carefully about security requirements for the WSA instance and the Web services you plan to deploy to it.

Creating and configuring a WSA instance is a two-step process. You must configure the WSA servlet and the JSE that executes the WSA. You first use either OpenEdge Management and OpenEdge Explorer or the `mergeprop` utility to define and configure the WSA instance. While OpenEdge Management and OpenEdge Explorer supports most WSA configuration options, you must use the `mergeprop` utility to edit some WSA configuration properties in the local `ubroker.properties` file, particularly those that define WSA administration roles and their associated access permissions.

You can use OpenEdge Management and OpenEdge Explorer or the `WSAMAN` utility to temporarily change a selected set of WSA instance properties at run time (WSA Run-time Properties). This can be helpful for debugging or testing certain settings before making them permanent in your WSA configuration.

After configuring the WSA instance, you use the appropriate tools to define the WSA instance as a Java servlet to your JSE. After completing the creation and configuration of a WSA instance, you might have to restart the JSE to start up the WSA instance before deploying Web services to it.

For specific information on creating and configuring WSA instances, see *OpenEdge Application Server: Administration*. For information on using the `mergeprop` utility, see *OpenEdge Getting Started: Installation and Configuration*.

Install WSA on a DMZ server

A *DMZ server* is a server that might not allow you to open untrusted network ports. Since the AdminServer uses ports which might be interpreted as untrusted, the standard WSA configuration might run on such a server. The WSA supports a "remote" configuration to work around this issue. The remote configuration installs only enough of OpenEdge on the remote server to run the WSA. This installation includes the WSA Java Servlet and the files used to support its local configuration.

The remote WSA uses a `ubroker.properties` file with a limited set of static startup parameters. You must manually edit this file to change the WSA instance's static configuration properties.

You can continue to administer the remote WSA's dynamic run-time properties and deploy and manage SOAP services by mapping it to an AdminServer on the Intranet behind the DMZ server. The Intranet AdminServer uses HTTP/S to pass WSA administration operations as SOAP messages to the WSA's Administration service.

To run a remote WSA configuration:

1. Install the remote WSA on the DMZ server. Manually edit the static startup parameters in its `ubroker.properties` file and install the WSA as a Web application in the local Web server's JSE.
2. Start the WSA the Web server's JSE and verify that a browser can access its URL from the Internet.
3. Connect to an AdminServer on the Intranet and configure a "remote" WSA instance using OpenEdge Management and OpenEdge Explorer or the `WSAMAN` utility by specifying the remote WSA's URL.

   The Intranet AdminServer creates a WSA mapping entry in its local `ubroker.properties` file with the URL of the remote WSA's administration SOAP service.

4. Use OpenEdge Management and OpenEdge Explorer or the `WSAMAN` utility to manage the "remote" WSA's dynamic run-time properties and deploy and manage the WSA's SOAP services.

   OpenEdge Management and OpenEdge Explorer connects to the Intranet AdminServer where you mapped the WSA and then connects to the remote WSA's SOAP administration service. When OpenEdge Management and OpenEdge Explorer sends an operation to the Intranet AdminServer, the AdminServer turns it into a SOAP message and forwards it to the WSA's SOAP administration service which executes the operation.

Distributing your WSDL file

Eventually, you should also decide how you want to distribute the WSDL file for your Web service to your end users. Some methods are more public than others. How end users access the WSDL can affect the security of your Web service. Some of the ways that you can distribute a WSDL file are the following:

- Use e-mail
- Post it on a Web server
- Host it in a UDDI directory

Note: When the WSDL specification was first proposed, UDDI directories were intended to be the primary method of distributing the WSDL files for public Web services. Most major companies, like Microsoft and IBM, have since abandoned the concept.

You can also host the file on a network using a WSA by deploying the Web service using the OpenEdge Web services tools. This deployed WSDL file resides at a URL determined by the WSA installation and other information specified for the Web service at deployment. Once the Web service is deployed, the WSA administrator can make the WSDL available by enabling access to WSDL listings on the network. For more information on Web service deployment, see the Web service chapters of *OpenEdge Application Server: Administration*.

To obtain a WSDL file deployed to a WSA instance, you can download it over the network through its URL, specified using the following syntax:

Syntax

```
http[s]://host:port[/web-server-context]/wsa-webapp-context/wsa-instance/
wsdl?targetURI=web-service-name
```

Note: The syntax is case sensitive.

For example, here is a WSDL retrieval URL for a Web service with the friendly name, `OrderInfo`, that is deployed to a WSA instance (`wsa1`) running in the WSA Web application context (`wsa`):

```
http://servicehost:80/wsa/wsa1/wsdl?targetURI=OrderInfo
```

For more information on the syntax of the WSDL retrieval URL, see the chapters on the WSA in *OpenEdge Application Server: Administration*.

Note: To aid developing client code for testing Web services under development, you can optionally generate a WSDL file from ProxyGen when generating pre-deployment versions of the Web service definition. ProxyGen writes this file to the specified output directory. For more information, see *OpenEdge Development: Open Client Introduction and Programming.*

8

Building Clients for OpenEdge SOAP Web services

After creating a Web service definition in ProxyGen for your AppServer application, you must test the Web service before deploying it into a production environment. To test your Web service, you must build a client to access it. If you are hosting the Web service on an Intranet, you might only need a single client for all your end users. But, if you intend to make your Web service publicly available, you should build several clients in various languages so you can test all the common possibilities.

Note: For more information on creating Web service definitions, see the chapter on generating proxies and Web service definitions in *OpenEdge Development: Open Client Introduction and Programming.*

To build clients to test your Web service, you must understand how clients and your Web service interact. The choices that you made while creating your Web service definition impact how clients use your Web service. The chapter discusses the general programming model for building clients to consume OpenEdge Web services.

The chapter covers general information that applies to any Web service as well as information specific to consuming OpenEdge Web services.

For details, see the following topics:

- Creating client interfaces from WSDL
- SOAP format impact on generated client interfaces
- Client programming for different session models
- Overview of calling methods on Web service objects
- Retrieving and sending object IDs: handling SOAP headers

- Defining and passing Web service method parameters
- Mapping relational data
- Mapping ABL procedures to SOAP messages
- Handling Web service errors and SOAP faults

Creating client interfaces from WSDL

As mentioned in Web services on page 27, advances in client toolkits have nearly eliminated the need to manually write a Web service client from the WSDL file. There are client toolkits available that can generate most of the client interface directly from the WSDL for most major platforms, including:

- Microsoft .NET
- Apache Axis
- OpenEdge

The proxies from these toolkits provide an API that generally appears as an interface to application functions. In fact, they provide an interface to messaging operations that hide the complexity of exchanging SOAP messages over HTTP.

Each client toolkit generates these proxies in a unique manner, but most create objects with methods. Usually, they create one object for each `<portType>` and one object for each `<complexType>` specified in the WSDL. Each client toolkit creates methods to generate and interpret SOAP messages appropriately for their platform.

All major client toolkits can generate a client interface from an OpenEdge Web service's WSDL file.

WSDL element overview for OpenEdge Web services

Previous chapters have discussed the WSDL file in general. A brief look at the parts of a WSDL file is now appropriate. A WSDL file is an XML document consisting of a series of ordered sections. These sections contain the elements defining the Web service objects and their bindings. In general, each succeeding section element references elements defined by preceding sections. This ensures the object definition and its operations are associated with the required bindings for the object.

Thus, the WSDL files generated by client toolsets follow the W3C WSDL 1.1 specification and include the element sections listed in the following table.

Table 17: WSDL element overview

Section	Description
`definitions`	Defined by one occurrence of the `<definitions>` element. This section identifies the Web service, defines all valid namespaces for the WSDL file, and contains all other WSDL sections.

Section	Description
types	Defined by one occurrence of the <types> element. This section includes a separate schema for each Web service object. There is a separate schema that defines the SOAP fault <detail> element. These schema define the input (request) and output (response) parameters for the Web service object. **Note:** The definitions for built-in XML Schema data types are not listed in the types section.
message	Defined by one or more <message> elements. This section defines the request/response message pair for all operations (ABL procedures or user-defined functions), as well as the built-in object management operations supported by each Web service object. For every operation, there is an input (or request) message and an output (or response) message. The input message groups the input parameters for the operation. The output message groups the output parameters for the operation. In addition, the message section defines the SOAP fault message returned by every operation on occurrence of a Web service error.
portTypes	Defined by one or more <portType> elements. This section defines the signatures of all operations using the message definitions from the message section. There is a separate <portType> element defined for each Web service object. Each <portType> element defines the operations for the specified object, using a separate <operation> element to define each operation. Each such <operation> element names the operation and references its input, output, and fault message definitions from the message section.
bindings	Defined by one or more <binding> elements. This section defines the SOAP bindings for all Web service operations. *SOAP bindings* show how calls to Web service operations are converted to SOAP request/response messages. A separate <binding> element defines each Web service object and contains <operation> elements that map to the corresponding <operation> elements in a <portType> element.
service	Defined by one occurrence of the <service> element. This section defines the deployed location of all Web service objects based on the root URL for the WSA instance that hosts the Web service. The <service> element includes one <port> element for each Web service object.

For more information on WSDL and its meaning, see the WSDL specification at the following URL:

```
http://www.w3.org/TR/wsdl
```

SOAP format impact on generated client interfaces

The SOAP format of your Web service affects how a client toolkit defines the objects and methods for interacting with the Web service. The following sections compare how the SOAP format affects the representation of various Web service components.

For examples of how some of these components appear in SOAP, see Sample Code with SOAP Messages for OpenEdge Web Services on page 143.

Method signatures

Client interface method signatures typically map to ABL prototypes as follows:

- **Doc/Lit** — Method signatures do not necessarily match the prototypes in the ABL
- **RPC/Literal** — Method signatures normally match the prototypes in ABL
- **RPC/Encoded** — Same as RPC/Literal

Method return values

Client interface methods typically provide return values for ABL procedures and user-defined functions as follows:

- **Doc/Lit** — Methods provide return values for:
  - User-defined functions (always). The result is either the method return value or the first output parameter.
  - Procedures (always). The result will either be the method return value or the first output parameter. If **Return ABL RETURN-VALUE** is specified in ProxyGen, the result is the ABL RETURN-VALUE. If **Return ABL RETURN-VALUE** is not specified in ProxyGen, the result is a null string.
- **RPC/Literal** — Methods provide return values for:
  - User-defined functions (always)
  - Procedures only when **Return ABL RETURN-VALUE** is specified in ProxyGen
- **RPC/Encoded** — Same as RPC/Literal

Client programming for different session models

You must program Web service clients differently, depending on the Web service session model. The following sections summarize these differences.

Caution: For any session model, failing to call the release method on any Open Client object that a Web service client uses (except a session-free AppObject) leaves the resources reserved for that object unavailable. In effect, this creates a memory leak in the WSA. The Web service deployer can manage these "orphaned" resources by property settings on the Web service. For more information, see the Web service properties reference sections of *OpenEdge Application Server: Administration*.

Programming clients for session-managed Web services

The programming model for session-managed Web services is similar to programming all other Open Clients, except for the use of object IDs:

- Before invoking any other method on a session-managed AppObject, you must instantiate (create) and call a connect method on the object to establish a connection to the AppServer context. The client must obtain the object ID for the AppObject after it is created. After that, you can invoke any method on the AppObject. The subsequent calls to all AppObject methods are handled sequentially using the established connection. You must call the release method on an AppObject when you no longer need the object (Web service).
- You can create ProcObjects and SubAppObjects using class factory methods on the AppObject or create ProcObjects on another SubAppObject. Once created, all objects share the same connection. This connection terminates only after you have called the release method on all Web service objects that you create. You must call each object's release method when you no longer need the object.
- You can call methods on a ProcObject as soon as you create it and after the client obtains the object ID for it. Calls to all ProcObject methods (internal procedures and user-defined functions) are sequential using the connection established by the AppObject. You must call the release method on a ProcObject when you no longer need the object.
- You can call methods on a SubAppObject as soon as you create it and after the client obtains the object ID for it. Calls to all SubAppObject methods are sequential using the connection established for the AppObject. You must call the release method on a SubAppObject when you no longer need the object.
- Once connected to a session-managed Web service, you must always send object IDs with each method call.

Programming clients for session-free Web services

The programming model for session-free Web Services differs significantly from the session-managed model:

- After you instantiate (create) a session-free AppObject, you can call any method on the object and you never connect to an AppServer. Calls to all AppObject methods are *executed in parallel* (calls execute simultaneously) using the available AppServer connections in the Web service *connection pool* (a pool of AppServer connections maintained for each session-free Web service). Each call to the AppObject is independent of every other call and can come from any client, in any order.
- You can create SubAppObjects and ProcObjects using class factory methods. Although no connection is established for the AppObject, SubAppObjects and ProcObjects are maintained uniquely for each client, and ProcObjects reserve their own AppServer connections from the Web service connection pool. You must call each object's release method when you no longer need the object and to return each object's AppServer connections to the connection pool.
- You can call methods on a ProcObject as soon as you create it and after the client obtains the object ID for it. Calls to all ProcObject methods (internal procedures and user-defined functions) are sequential using the connection established for the ProcObject. You must call the release method on a ProcObject when you no longer need the object and to return the object's AppServer connection to the connection pool.
- You can call methods on a SubAppObject as soon as you create it and after the client obtains the object ID for it. Calls to all SubAppObject methods are executed in parallel. You must call the release method on a SubAppObject when you no longer need the object, to remove it from the list of client SubAppObjects maintained by the WSA and to return its AppServer connection to the connection pool.
- Once an object is created, you must always send object IDs with each method call on a session-free SubAppObject or ProcObject, but you never send object IDs on method calls to a session-free AppObject.

Note: SubAppObjects and ProcObjects have limited utility in the session-free model and generally should not be defined for session-free Web services. For more information, see How session models affect Web service objects on page 114.

Overview of calling methods on Web service objects

The following sections provide an overview of the methods supported on Web service objects, and how to use them based on the session model of the Web service. The **bold-italicized** variable names are replaced by real object and method names during WSDL file generation:

- ***AppObject*** — The name of the AppObject for which the named item is defined or associated
- ***SubAppObject*** — The name of the SubAppObject for which the named item is defined or associated
- ***ProcObject*** — The name of the ProcObject for which the named item is defined or associated
- ***ProcName*** — The name of a method that executes an ABL non-persistent procedure or internal procedure on the AppServer
- ***FuncName*** — The name of a method that executes an ABL user-defined function on the AppServer

Note: Open Client object names have fewer legal characters to match restrictions in non-ABL environments. Avoid special characters and hyphens in object names.

Many of the methods referenced here are standards from the Open Client programming model. The precise syntax for invoking these methods differs depending on the client development language used to access Web services; however, the basic signatures for these methods are the same in all languages. For more information on how these methods are used in Web service clients, see Sample Code with SOAP Messages for OpenEdge Web Services on page 143.

The following sections describe usage for:

- Client interface methods for session-managed AppObjects on page 124
- Client interface methods for session-free AppObjects on page 126
- Client interface methods for SubAppObjects and ProcObjects on page 127

Client interface methods for session-managed AppObjects

A session-managed AppObject provides the following methods:

- `Connect_` *`AppObject`* `(...)`
- `Release_` *`AppObject`* `()`
- `CreateAO_` *`SubAppObject`* `()`
- `CreatePO_` *`ProcObject`* `(...)`
- *`ProcName`* `(...)`

Use this method to connect to an AppServer:

```
Connect_AppObject ( . . . )
```

This method must be executed before any other method can be called. The SOAP response header returned by this method contains an *AppObject*ID element whose value must be sent in the SOAP request header for all other methods invoked on this AppObject.

The AppServer Connect procedure has the ability to return user-defined strings to clients using the WSA or the Sonic ESB Adapter on success or failure. The ABL Connect procedure uses the ABL RETURN ERROR *string* or RETURN *string* statements to specify the return strings. By default, the strings are returned to the WSA or Sonic ESB Adapter and logged.

To access the strings on the actual client, the proxy must have been generated with ProxyGen using the **Return ABL RETURN-VALUE on Connect** option of the **Generate Proxies** dialog box.

On a successful connection, the client can access the returned string by the result OUTPUT parameter on the associated Connect_*AppObject*( ) method or as the return value of Connect_*AppObject*( ) if it is run as a function. On a failed connection, the client can access the returned string in the <faultstring> element of the returned SOAP fault. If no user-defined string was returned from the Connect procedure, then parameter value or SOAP element will be an empty string.

Note: ProxyGen normally configures a Connect_*AppObject*( ) method with three parameters (string userid, string password, and string AppServerInfo). Enabling the **Return ABL RETURN-VALUE on Connect** option adds the output parameter string result, which contains the return value of the Connection procedure.

This option does not affect the normal process of returning SOAP faults when a connection attempt fails from a client using a Web Services Adapter. That is, when the Connect procedure fails and returns a string value, that string value will be sent to the client in the <faultstring> element of a SOAP fault. If the Connect procedure does not return a string, then the normal SOAP fault will be returned to the client.

Use this method to release the AppObject connection:

```
Release_AppObject ( )
```

Once this method is executed, no other methods on the AppObject can be called. The SOAP request header must contain the value of the *AppObject*ID element. If other objects (SubAppObjects or ProcObjects) are using the same connection, the connection is not terminated until the corresponding release method is called on every object.

Use this method to create a SubAppObject:

```
CreateAO_SubAppObject ( )
```

This method must be executed before calling any other methods on the SubAppObject. The SOAP request header must contain the value of the *AppObject*ID element. The SOAP response header returned by this method contains a *SubAppObject*ID element whose value must be sent in the SOAP request header for all methods invoked on this SubAppObject.

Use this method to create a ProcObject and execute the corresponding persistent procedure:

```
CreatePO_ProcObject ( . . . )
```

This method must be executed before calling any other methods on the ProcObject. The SOAP request header must contain the value of the *AppObject*ID. The SOAP response header returned by this method contains a *ProcObject*ID whose value must be sent in the SOAP request header for all methods invoked on this ProcObject.

Call a *ProcName* method on the AppObject to execute a corresponding non-persistent external procedure typically identified by *ProcName*:

```
ProcName ( . . . )
```

The SOAP request header must contain the value of the *AppObject*ID element.

Client interface methods for session-free AppObjects

A session-free AppObject provides the following methods:

- *ProcName* (...)
- CreateAO_ *SubAppObject* ()
- CreatePO_ *ProcObject* (...)

Call a *ProcName* method on the AppObject to execute a corresponding non-persistent external procedure typically identified by *ProcName*:

```
ProcName ( . . . )
```

Because no context is maintained for a session-free AppObject, calls to these methods require no object IDs to be sent in the SOAP request header.

Use this method to create a SubAppObject:

```
CreateAO_SubAppObject ( )
```

Note: SubAppObjects are not recommended for use in session-free Web services.

This method must be executed before calling any other methods on the SubAppObject. The SOAP response header returned by this method contains a *SubAppObject*ID element whose value must be sent in the SOAP request header for all methods invoked on this SubAppObject. Because no context is maintained for a session-free AppObject, calls to this method require no object ID to be sent in the SOAP request header.

Use this method to create a ProcObject and execute the corresponding persistent procedure:

```
CreatePO_ProcObject ( . . . )
```

Note: ProcObjects are not recommended for use in session-free Web services.

This method must be executed before calling any other methods on the ProcObject. The SOAP response header returned by this method contains a *ProcObject*ID element whose value must be sent in the SOAP request header for all methods invoked on this ProcObject. Because no context is maintained for a session-free AppObject, calls to this method requires no object ID to be sent in the SOAP request header.

Client interface methods for SubAppObjects and ProcObjects

You use the methods for ProcObjects and SubAppObjects in the same way regardless of the session model. The value for the *ProcObject*ID element or *SubAppObject*ID element that you send in the SOAP request header for methods invoked on each object is initially returned in the SOAP response header of the CreatePO_*ProcObject* method or CreateAO_*SubAppObject* method that you called to instantiate the object.

ProcObject methods

A ProcObject provides the following methods:

- Release_*ProcObject*()
- *ProcName* (...)
- *FuncName* (...)

Use this method to terminate and remove the context of the persistent procedure that is managed by the ProcObject:

```
Release_ProcObject ( )
```

Once this method is executed, no other methods on the ProcObject can be called. The SOAP request header must contain the value of the *ProcObject*ID element. If other objects (AppObject or SubAppObjects) are sharing the same connection, the connection does not terminate until you call the release method for all the objects sharing the connection.

Call a *ProcName* method on the ProcObject to execute a corresponding internal procedure in the persistent procedure that is managed by the ProcObject:

```
ProcName ( . . . )
```

The SOAP request header must contain the value of the *ProcObject*ID element.

Call a *FuncName* method on the ProcObject to execute a corresponding user-defined function in the persistent procedure that is managed by the ProcObject:

```
FuncName ( . . . )
```

The SOAP request header must contain the value of the *ProcObject*ID element.

SubAppObject methods

A SubAppObject provides the following methods:

- Release_*SubAppObject*()
- *ProcName* (...)
- CreatePO_*ProcObject* (...)

Use this method to release a SubAppObject:

```
Release_SubAppObject ( )
```

Once this method is executed, no other methods on the SubAppObject can be called. The SOAP request header must contain the value of the *SubAppObject*ID element. If other objects (AppObject or ProcObjects) are sharing the same connection, the connection does not terminate until you call the release method for all the objects sharing the connection.

Call a *ProcName* method on the SubAppObject to execute a corresponding non-persistent external procedure typically identified by *ProcName*:

```
ProcName ( . . . )
```

The SOAP request header must contain the value of the *SubAppObject*ID element.

Use this method to create a ProcObject and call the corresponding persistent procedure:

```
CreatePO_ProcObject ( . . . )
```

This method must be executed before calling any other methods on the ProcObject. The SOAP request header must contain the value of the *SubAppObject*ID element. The SOAP response header returned by this method contains a *ProcObject*ID element whose value must be sent in the SOAP request header for all methods invoked on this ProcObject.

Retrieving and sending object IDs: handling SOAP headers

Session Models and object IDs on page 113 explains that object IDs must be retrieved from and sent in SOAP headers for methods on the following Open Client objects:

- Session-managed AppObjects

- ProcObjects
- SubAppObjects

Each client toolkit provides different means to access SOAP headers. In some environments, such as Microsoft .NET, the interface automatically moves information from the response header to subsequent request headers within the same object. You do have to do a little work to move the information between objects (for example, copying a ProcObject ID from the AppObject that creates a ProcObject to the ProcObject itself). In other environments, you are responsible for extracting the information from the response header and sending it in the SOAP headers for subsequent requests.

The WSDL defines the SOAP elements that hold the object ID using a `<complexType>` declaration in the `types` section for each Web service object schema that requires it. The headers in the SOAP messages that are sent and received for a given object then contain the required object ID values.

Defining object IDs in WSDL

The follow sample shows the `types` section that might appear in the WSDL for many of the sample Web services in this chapter. (This example is for Doc/Lit, but similar for all SOAP formats.) For example:

WSDL Containing an object ID definition

```
<types>
   <schema elementFormDefault="qualified"
      targetNamespace="urn:OrderSvc:OrderInfo"
      xmlns="http://www.w3.org/2001/XMLSchema">
      <complexType name="OrderInfoID">
         <sequence>
            <element name="UUID" type="xsd:string"/>
         </sequence>
      </complexType>
      <!-- Additional schema declarations here (if any) -->

   </schema>

   <!-- Additional Object Schema Declarations (if any) -->

</types>
```

Note: The samples in this chapter are not all available on the Documentation and Samples (`doc_samples`) directory of the OpenEdge product DVD or Progress Documentation Web site.

The WSDL schema definition for each Web service object (except a session-free AppObject) defines the SOAP header element that contains the value of its object ID as a `<complexType>`. As shown in the example, the name for the SOAP header element is the name of the `<complexType>`, in this example, `"OrderInfoID"`. The name of the element that contains the value of the object ID is `"UUID"`, defined as an element of type `"xsd:string"`. This definition is the same for the object IDs of all Web service objects, differing only in the name of the object ID element.

Using object IDs in a SOAP message

This is a sample header of a SOAP message containing an object ID for the object specified in the sample WSDL, using the WSDL-defined `<OrderInfoID>` SOAP element:

SOAP header containing an object ID

```
<soap:Header>
  <OrderInfoID xmlns ="urn:OrderSvc:OrderInfo">
  <UUID xsi:type="xsd:string">2e62cab6b81150d5:167f64e:f295e997b0:
  -8000;<OrderInfo|PX-000001|AO>;M/IryPm3piDcF/W5DsH4GA==</UUID>
  </OrderInfoID>
</soap:Header>
```

The value of the object ID appears in bold, contained by the <*UUID*> element.

The same basic <OrderInfoID> element contains the object ID in the SOAP response header that initially returns the OrderInfoID object ID, when the object is created, and is required in any subsequent SOAP request header sent by methods invoked on the OrderInfo object.

Thus, for all Web service objects that require object IDs, your client application must parse out the object ID value in the <UUID> element contained by the object ID element (<OrderInfoID> in the example) and returned in the SOAP response header at object creation, whether it happens automatically or you must program it explicitly. Similarly, for every SOAP request sent by a method invoked on this same object, your client application must create an object ID element containing a <UUID> element that holds this identical object ID value in the SOAP header of the request message.

For examples of SOAP headers that contain object IDs and sample code that handles object IDs, see the following chapters:

- Sample Code with SOAP Messages for OpenEdge Web Services on page 143
- Developing a .NET Client to Consume OpenEdge SOAP Web Services on page 271
- Develop a Java Client to Consume OpenEdge SOAP Web Services on page 295

For examples of client applications that handle object IDs, see the sample OpenEdge Web service applications available on the Documentation and Samples (doc_samples) directory of the OpenEdge product DVD. For information on how to access these applications, see Sample SOAP Web service applications on page 52.

Defining and passing Web service method parameters

Most parameters are defined and passed in SOAP messages as XML Schema data types. OpenEdge Web services expose ABL parameter data types as XML data types in the WSDL based on the "2001 XML Schema: Data types" (referred to as xsd in Table 18: Supported XML data types on page 130).

The following table lists the data type mappings for parameters between ABL and XML data types. Most of these parameters can also be passed as arrays.

Table 18: Supported XML data types

ABL data type	XML Schema data type
CHARACTER	xsd:string
COM-HANDLE	xsd:long
DATE	xsd:date
DATETIME	xsd:dateTime
DATETIME-TZ	xsd:dateTime

ABL data type	XML Schema data type
DECIMAL	xsd:decimal
INT64	xsd:long
INTEGER **(32 bit)**	xsd:int
LOGICAL	xsd:boolean
LONGCHAR	xsd:string
MEMPTR[7]	xsd:base64Binary
RAW	xsd:base64Binary
RECID (32 or 64 bit)	xsd:long
ROWID	xsd:base64Binary
WIDGET-HANDLE	xsd:long
TABLE (static temp-table)	complexType
TABLE-HANDLE (dynamic temp-table)[8]	complexType (<any>)
DATASET (static ProDataSet)[8]	complexType
DATASET-HANDLE (dynamic ProDataSet)[8]	complexType (<any>)

Note: ABL object type (class or interface) parameters and ABL BUFFER parameters are not supported.

Client data type mapping

Each client environment provides its own mapping from XML Schema data types to client language data types. For example, an ABL CHARACTER parameter is mapped to a java.lang.String class in Java and a System.String type in .NET.

Relational data types

OpenEdge WSDL represents TABLE, TABLE-HANDLE, DATASET, and DATASET-HANDLE parameters as <complexType> element definitions. Mapping relational data on page 133 describes these <complexType> elements.

[7] LONGCHAR and MEMPTR data types are designed to support very large "strings" of data. Use of these data types as parameters in Web services can result in a serious performance impact.

[8] TABLE, TABLE-HANDLE, DATASET, and DATASET-HANDLE data types cannot be passed as arrays. For more information on passing arrays, see Array parameters on page 132.

Date and time data

The ABL DATE, DATETIME, and DATETIME-TZ data types are explicit with respect to the inclusion or exclusion of time and time zone values. When sending date/time values to an OpenEdge Web service, the client application must precisely match the expected format. The WSA returns a SOAP fault if the client request fails to include a time or time zone when that information is expected, or if the client includes unexpected time or time zone information.

In the case of a DATE field, the WSDL document maps the item unambiguously to the XML Schema data type xsd:date. Both DATETIME and DATETIME-TZ, however, map to the xsd:dateTime data type; therefore, the WSDL does not tell the client developer whether a time zone value is required. The developer must obtain this information by another means and must ensure that the client application sends the expected value.

The following table lists the XML date data formats that are valid as input for each of the ABL data types; use of any other input format results in a SOAP fault.

Table 19: Valid date input formats

ABL data type	Valid input formats
DATE	*CCYY-MM-DD*
DATETIME[9]	*CCYY-MM-DDThh:mm:ss* *CCYY-MM-DDThh:mm:ssZ* *CCYY-MM-DDThh:mm:ss+hh:mm* *CCYY-MM-DDThh:mm:ss-hh:mm*
DATETIME-TZ	*CCYY-MM-DDThh:mm:ssZ* *CCYY-MM-DDThh:mm:ss+hh:mm* *CCYY-MM-DDThh:mm:ss-hh:mm*

Dedicated ABL data types

The COM-HANDLE, RECID, ROWID, and WIDGET-HANDLE ABL data types are not meaningful outside the ABL environment. You can obtain their values from an ABL procedure (through one Web service method) and pass them back to another ABL procedure (through another Web service method), but there is no other practical use for them on the client side.

Array parameters

The WSA supports arrays (extents) as parameters for the data types listed in Table 18: Supported XML data types on page 130. These data types are mapped to XML Schema data types as indicated in this. In the WSDL document, the XML Schema data types are housed in a complex structure whose type definition depends on the encoding style.

Note: TABLE (temp-table), TABLE-HANDLE (temp-table handle), DATASET (ProDataSet), and DATASET-HANDLE (ProDataSet handle) parameters cannot be array parameters.

[9] Any time zone information input to DATETIME is lost.

Fixed arrays

In cases where ABL refers to fixed-array parameters, only the Doc/Lit WSDL style/use format represents the fixed size of the array; the RPC/Encoded and RPC/Literal formats represent all arrays as unbounded. Therefore, when using either of the RPC WSDL style formats, the developer must know the size of each array parameter that is expected. The WSA returns a SOAP fault if the array sizes do not match.

Note: The Doc/Lit schema represents each parameter individually, and thus specifies the size for each fixed array parameter.

For details and examples of how WSDL represents arrays, see WSDL Details on page 355.

Mapping relational data

OpenEdge Web services support the passing of ABL static and dynamic temp-tables and ProDataSets as parameters. The WSDL Analyzer enables ABL clients to handle all these parameters simply. Non-ABL clients require more coding to handle dynamic temp-tables and ProDataSets and to handle ProDataSets with before-image data.

For examples of client applications using relational data, see Sample Code with SOAP Messages for OpenEdge Web Services on page 143. For examples of how WSDL represents relational data, see WSDL Details on page 355.

Defining TABLE (static temp-table) parameters

TABLE parameters pass only the data , because the static temp-table's schema is known at WSDL generation. In the WSDL, OpenEdge Web services map a TABLE definition to a `<complexType>` consisting of a `<sequence>` of elements that represent a row (temp-table record). Each `<element>` in this sequence represents a column (temp-table field) of the row.

For all SOAP formats, client interfaces typically represent temp-table parameters as follows:

- For every temp-table, a row is represented by an object.
- Every temp-table parameter is represented as an array of that temp-table's row objects.
- For an ABL client, the WSDL Analyzer transforms the WSDL definition of a temp-table parameter into a matching ABL temp-table definition.

The following are general formats for TABLE parameters in SOAP messages. For an RPC/Literal or Doc/Lit Web service, the TABLE parameter is represented as a `<sequence>` of TABLE row elements. Each element is named after the row `<element>` in the `<complexType>` used to define the TABLE row for the parameter. This WSDL-named row `<element>` corresponds to the `<Item>` element used to represent SOAP array rows in RPC/Encoded Web services.

Thus, using the sample row element named `ttEmpRow`, a SOAP message contains a TABLE parameter for this row definition in the following form:

TABLE parameters—general Document (or RPC)/Literal format

```
<ttEmpRow> <!-- row instance 1 --> </ttEmpRow>
<ttEmpRow> <!-- row instance 2 --> </ttEmpRow>
<ttEmpRow> <!-- row instance 3 --> </ttEmpRow>
...
```

For an RPC/Encoded Web service, the TABLE parameter is represented as a SOAP array of TABLE rows, where each row is encapsulated by an <Item> element:

TABLE parameters—general RPC/Encoded format

```
<Item> <!--- row instance 1 --> </Item>
<Item> <!--- row instance 2 --> </Item>
<Item> <!--- row instance 3 --> </Item>
...
```

Each column of a TABLE row can hold any data type shown in the following table.

Table 20: XML data types for TABLE parameter columns

ABL data type	XML Schema data type
BLOB[10]	xsd:base64Binary
CHARACTER	xsd:string
CLOB1	xsd:string
COM-HANDLE	xsd:long
DATE	xsd:date
DATETIME	xsd:dateTime
DATETIME-TZ	xsd:dateTime
DECIMAL	xsd:decimal
INT64	xsd:long
INTEGER (32 bit)	xsd:int
LOGICAL	xsd:boolean
RAW	xsd:base64Binary
RECID (32 or 64 bit)	xsd:long
ROWID	xsd:base64Binary
WIDGET-HANDLE	xsd:long

[10] BLOB and CLOB data types are designed to support very large objects. Use of these data types for table fields in Web services can result in a serious performance impact.

Defining TABLE-HANDLE (dynamic temp-table) parameters

TABLE-HANDLE parameters pass both the schema and data, because the dynamic temp-table schema is not known at compile time. In the WSDL, OpenEdge Web services map an ABL TABLE-HANDLE to a <complexType> containing a sequence of xsd:any.

For all SOAP formats, client interfaces typically represent TABLE-HANDLE parameters as follows:

- For every TABLE-HANDLE parameter within a Web service object, there is a single object representing all TABLE-HANDLEs.
- In both request messages and response messages, the schema of the TABLE-HANDLE must accompany the data.
- For every input TABLE-HANDLE, you must include the schema of the TABLE-HANDLE in the form of an XML Schema followed by the data in the form of an XML document fragment.
- For every output TABLE-HANDLE, a non-ABL client must parse the XML Schema and data in the SOAP response message.
- The WSDL Analyzer recognizes the WSDL definition of a TABLE-HANDLE parameter and maps it to a TABLE-HANDLE parameter for an ABL client.

The following WSDL sample shows this common TABLE-HANDLE parameter definition:

TABLE-HANDLE definition for all dynamic temp-table parameters

```
<complexType name="TableHandleParam">
   <sequence>
      <any namespace="##local"/>
   </sequence>
</complexType>
```

The non-ABL client application must create (for input) and parse (for output) the XML Schema along with the data for the parameter. How the client inserts the input schema and data in request messages and how it parses the output schema and data from response messages is entirely dependent on the client toolkit.

This is the general format in OpenEdge Web services for representing a TABLE-HANDLE in a SOAP message, where the schema is defined in a <schema> element and each row is encapsulated by an <Item> element within a <Data> element:

TABLE-HANDLE parameters—general format

```
<DataSet>
   <schema>

        <!-- TEMP-TABLE row definition in XML Schema -->

   </schema>
    <Data>

      <Item> <!--- row instance 1 --> </Item>
      <Item> <!--- row instance 2 --> </Item>
      <Item> <!--- row instance 3 --> </Item>
      ...

   </Data>
</DataSet>
```

Each column of a TABLE-HANDLE row can hold any data type shown in the following table.

Table 21: XML data types for TABLE-HANDLE parameter columns

ABL data type	XML Schema data type
CHARACTER	xsd:string
DATE	xsd:date
DATETIME-TZ	xsd:dateTime
DECIMAL	xsd:decimal
INT64	xsd:long
INTEGER (32 bit)	xsd:int
LOGICAL	xsd:boolean
RAW	xsd:base64Binary

Defining DATASET (static ProDataSet) parameters

DATASET parameters pass only the data, because the static ProDataSet's schema is known at WSDL generation. In the WSDL, OpenEdge Web services map a DATASET definition to a <complexType> consisting of a <sequence> of elements that represent the ProDataSet's temp-tables. Each temp-table element includes a <complexType> describing the temp-table's fields. The definition also includes elements describing the data relations and indexes.

For all SOAP formats, client interfaces typically represent dataset parameters as follows:

- For every dataset, each temp-table is represented by an object.
- Every dataset parameter is represented as arrays of the constituent temp-table objects.
- For an ABL client, the WSDL Analyzer transforms the WSDL definition of a ProDataSet parameter into a matching ProDataSet.

By default, a ProDataSet parameter includes only the current data. You must specify in ProxyGen the ProDataSet parameters for which you want to include before-image data. If the ProDataSet parameter includes before-image data, the before-image data is serialized in a proprietary OpenEdge datasetChanges document.

The following snippet shows the general format for DATASET parameters in SOAP messages:

DATASET parameters—general SOAP format

```
<PDSname>
      <Buffer1Name> <!--- TEMP-TABLE-1 row instance 1 --> </Buffer1Name>
      <Buffer1Name>    <!--- TEMP-TABLE-1 row instance 2 --> </Buffer1Name>
        ...
        <Buffer2Name>   <!--- TEMP-TABLE-2 row instance 1 --> </Buffer2Name>
       <Buffer2Name>   <!--- TEMP-TABLE-2 row instance 2 --> </Buffer2Name>
        ...
</PDSname>
```

Defining DATASET-HANDLE (dynamic ProDataSet) parameters

DATASET-HANDLE parameters pass both the schema and data, because the dynamic ProDataSet schema is not known at compile time. In the WSDL, OpenEdge Web services map an ABL DATASET-HANDLE to an arbitrary complex type (<any>). There is a single definition used for all ProDataSet parameters in all supported SOAP formats.

For all SOAP formats, client interfaces typically represent DATASET-HANDLE parameters as follows:

- All DATASET-HANDLE parameters within a Web service object are represented as one of two objects, one for ProDataSets without before-image data and one for ProDataSets with before-image data.
- In both request messages (input) and response messages (output), the schema of the DATASET-HANDLE must accompany the data.
- For every input DATASET-HANDLE, you must include the schema of the DATASET-HANDLE in the form of an XML Schema followed by the data in the form of an XML document fragment.
- For every output DATASET-HANDLE, a non-ABL client must parse the XML Schema and data in the SOAP response message.
- For an ABL client, the WSDL Analyzer recognizes the WSDL definition of a DATASET-HANDLE parameter and maps it to a DATASET-HANDLE parameter for an ABL client.

The following WSDL sample shows this common ProDataSet parameter definition:

Common DATASET-HANDLE definition for all SOAP formats

```
<complexType name="DataSetHandleParam">
  <annotation>
    <documentation>This is the schema definition for an OpenEdge dynamic
     ProDataSet parameter. The first element in this sequence must be a
     w3c XML Schema document describing the definition of the ProDataSet.
     The second element contains the serialized data.
    </documentation>
  </annotation>
  <sequence>
    <any maxOccurs="2" minOccurs="2"/>
  </sequence>
</complexType>
```

The client application must create (for input) and parse (for output) the XML Schema along with the data for the parameter. How the client inserts the input schema and data in request messages and how it parses the output schema and data from response messages depends entirely on the client application.

This is the general format in OpenEdge Web services for representing a DATASET-HANDLE in a SOAP message:

DATASET-HANDLE parameters—general format

```
<DataSet>
   <schema ...>
      <element ProDataSet>
         <!-- TEMP-TABLE-1 definition in XML Schema -->
         <!-- TEMP-TABLE-2 definition in XML Schema -->
         . . .
      </element>
      . . .
   </schema>
   <ProDataSet>

      <TEMP-TABLE-1> <!--- row instance 1 --> </TEMP-TABLE-1>
      <TEMP-TABLE-1> <!--- row instance 2 --> </TEMP-TABLE-1>
      ...
      <TEMP-TABLE-2> <!--- row instance 1 --> </TEMP-TABLE-2>
      <TEMP-TABLE-2> <!--- row instance 2 --> </TEMP-TABLE-2>
      ...

   </ProDataSet>
</DataSet>
```

Additional considerations

When dealing with relational data in an OpenEdge Web service, you should also consider:

- Including before-image data
- Name collisions
- R-code header changes

Including before-image data

Before-image data is serialized in a proprietary OpenEdge `datasetChanges` document. The WSDL represents the parameter as arbitrary complex data with an <any> element. All SOAP formats represent this data as arbitrary complex data with XML Schema attributes that identify it as an OpenEdge `datasetChanges` document.

An ABL-based client can map the <any> element to a ProDataSet parameter and parse the OpenEdge `datasetChanges` document into a ProDataSet and its before-image data. For more information on how ABL handles before-image data in XML, see the chapter on reading and writing XML data from ProDataSets in *OpenEdge Development: Working with XML*. Non-ABL clients map the <any> element to an XML document that the client developer needs to parse with an XML API.

Name collisions

A ProxyGen AppObject or SubAppObject can contain multiple procedures, which might have ProDataSets with the same name. If such a collision occurs within an object, ProxyGen checks the ProDataSet's definition and responds as follows:

1. If the definitions match, ProxyGen generates a single XML Schema definition for that ProDataSet name. All operations using that ProDataSet name reference the single XML Schema definition.
2. If the definitions do not match, ProxyGen renames the second and subsequent ProDataSets of that name. It renames them by adding a counter to the end of the ProDataSet name. This renaming shows up in different places depending on the style/encoding that you are using.

R-code header changes

ProxyGen uses information in the headers of r-code files to generate the WSM file. So, the WSDL definition of a ProDataSet is limited by the information written into the r-code header. Starting with OpenEdge R10.1C, the r-code header includes support for a temp-table or ProDataSet's `NAMESPACE-URI` attribute and a temp-table field's `XML-NODE-TYPE` attribute. The r-code header also includes support for the `XML-NODE-NAME` attribute on ProDataSets, temp-tables, and temp-table fields.

To accommodate the addition of the `NAMESPACE-URI` and `XML-NODE-NAME` attributes, the r-code header includes a header version number which is independent of the r-code version. The AVM adds this element to the r-code header only if the file contains a temp-table or ProDataSet with the `NAMESPACE-URI` or `XML-NODE-NAME` attributes. When this element is present, you cannot use the r-code file with the ProxyGen from releases before Release 10.1C. Previous versions of ProxyGen return an error if they encounter this attribute.

Mapping ABL procedures to SOAP messages

The mapping of an ABL procedure (or, similarly, a user-defined function) to its final representation as a pair of SOAP request/response messages follows a well-defined series of steps:

1. ProxyGen generates a Web service definition that includes the selected ABL procedure in the context of some Open Client object during Web service development (see *OpenEdge Development: Open Client Introduction and Programming*).
2. The WSA generates the WSDL file for the Web service during Web service deployment (see *OpenEdge Application Server: Administration*). This WSDL file includes elements that define a Web service operation that maps to the selected ABL procedure.
3. A developer uses a client toolkit to generate the source code for the client interface from the WSDL file. The client toolkit reads the WSDL file and writes out the source code for the client interface as a series of objects and methods, each of which represents a Web service operation.

   Note: In OpenEdge, the WSDL Analyzer generates documentation on how to represent Web service operations in ABL. For more information, see Use the WSDL Analyzer on page 182.

4. The developer writes a client application using the client interface generated in Step 3. The application invokes the method mapped to the Web service operation defined in Step 2, which sends a SOAP request message to the WSA where the Web service is deployed.
5. The WSA receives the SOAP request and packages the input parameters in an AppServer message which results in executing the corresponding an ABL procedure on an AppServer.
6. The ABL procedure then returns any output parameters and any return value to the WSA.
7. The WSA packages these procedure results in a SOAP response message, which it returns to the client that originally sent the request.

In short, the process transforms:

1. ABL procedure prototype to WSDL operation on page 140
2. WSDL operation to client method prototype on page 140
3. Client method call to SOAP request/response message pair on page 140

The examples that follow show how these three transformations proceed.

Note: Some of these examples are available as samples on the Documentation and Samples (doc_samples) directory of the OpenEdge product DVD or Progress Documentation Web site. For more information on accessing them, see Sample SOAP Web service applications on page 52.

ABL procedure prototype to WSDL operation

This is the ABL procedure prototype for the sample external procedure, FindCustomerByNum.p:

ABL procedure prototype

```
/* FindCustomerByNum.p */

DEFINE INPUT PARAMETER CustomerNumber AS INTEGER.
DEFINE OUTPUT PARAMETER CustomerName AS CHARACTER.

FIND FIRST Customer WHERE Customer.CustNum = CustomerNumber NO-ERROR.
IF AVAILABLE Customer THEN
    CustomerName = Customer.NAME.
ELSE
    CustomerName = ?.
```

ProxyGen can extract some of the needed information from this prototype to map it to a corresponding Web service operation definition, including the procedure name (filename for an external procedure) and the parameter mode (input or output), names, and data types of any parameters. However, you must specify some of the needed information directly in ProxyGen, such as whether the ABL RETURN-VALUE is used and (for external procedures) the Open Client object to which the operation belongs.

For an example of how WSDL represents a procedure call, see WSDL Details on page 355.

WSDL operation to client method prototype

This is a VB.NET method prototype for the FindCustomerByNum operation defined in the WSDL file:

Interface method prototype generated from a WSDL operation definition

```
Public Sub FindCustomerByNum(
              ByVal CustomerNumber As Integer,
              ByRef CustomerName As String)
```

This prototype has basically the same information as the original ABL procedure prototype in FindCustomerByNum.p. In this case, ByVal specifies a value for the CustomerNumber parameter used for input, and ByRef specifies a reference to a variable for the CustomerName parameter used for output. Also, when VB.NET generates the client interface object that contains this method, the information provided in the WSDL portType, bindings, and service sections specify the object on which this method is defined (<portType>), the format of SOAP messages for this method (<binding>), and the location of the WSA instance to which the Web service is deployed (<port> within <service>).

Client method call to SOAP request/response message pair

This is a sample VB.NET method call to the FindCustomerByNum( ) method defined in the client interface, where the OrderInfo AppObject instance on which the method is called is named webService:

Interface method call generating SOAP messages

```
Dim CustomerName As String
webService.FindCustomerByNum(3, CustomerName)
```

Thus, the call passes a value of 3 for the `CustomerNumber` parameter as input and receives the value returned by the `CustomerName` output parameter in a variable that happens also to be named `CustomerName`.

This is the SOAP request message sent out by the client after invoking the `FindCustomerByNum( )` method. You can see that the value (3) for the input parameter, `CustomerNumber`, is passed in the SOAP message body:

SOAP request message for method input parameters

```
<?xml version="1.0" encoding="utf-8" ?>
<soap:Envelope namespaces defined here...>
  <soap:Body>
    <FindCustomerByNum xmlns="urn:OrderSvc:OrderInfo">
      <CustomerNumber>3</CustomerNumber>
    </FindCustomerByNum>
  </soap:Body>
</soap:Envelope>
```

This is the SOAP response message returned by the WSA with the value (`"Hoops"`) for the output parameter, `CustomerName`:

SOAP response message for method output parameters

```
<?xml version="1.0" encoding="UTF-8" ?>
<soap:Envelope namespaces defined here...>
  <soap:Body>
    <FindCustomerByNumResponse xmlns="urn:OrderSvc:OrderInfo">
      <CustomerName>Hoops</CustomerName>
    </FindCustomerByNumResponse>
  </soap:Body>
</soap:Envelope>
```

If an error occurred at any point after the SOAP request message was received by the WSA, a SOAP fault message would be returned instead of the SOAP response message shown in the example. For information on SOAP fault messages returned for a method, see Handling Web service errors and SOAP faults on page 141.

Handling Web service errors and SOAP faults

Clients receive Web service errors in the form of a SOAP fault. A SOAP fault specifies a particular format for the body of SOAP response messages that return errors instead of successful responses to SOAP requests. Errors are also reflected in log files for various components of the OpenEdge Web services tools and the Web server or JSE. Run-time errors, which are normally returned to the client application, can occur at the following points in a message exchange:

- Client errors occur:

  - Before a request is sent to the Web service. The nature of these errors and how they are propagated depends on the client platform.
  - While the request is being sent to the Web service. These errors can be written to a log and might result in a SOAP fault.

- Server errors occur after the Web service begins processing the request, preparing and sending the request to the AppServer. These errors can be written to a log and result in a SOAP fault.

Client programming for SOAP faults

Client interfaces typically convert SOAP faults to client exceptions. Client code should handle SOAP faults and alert the user. Client languages catch errors in different ways. One of the more common techniques is to use `try...catch` blocks such as those used in Java and C#.

Note: For ABL, OpenEdge translates SOAP faults into ABL errors and provides access to the SOAP fault information. For more information, see Handling Errors in ABL Requests to OpenEdge SOAP Web Services on page 255.

Caution: In any `catch` block or other error routine where you exit the program, you must release all Web service objects that you have created in the program.

This is the general format for a SOAP fault, with content indicated by the XML comments:

SOAP faults—general format

```
<?xml version="1.0" encoding="UTF-8" ?>
<soap:Envelope namespaces defined here…>
  <soap:Body>
    <soap:Fault>
      <faultcode> <!-- Client or Server Environment --> </faultcode>
      <faultstring> <!-- Basic Error Message (12345) --> </faultstring>
      <detail>
        <FaultDetail xmlns="http://... WSA root URL ...">
          <errorMessage xsi:type="xsd:string">
            <!-- Initial error message (99999) --></errorMessage>
          <requestID> <!-- Unique request ID --> </requestID>
        </FaultDetail>
      </detail>
    </soap:Fault>
  </soap:Body>
</soap:Envelope>
```

For more information on catching and viewing SOAP faults and working with log files to debug OpenEdge Web services, see SOAP faults on page 169.

9

Sample Code with SOAP Messages for OpenEdge Web Services

The following samples provide individual examples of how SOAP messages are sent between the client and an OpenEdge SOAP Web service, and code that produces some of these messages. The code samples are written in VB.NET or C#.NET.

Note: You can find some of the sample applications in *OpenEdge_install_dir*`/src/samples/webservices`.

For details, see the following topics:

- Sample Web service specifications
- Consume a session-managed Web service
- Consume a session-free Web service
- Run an ABL non-persistent procedure
- Create and use a ProcObject
- Run an internal procedure or user-defined function
- Release an object
- Pass static and dynamic temp-table parameters
- Process a SOAP fault message
- Pass static and dynamic ProDataSet parameters

Sample Web service specifications

These examples rely on sample Web service specifications shown in the following table.

Sample Web service specifications

Property or component	Configuration, value, or name
Session model	Managed **Note:** Some information and examples are also provided to show session-free interactions.
SOAP format	`Doc/Lit`
TargetNamespace	`"urn:OrderSvc"`
AppObject	`OrderInfo`
ProcObject	`CustomerOrder`

Some of the information presented in these examples provides a review of concepts introduced and described in previous chapters of this manual. Note that some SOAP messages and code samples are edited for brevity.

Client references to the sample VB.NET interface include the following method declarations for these interface objects:

- Interface AppObject, `OrderInfo`:

VB.NET method declarations on AppObject, OrderInfo

```
Public Sub Connect_OrderInfo(
       ByVal userId As String,
       ByVal password As String,
       ByVal appServerInfo As String)
Public Function FindCustomerByNum(
       ByVal CustomerNumber As Integer,
       ByRef CustomerName As String) As String
Public Function CreatePO_CustomerOrder(
       ByVal custNum As Integer) As String
Public Sub Release_OrderInfo( )
```

The `FindCustomerByNum` and `CreatePO_CustomerOrder` methods are represented as functions because methods in Doc/Lit WSDLs are always defined to return a value, regardless of whether the procedure defined in ProxyGen is specified to return the ABL `RETURN-VALUE`. If **Return ABL RETURN-VALUE** is not specified, the return value for the function will be a null String. For more information, see *OpenEdge Development: Open Client Introduction and Programming.*

VB.NET method declarations on ProcObject, CustomerOrder

```
Public Function GetOrderDetails(
       ByRef OrderDetails( ) As OrderDetailsRow) As String
Public Function GetTotalOrdersByNumber(
       ByVal Threshold As Decimal) As Integer
Public Sub Release_CustomerOrder( )
```

Note: ProxyGen normally configures a `Connect_AppObject( )` method with three parameters (`string userid`, `string password`, and `string appServerInfo`). Enabling the **Return ABL RETURN-VALUE on Connect** option adds the output parameter `string result`, which contains the return value of the Connection procedure.

Consume a session-managed Web service

To access a session-managed Web service, you maintain connection context by passing object IDs associated with each request.

To begin using a session-managed Web service:

1. Instantiate (create) the AppObject as appropriate for the client platform.
2. Connect to an AppServer by calling the connect method on the AppObject before calling any other Web Service (AppObject) method.
3. Obtain the AppObject ID value from the SOAP response header for the connect method and use it for all subsequent calls to methods on the session-managed AppObject.
4. Invoke any available methods on the AppObject, as required.
5. Ensure that the last method you invoke on the AppObject is the object's release method. For more information, see Release an object on page 153.

As with other Open Clients, there is no ABL involved in implementing the connect method on an AppObject. For Web services, however, the operation is an object method that is required by the WSA.

This is a VB.NET declaration for an AppObject connect method, `Connect_OrderInfo( )`:

VB.NET prototype for an AppObject Connect_Object method

```
Public Sub Connect_OrderInfo(
             ByVal userId As String,
             ByVal password As String,
             ByVal appServerInfo As String)
```

Note: For more information on the parameters to this method, see the sections on connecting to an AppServer in *OpenEdge Development: Open Client Introduction and Programming*. Note that there is no AppServer URL parameter. For a Web service (unlike other Open Client applications), the deployer manages the AppServer connection information for each Web service through the WSA instance where the Web service is deployed. Each deployed Web service has writable properties to specify this information. For more information, see the sections on Web service deployment in *OpenEdge Application Server: Administration*.

When the client executes the connect method, the SOAP response message contains a SOAP header with the AppObject ID. You must send this AppObject ID in the SOAP header of the request message for every subsequent method call on the AppObject. How you handle the SOAP header and AppObject ID depends on your client type. For some clients, such as .NET, this process is automated. For other clients, such as ABL and Java, you need to create the code to handle this yourself. For more information on handling SOAP headers and object IDs, see Handling SOAP Message Headers in ABL and Develop a Java Client to Consume OpenEdge SOAP Web Services.

This is a sample instantiation and invocation of the connect method on the `OrderInfo` AppObject:

VB.NET client code for the connect method on AppObject, OrderInfo

```
webService = New OrderSvc.OrderInfoObj( )
webService.Connect_OrderInfo( "", "", "" )
```

This is a sample Doc/Lit SOAP request message that might be generated from invoking the `Connect_OrderInfo( )` method, as in the example:

SOAP connect request for AppObject, OrderInfo

```
<?xml version="1.0" encoding="utf-8" ?>
<soap:Envelope namespaces defined here...>
  <soap:Body>
    <Connect_OrderInfo xmlns="urn:OrderSvc:OrderInfo">
      <userId />
         <password />
         <appServerInfo />
         </Connect_OrderInfo>
  </soap:Body>
</soap:Envelope>
```

Note the data for the request highlighted in the example for parameters passed as empty strings.

This is a sample Doc/Lit SOAP response that might be generated by the WSA as a response to the `Connect_OrderInfo( )` method:

SOAP response to OrderInfo AppObject connect request

```
<?xml version="1.0" encoding="utf-8" ?>
<soap:Envelope namespaces defined here...>
<soap:Header>
  <OrderInfoID xmlns="urn:OrderSvc:OrderInfo">
    <UUID>2e62cab6b81150d5:167f64e:f295e997b0:-8000;
          <OrderInfo|PX-000001|AO>;M/IryPm3piDcF/W5DsH4GA==</UUID>
  </OrderInfoID>
</soap:Header>
<soap:Body>
  <Connect_OrderInfoResponse xmlns="urn:OrderSvc:OrderInfo" />
</soap:Body>
</soap:Envelope>
```

Note the value for the returned AppObject ID, `OrderInfo`, highlighted in the example. Thus, the SOAP response header returns the following AppObject ID contained in the `OrderInfoID` element:

```
2e62cab6b81150d5:167f64e:f295e997b0:-8000;<OrderInfo|PX-000001|AO>;M/IryPm3p
iDcF/W5DsH4GA==
```

Consume a session-free Web service

Because the AppObject for a session-free Web service maintains no connection to the Web service, you can call the methods of a session-free AppObject with no preparation. When the WSA instance receives such a method request, it simply locates an available AppServer connection in the connection pool for that Web service and invokes the corresponding procedure or function on the available AppServer.

Note: All AppServers that participate in the connection pool for a session-free Web service are assumed to share the same version and capabilities and have access to the same set of databases and other shareable resources on a network. For more information, see *OpenEdge Application Server: Developing AppServer Applications.*

To use a session-free Web service:

Instantiate (create) the AppObject as appropriate for the client platform. For example:

VB.NET client code to instantiate session-free AppObject, OrderInfo

```
webService = New OrderSvc.OrderInfoObj( )
```

Invoke any available methods on the AppObject, as required.

Run an ABL non-persistent procedure

Methods that run a non-persistent procedure can:

- Appear on any AppObject
- Require an object ID in the SOAP request header for each method invocation unless the object is a session-free AppObject

This is the ABL prototype for the sample `FindCustomerByNum( )` method:

ABL prototype for a non-persistent external procedure

```
/* FindCustomerByNum.p */

DEFINE INPUT PARAMETER CustomerNumber AS INTEGER.
DEFINE OUTPUT PARAMETER CustomerName AS CHARACTER.
```

This is a sample VB.NET declaration for the ABL non-persistent procedure method, `FindCustomerByNum( )`:

VB.NET prototype for a method that runs an ABL non-persistent procedure

```
Public Function FindCustomerByNum(
       ByVal CustomerNumber As Integer,
       ByRef CustomerName As String) As String
```

This is a sample call to this method:

VB.NET client code calling an external procedure method

```
Dim CustomerName As String
Dim retVal As String
retVal=webService.FindCustomerByNum(3, CustomerName)
```

This is a sample Doc/Lit SOAP request that might be generated from this `FindCustomerByNum( )` method invocation:

SOAP request from calling the FindCustomerByNum procedure method

```
<?xml version="1.0" encoding="utf-8" ?>
<soap:Envelope namespaces defined here...>
  <soap:Header>
    <OrderInfoID xmlns="urn:OrderSvc:OrderInfo">
      <UUID>2e62cab6b81150d5:167f64e:f295e997b0:-8000;
            <OrderInfo|PX-000001|AO>;M/IryPm3piDcF/W5DsH4GA==</UUID>
    </OrderInfoID>
  <soap:Header>
  <soap:Body>
    <FindCustomerByNum xmlns="urn:OrderSvc:OrderInfo">
      <CustomerNumber>3</CustomerNumber>
    </FindCustomerByNum>
  </soap:Body>
</soap:Envelope>
```

Note the following elements in the preceding SOAP message:

- AppObject ID (`OrderInfoID`) sent using the <UUID> element of the SOAP header
- Data for the request highlighted in the example, including the request for a `CustomerNumber` value of 3

This is a sample Doc/Lit SOAP response that is generated by the WSA from this invocation of the `FindCustomerByNum( )` method:

SOAP response from calling the FindCustomerByNum method

```
<?xml version="1.0" encoding="UTF-8" ?>
<soap:Envelope namespaces defined here...>
  <soap:Body>
    <FindCustomerByNumResponse xmlns="urn:OrderSvc:OrderInfo">
      <result xsi:nil="true" />
      <CustomerName>Hoops</CustomerName>
    </FindCustomerByNumResponse>
  </soap:Body>
</soap:Envelope>
```

Note: The CustomerName value, `"Hoops"`, returned and highlighted in the example.

Create and use a ProcObject

Each AppObject that defines ProcObjects also defines a built-in class factory method specifically for each ProcObject. This method runs a persistent procedure on the AppServer that thereby establishes a persistent AppServer session context that is encapsulated by the ProcObject for access by the client.

To create and use a ProcObject:

1. Instantiate (create) the ProcObject as appropriate for the client platform.
2. Call the class factory method for this ProcObject on the parent AppObject or SubAppObject to run the persistent procedure on the AppServer.
3. Obtain the ProcObject ID value from the response header of the class factory method. Use this ProcObject ID for all subsequent calls to methods on the ProcObject.
4. Invoke any available methods on the ProcObject.
5. Ensure that the last method you invoke on the ProcObject is the object's release method. For more information, see Release an object on page 153.

Note: You can instantiate a ProcObject either before or after calling the class factory method and getting the ProcObject ID, but you must complete all of these steps before you invoke methods on the ProcObject.

ProcObject session context

For a session-managed ProcObject, the method establishes the persistent session context using the same AppServer connection as the parent AppObject. For a session-free ProcObject, the method establishes the persistent session context on any AppServer that the WSA makes available through the Web service connection pool, and the client connection to that context persists until the ProcObject is released. Note that for multiple ProcObjects defined for the same session-free Web service, no two objects ever share the same session context. While for a session-managed Web service, all defined ProcObjects always share the same session context.

ProcObject IDs

You use the same type of class factory method to create ProcObjects for both session-managed and session-free Web Services. For a ProcObject whose defining parent is a SubAppObject or a session-managed AppObject, you must send the object ID of the parent in the SOAP request message header. However, for a ProcObject whose defining parent is a session-free AppObject, you do not have an AppObject ID to send in the SOAP request header when you invoke the class factory method to create the ProcObject.

For every ProcObject, regardless of its parent, the SOAP response header for the class factory method returns a ProcObject ID that associates the ProcObject session context with the client. You must send this ProcObject ID in the SOAP request header for all other method calls on the ProcObject.

ProcObject class factory methods

This is the ABL prototype for the persistent procedure that runs for the sample ProcObject class factory method, `CreatePO_CustomerOrder( )`:

ABL prototype for a persistent procedure to implement a ProcObject

```
/* CustomerOrder.p */

DEFINE INPUT PARAMETER custNum AS INTEGER.
```

Note: The parameter list for the persistent procedure that runs for the ProcObject class factory method is AppServer application dependent, and is the basis for creating the parameter list of the ProcObject class factory method. A persistent procedure can also be specified in ProxyGen to return a string value using the ABL RETURN statement.

This is a VB.NET declaration for the ProcObject class factory method, `CreatePO_CustomerOrder( )`:

VB.NET prototype for the ProcObject CreatePO_CustomerOrder method

```
Public Function CreatePO_CustomerOrder
       (ByVal custNum As Integer) As String
```

Note: This method maps to a persistent procedure that has been specified to return the string from the ABL RETURN-VALUE function.

The following code snippet:

1. Instantiates the ProcObject on the client, enabling access to its methods.
2. Calls the CreatePO_CustomerOrder( ) method on the AppObject, `webService`, to create the ProcObject, CustomerOrder, on the WSA and run `CustomerOrder.p` persistently.
3. Copies the ProcObject ID to the ProcObject from the AppObject (`webService`) that creates the ProcObject.

VB.NET client code to create the ProcObject, CustomerOrder

```
custOrder = New OrderSvc.CustomerOrderObj( )
custName = webService.CreatePO_CustomerOrder(3)
custOrder.CustomerOrderIDValue = webService.CustomerOrderIDValue
```

This is a Doc/Lit SOAP request generated by invoking the `CreatePO_CustomerOrder( )` method to create the ProcObject, passing in a `custNum` value of 3:

SOAP request to create ProcObject, CustomerOrder

```
<?xml version="1.0" encoding="utf-8" ?>
<soap:Envelope namespaces defined here...>
  <soap:Header>
    <OrderInfoID xmlns="urn:OrderSvc:OrderInfo">
      <UUID>2e62cab6b81150d5:167f64e:f295e997b0:-8000;
            <OrderInfo|PX-000001|AO>;M/IryPm3piDcF/W5DsH4GA==</UUID>
    </OrderInfoID>
  </soap:Header>
  <soap:Body>
    <CreatePO_CustomerOrder xmlns="urn:OrderSvc:OrderInfo">
      <custNum>3</custNum>
    </CreatePO_CustomerOrder>
  </soap:Body>
</soap:Envelope>
```

Note the value for the request highlighted in the example, especially the AppObject ID sent for the AppObject, `OrderInfo`, which is the parent of the ProcObject being created for customer number 3.

This is a sample Doc/Lit SOAP response that is generated by the WSA from this invocation of the `CreatePO_CustomerOrder( )` method:

SOAP response from creating ProcObject, CustomerOrder

```
<?xml version="1.0" encoding="UTF-8" ?>
<soap:Envelope namespaces defined here...>
  <soap:Header>
    <CustomerOrderID xmlns="urn:OrderSvc:CustomerOrder">
      <UUID>2e62cab6b81150d5:167f64e:f295e997b0:-8000;
            <OrderInfo|PX-000002|PO>;G1Vc/vmohvLnwxQQXwA6Cg==</UUID>
    </CustomerOrderID>  </soap:Header>
  <soap:Body>
    <CreatePO_CustomerOrderResponse xmlns="urn:OrderSvc:OrderInfo">
      <result>Hoops</result>
    </CreatePO_CustomerOrderResponse>
  </soap:Body>
</soap:Envelope>
```

Note the value returned for the `CustomerOrder` ProcObject ID highlighted in the example. The Web service returns this ProcObject ID even if it is session free, to allow the ProcObject to access its own AppServer session context.

Thus, the SOAP response header returns the following ProcObject ID contained in the `CustomerOrderID` element:

```
2e62cab6b81150d5:167f64e:f295e997b0:-8000;<OrderInfo|PX-000002|PO>;G1Vc/vmoh
vLnwxQQXwA6Cg==
```

Finally, note the ABL `RETURN-VALUE` result, returned from running the persistent procedure, which returns the customer name, `"Hoops"`.

Run an internal procedure or user-defined function

Methods to run an ABL internal procedure and user-defined function of a persistent procedure (ProcObject) are indistinguishable in client code. These methods:

- Run only in the context of a defining ProcObject
- Require a ProcObject ID in the SOAP request header, which is the object ID of the defining ProcObject

This is the ABL prototype for the sample user-defined function, `GetTotalOrdersByNumber( )`:

ABL prototype for a user-defined function

```
/* CustomerOrder.p */

FUNCTION GetTotalOrdersByNumber RETURNS INTEGER
   (Threshold AS DECIMAL):
```

This is a VB.NET declaration for the ABL user-defined function method, `GetTotalOrdersByNumber( )`:

VB.NET prototype for an ABL user-defined function method

```
Public Function GetTotalOrdersByNumber
                  (ByVal Threshold As Decimal) As Integer
```

The following is a sample method call for the user-defined function method, `GetTotalOrdersByNumber`, which is an interface method on the sample ProcObject, `CustomerOrder`:

VB.NET client code of method to run an ABL user-defined function

```
totNumber = custOrder.GetTotalOrdersByNumber(2150.99)
```

Note that user-defined function methods return a value whose data type maps to the ABL data type of the user-defined function's return value.

This is a sample Doc/Lit SOAP request that might be generated from invoking the `GetTotalOrdersByNumber( )` method to execute the ABL user-defined function, passing in a `Threshold` order value of 2150.99:

SOAP request for user-defined function method, GetTotalOrdersByNumber

```
<?xml version="1.0" encoding="utf-8" ?>
<soap:Envelope namespaces defined here...>
  <soap:Header>
    <CustomerOrderID xmlns="urn:OrderSvc:CustomerOrder">
         <UUID>2e62cab6b81150d5:167f64e:f295e997b0:-8000;
               <OrderInfo|PX-000002|PO>;G1Vc/vmohvLnwxQQXwA6Cg==</UUID>
    </CustomerOrderID>
  </soap:Header>
  <soap:Body>
    <GetTotalOrdersByNumber xmlns="OrderSvc:CustomerOrder">
      <Threshold>2150.99</Threshold>
    </GetTotalOrdersByNumber>
  </soap:Body>
</soap:Envelope>
```

Note the object ID for the ProcObject, `CustomerOrder`, sent to make the request on a method of the ProcObject.

This is the SOAP response returning a function value of `5`, which is the total number of orders that satisfy the specified order `Threshold` value:

SOAP response from calling the GetTotalOrdersByNumber method

```
<?xml version="1.0" encoding="UTF-8" ?>
<soap:Envelope namespaces defined here...>
  <soap:Body>
    <GetTotalOrdersByNumberResponse xmlns="urn:OrderSvc:CustomerOrder">
      <result>5</result>
    </GetTotalOrdersByNumberResponse>
  </soap:Body>
</soap:Envelope>
```

Release an object

When you are finished using any Web service object (except a session-free AppObject), you must invoke the built-in release method to release that object and return its resources for use by other clients.

As with other Open Clients, there is no ABL involved in implementing the release method on an Open Client object. However, for Web services, the operation is an object method is required by the WSA.

This is a VB.NET declaration for the AppObject release methods:

VB.NET prototype for a Release_Object method

```
Public Sub Release_OrderInfo( )
Public Sub Release_CustomerOrder( )
```

Although these methods take no parameters, you must remember to send the object ID for the object you are releasing in the SOAP header of the release request message. How you handle the SOAP header and object ID depends on your client type. For some clients, such as .NET, this process is automated. For other clients, such as ABL and Java, you need to create the code to handle this yourself. For more information on handling SOAP headers and object IDs, see Handling SOAP Message Headers in ABL and Develop a Java Client to Consume OpenEdge SOAP Web Services.

These are sample calls to the release methods declared for the sample Web service:

VB.NET client code calling methods to release objects

```
custOrder.Release_CustomerOrder( )
webService.Release_OrderInfo( )
```

Note: AppServer connections used by session-free methods are usually returned to the Web service connection pool after the SOAP response message for the release method is returned.

Pass static and dynamic temp-table parameters

The examples in the following topics show how parameters are passed for static and dynamic temp-tables.

Invoke a method with a TABLE parameter

To invoke a method that passes a TABLE parameter, the client application typically must:

- Create rows using the interface object that represents the TABLE row
- Insert the rows in an array that represents the TABLE parameter

This is the ABL prototype for a sample method, `staticTT( )`, that passes a TABLE parameter:

ABL prototype that passes a TABLE parameter

```
/* staticTT.p */

DEFINE INPUT-OUTPUT PARAMETER TABLE FOR ttEmp.
```

This is the declaration for a VB.NET client interface method, `staticTT( )`, which has a TABLE parameter, `ttEmp`, passed as the class, `staticTT_ttEmpRow`:

VB.NET declaration of interface method passing static TEMP-TABLE, ttEmp

```
Public Class staticTT_ttEmpRow    Public Name As String
    Public Number As Integer
End Class

Public Sub staticTT(ByRef ttEmp( ) As staticTT_ttEmpRow)
```

The following client code defines a two row array (`myTempTable`) according to a defined schema (`staticTT_ttEmpRow`), then defines and creates two rows assigned with values. It then initializes the array (as TABLE, `ttEmp`) with the two rows and passes it to the `staticTT( )` interface method, which passes the TABLE to the Web service:

VB.NET client code passing TABLE, ttEmp, to an interface method

```
Dim myTempTable(1) as webService.staticTT_ttEmpRow
Dim myRow1 as webService.staticTT_ttEmpRow =
                              New webService.staticTT_ttEmpRow( )
Dim myRow2 as webService.staticTT_ttEmpRow =
                              New webService.staticTT_ttEmpRow( )

myRow1.Name = "Fred"
myRow1.Number = 1
myRow2.Name = "Barney"
myRow2.Number = 2

myTempTable(0) = myRow1
myTempTable(1) = myRow2

webService.staticTT(myTempTable)
```

The following is a Doc/Lit SOAP message that this call to `staticTT( )` might send:

Doc/Lit SOAP request to pass a TABLE parameter

```
<?xml version="1.0" encoding="utf-8" ?>
  <soap:Envelope namespaces defined here...>
    <soap:Header>
      <EmployeeID xmlns="urn:EmployeeSrvc:Employee">
        <UUID>2e62cab6b81150d5:-1380e8e:f27fb934f4:
        -8000;<Employee|PX-000004|AO>;5REiR9inxXQi4s6ghRWkfg==</UUID>
      </EmployeeID>
    </soap:Header>
    <soap:Body>
      <staticTT xmlns="urn:EmployeeSrvc:Employee">
        <ttEmp>
          <ttEmpRow>
            <Name>Fred</Name>
            <Number>1</Number>
          </ttEmpRow>
          <ttEmpRow>
            <Name>Barney</Name>
            <Number>2</Number>
          </ttEmpRow>
        </ttEmp>
      </staticTT>
    </soap:Body>
  </soap:Envelope>
```

Note: The `staticTT( )` method must send the object ID for the `Employee` AppObject in the SOAP request header because `staticTT( )` is a method on the session-managed AppObject.

As a point of comparison, the following is a RPC/Encoded SOAP message that this call to `staticTT( )` might send:

RPC/Encoded SOAP request to pass a TABLE parameter

```
<?xml version="1.0" encoding="utf-8" ?>
<soap:Envelope namespaces defined here...>
  <soap:Header>
    <q1:EmployeeID id="h_id1" xmlns:q1="urn:EmployeeSrvc:Employee">
      <UUID xsi:type="xsd:string">2e62cab6b81150d5:-1380e8e:f27fb934f4:
      -8000;<Employee|PX-000004|AO>;5REiR9inxXQi4s6ghRWkfg==</UUID>
    </q1:EmployeeID>
  </soap:Header>
  <soap:Body soap:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/">
    <q1:staticTT xmlns:q1="urn:EmployeeSrvc:Employee">
      <ttEmp href="#id1" />
    </q1:staticTT>
    <soapenc:Array id="id1" xmlns:q2="urn:EmployeeSrvc:Employee"
          soapenc:arrayType="q2:staticTT_ttEmpRow[2]">
      <Item href="#id2" />
      <Item href="#id3" />
    </soapenc:Array>
    <q3:staticTT_ttEmpRow id="id2" xsi:type="q3:staticTT_ttEmpRow"
          xmlns:q3="urn:EmployeeSrvc:Employee">
      <Name xsi:type="xsd:string">Fred</Name>
      <Number xsi:type="xsd:int">1</Number>
    </q3:staticTT_ttEmpRow>
     <q4:staticTT_ttEmpRow id="id3" xsi:type="q4:staticTT_ttEmpRow"
          xmlns:q4="urn:EmployeeSrvc:Employee">
      <Name xsi:type="xsd:string">Barney</Name>
      <Number xsi:type="xsd:int">2</Number>
    </q4:staticTT_ttEmpRow>
  </soap:Body>
</soap:Envelope>
```

Note: The `staticTT( )` method must send the object ID for the `Employee` AppObject in the SOAP request header because `staticTT( )` is a method on the session-managed AppObject.

Invoke a method with a TABLE-HANDLE parameter

To invoke a method that passes a `TABLE-HANDLE` parameter:

- The client application must create and send an XML Schema along with the data to fully describe the dynamic temp-table in the SOAP request message. The `TABLE-HANDLE` parameter in a SOAP request or response consists of an XML `<DataSet>` element containing two child elements:
  - An XML Schema element, `<schema>`, representing the schema for the `TABLE-HANDLE`
  - An XML representation of data using an element, `<Data>`, with each row represented as a sub-element, `<Item>`
- A non-ABL client application must parse the XML Schema and data from the SOAP response message to make the `TABLE-HANDLE` accessible as native data within the application.

This is the ABL prototype for a sample method, `dynttIO( )`, that passes a `TABLE-HANDLE` parameter:

ABL prototype that passes a TABLE-HANDLE parameter

```
/* dynttIO.p */

DEFINE INPUT-OUTPUT PARAMETER TABLE-HANDLE ttHandle.
```

This is the declaration for a VB.NET client interface method (dynTTIO( )) which has a TABLE-HANDLE parameter, ttHandle, as a VB.NET object:

VB.NET declaration of interface method passing TABLE-HANDLE, ttHandle

```
Public Sub dynttIO(ByRef ttHandle As Object)
```

The following VB.NET client code passes the dyntt object representing a TABLE-HANDLE to the dynttIO( ) method:

VB.NET client code passing TABLE-HANDLE, ttHandle, to interface method

```
Dim dyntt as Object

'... Code to build up the dyntt Object (XML Schema and data)

webService.dynttIO(dyntt)
```

For more information on how you might manage TABLE-HANDLE parameters in VB.NET, see the topic Developing a .NET Client to Consume OpenEdge SOAP Web Services. For Java, see the topic Develop a Java Client to Consume OpenEdge SOAP Web Services.

This is the structure of the Doc/Lit SOAP request message that the sample dynttIO method sends to pass a dynamic temp-table that you create for the ttHandle TABLE-HANDLE parameter:

Doc/Lit SOAP request for TABLE-HANDLE, ttHandle

```
<?xml version="1.0" encoding="utf-8" ?>
<soap:Envelope namespaces defined here...>
  <soap:Header .../>
  <soap:Body>
    <dynttIO xmlns="urn:DynTTSrvc:DynTT">
      <ttHandle>
        <DataSet xmlns="">
          <schema>
            <!-- Schema definition goes here -->
          </schema>
          <Data>
            <!-- Data goes here -->
          </Data>
        </DataSet>
      </ttHandle>
    </dynttIO>
  </soap:Body>
</soap:Envelope>
```

The ttHandle TABLE-HANDLE parameter becomes an XML <ttHandle> element containing the <DataSet> element that contains the schema and the data.

Note: Not shown is any required object ID that must be sent in the SOAP header for the object on which dynttIO( ) is invoked.

This is a sample XML Schema created by VB.NET for the TABLE-HANDLE contained by the sample <DataSet> element in the sample Doc/Lit SOAP request:

TABLE-HANDLE <schema> element for an Doc/Lit SOAP request

```
<xs:schema id="Data" xmlns=""
           xmlns:xs="http://www.w3.org/2001/XMLSchema"
           xmlns:msdata="urn:schemas-microsoft-com:xml-msdata">
  <xs:element name="Data" msdata:IsDataSet="true">
    <xs:complexType>
      <xs:choice maxOccurs="unbounded">
        <xs:element name="Item">
          <xs:complexType>
            <xs:sequence>
              <xs:element name="Name" type="xs:string" minOccurs="0"/>
              <xs:element name="Number" type="xs:int" minOccurs="0"/>
            </xs:sequence>
          </xs:complexType>
        </xs:element>
      </xs:choice>
    </xs:complexType>
  </xs:element>
</xs:schema>
```

Note the definition of the <Data> element containing the data for the table, and how the column type information is specified within the <Item> element.

This is a sample <Data> element you would create to accompany the specified schema in the sample Doc/Lit SOAP request, including the column values for the two rows initialized in the sample VB.NET code:

TABLE-HANDLE <Data> element for an Doc/Lit SOAP request

```
<Data>
  <Item>
    <Name>Fred</Name>
    <Number>1</Number>
  </Item>
  <Item>
    <Name>Barney</Name>
    <Number>2</Number>
  </Item>
</Data>
```

Process a SOAP fault message

The following sample SOAP fault shows the response to a request sent for an object (OrderInfo) of a disabled Web service:

Sample SOAP fault for disabled Web service

```
<?xml version="1.0" encoding="UTF-8" ?>
<soap:Envelope namespaces defined here…>
  <soap:Body>
    <soap:Fault>
      <faultcode>SOAP-ENV:Server</faultcode>
      <faultstring>An error was detected ... request. (10893) </faultstring>
      <detail>
        <FaultDetail ... >
          <errorMessage>The urn:OrderSvc:OrderInfo service is unavailable
                        (10921)</errorMessage>
          <requestID> 2e62cab6b81150d5:-17c6a3c:f1dffbd11b:-8000#1f
          </requestID>
        </FaultDetail>
      </detail>
    </soap:Fault>
  </soap:Body>
</soap:Envelope>
```

Caution: When exiting the program in response to a SOAP fault, you must release all Web service objects you created in the program.

Note: SOAP fault messages conform to SOAP 1.1.

The contents of the highlighted SOAP elements include some of the key components of the fault message, containing such error information as a general error code (`<faultcode>`) and message (`<faultstring>`). These elements are followed by more detailed information, including the message indicating a more precise cause for the error (`<errorMessage>`), and a unique identifier for the request that returned the error (`<requestID>`). The contents of the `<detail>` element is defined in the WSDL `Types` section. For more information on handling errors, including SOAP fault messages generated for WSA-managed Web services, see Test and debug OpenEdge SOAP Web Services on page 165.

Pass static and dynamic ProDataSet parameters

The examples in the following topics show how parameters are passed for static and dynamic ProDataSets.

These examples rely on the sample Web service specifications shown in the following table.

Property or component	Value or name	Object type
Web service	`CustOrders`	–
URL	`http://servicehost:80/wsa/wsa1`	–
Session model	Session-Free	–
SOAP format	`Doc/Lit`	–
TargetNamespace	`urn:CustOrders`	–

Property or component	Value or name	Object type
WSDL objects	`CustOrdersObj`	AppObject
	`dsCustOrd`	ProDataSet dsCustOrd

Note: Examples in the following topics do not continue the previous examples. They use C#.NET, rather than VB.NET.

Invoke a method with a DATASET parameter

To invoke a method that passes a `DATASET` parameter, the client application typically must:

- Create rows using the interface object that represents the `TABLE` row
- Insert the rows in arrays that represent the constituent temp-tables in the ProDataSet

For example, the following snippet of code passes a ProDataSet parameter represents and operation in the Web service:

getCustOrders.p

```
/* getCustOrders.p */
DEFINE TEMP-TABLE ttCust NO-UNDO
    FIELD CustNum AS INTEGER
    FIELD Name AS CHARACTER
    INDEX CustNumIdx IS UNIQUE PRIMARY CustNum.

DEFINE TEMP-TABLE ttOrder NO-UNDO
    FIELD OrderNum AS INTEGER
    FIELD CustNum AS INTEGER
    INDEX OrderNumIdx IS UNIQUE PRIMARY OrderNum
    INDEX CustOrdIdx IS UNIQUE CustNum OrderNum.
```

```
DEFINE TEMP-TABLE ttOrderLine NO-UNDO
    FIELD OrderNum AS INTEGER
    FIELD LineNum AS INTEGER
    INDEX OrderLineIdx IS UNIQUE PRIMARY OrderNum LineNum.

DEFINE DATASET dsCustOrd FOR ttCust, ttOrder, ttOrderLine
    DATA-RELATION CustOrdRel FOR ttCust, ttOrder
        RELATION-FIELDS (CustNum, CustNum)
    DATA-RELATION OrdLinesRel FOR ttOrder, ttOrderLine
        RELATION-FIELDS (OrderNum, OrderNum) NESTED.

DEFINE INPUT PARAMETER iCustNum AS INTEGER.
DEFINE OUTPUT PARAMETER DATASET FOR dsCustOrd.
/* fill dataset and return to caller */
...
```

When you add a Web Reference for the `CustOrders` Web service to Microsoft® Visual Studio, it creates the following proxies in a `References` file for the `getCustOrders` operation:

Sample C#.NET proxy code for getCustOrders

```
public string getCustOrders(
       System.Nullable<int> iCustNum, out dsCustOrd dsCustOrd)
  {
    object[] results = this.Invoke("getCustOrders", new object[] {
      iCustNum});
    dsCustOrd = ((dsCustOrd)(results[1]));
    return ((string)(results[0]));
  }

...

public partial class dsCustOrd {
    private dsCustOrdTtCust[] ttCustField;
    private dsCustOrdTtOrder[] ttOrderField;
    ...
}

...

public partial class dsCustOrdTtCust {
    private System.Nullable<int> custNumField;
    private string nameField;
    ...
}

...

public partial class dsCustOrdTtOrder {
    private System.Nullable<int> orderNumField;
    private System.Nullable<int> custNumField;
   <!-- nested data relation with ttOrderLine -->
   private dsCustOrdTtOrderTtOrderLine[] ttOrderLineField;
    ...
}

...
```

```
public partial class dsCustOrdTtOrderTtOrderLine {
    private System.Nullable<int> orderNumField;
    private System.Nullable<int> lineNumField;
    ...
}
```

When you reference the Web service in your code, Microsoft Visual Studio offers these proxy objects as appropriate. You can then create code to access the ProDataSet parameter like the following:

Sample C#.NET application for getCustOrders operation

```
using System;
using System.Collections.Generic;
using System.Text;
using System.IO;

namespace getCustOrders
{  class Program
  {
    static void Main(string[] args)
    {
      int iCustNum;
      wsCustOrders.CustOrdersService ws = new
                                          wsCustOrders.CustOrdersService();
      wsCustOrders.dsCustOrd dsCustOrd;
      iCustNum = 1;
      ws.getCustOrders(iCustNum, out dsCustOrd);

      FileStream fs = new FileStream("getCustOrder.out", FileMode.Create);
      StreamWriter w = new StreamWriter(fs);

      //temp-table ttCust
      for (int i = 0; i < dsCustOrd.ttCust.Length; i++)
      {
         w.Write(dsCustOrd.ttCust[i].CustNum);
         w.Write(dsCustOrd.ttCust[i].Name);
         w.WriteLine();
      }
      //temp-table ttOrder
      for (int i = 0; i < dsCustOrd.ttOrder.Length; i++)
      {
        w.Write(dsCustOrd.ttOrder[i].CustNum);
        w.Write(dsCustOrd.ttOrder[i].OrderNum);
        w.WriteLine();
        //nested temp-table ttOrderLine
        for (int j = 0; j < dsCustOrd.ttOrder[i].ttOrderLine.Length; j++)
          {
             w.Write(dsCustOrd.ttOrder[i].ttOrderLine[j].LineNum);
             w.Write(dsCustOrd.ttOrder[i].ttOrderLine[j].OrderNum);
          }
        }
        w.Close();
      }
  }
}
```

Note: Because .NET has a proprietary method of recognizing and exposing ADO .NET DataSets in WSDL documents, its toolkit cannot translate the WSDL definition of a ProDataSet directly into an ADO .NET DataSet. For an example of creating an ADO .NET DataSet from a ProDataSet parameter, see Creating .NET DataSets from ProDataSet parameters.

Invoke a method with a DATASET-HANDLE parameter

To invoke a method that passes a `DATASET-HANDLE` parameter:

- The client application must create and send an XML Schema along with the data to fully describe the dynamic temp-table in the SOAP request message. The `DATASET-HANDLE` parameter in a SOAP request or response consists of an XML element containing two child elements:
  - An XML schema element representing the schema for the `DATASET-HANDLE`

    - An XML representation of data, using a data element with child elements representing individual rows for each constituent temp-table

- The client application must parse the XML Schema and data from the SOAP response message to make the DATASET-HANDLE accessible as native data within the application.

For example, the following snippet of code is from a procedure that passes a dynamic ProDataSet parameter:

```
/* getDynDs.p */
DEFINE INPUT PARAMETER criteria as CHARACTER.
DEFINE OUTPUT PARAMETER DATASET-HANDLE hDset.

/* Create dataset based on criteria
** fill dataset and return to caller */
. . .
```

When you add a Web Reference for the Web service to Microsoft® Visual Studio, it creates the following proxies in a References file for the getDynDS operation:

Sample C#.NET proxy code for getDynDs

```
public string getDynDs(
   string criteria,
   out DataSetHandleParam hDset) {
      object[] results = this.Invoke("getDynDs", new object[] {
         criteria});
      hDset = ((DataSetHandleParam)(results[1]));
      return ((string)(results[0]));
}
. . .

public partial class DataSetHandleParam {
   private System.Xml.XmlElement[] anyField;
. . .
}
```

When you reference the Web service in your code, Microsoft Visual Studio offers these proxy objects as appropriate. You can then create code to access the ProDataSet parameter like the following:

Sample C#.NET code for invoking getDynDs

```
sampleDynDS.sampleDynDSService mySvc = new sampleDynDS.sampleDynDSService();
sampleDynDS.DataSetHandleParam dsh;

mySvc.getDynDs(textBox1.Text, out dsh);
```

10

Test and debug OpenEdge SOAP Web Services

The following topics explain how to test and debug OpenEdge Web services. It assumes you are familiar with Web services and the Web Services tools in OpenEdge, as described in preceding topics. The information in the following topics is useful for both Web service and client developers to troubleshoot OpenEdge Web services and client applications that access them.

For details, see the following topics:

- Test the ABL application as a Web service
- Error information levels
- Identifying relevant log files
- SOAP faults
- Use a SOAP message viewer
- Identify errors
- Sample error scenarios

Test the ABL application as a Web service

You can generally use two different approaches for testing an ABL application written to support an OpenEdge Web service:

- **Unit testing from ABL** — From ABL, you can access the server-side functionality directly or as an OpenEdge Web service.
- **Testing from a Web service client** — From a Web service client using any platform, including ABL, you can thoroughly test the Web service as it might behave in the environment in which you will deploy it.

The approach that you take depends on your preferences, needs, and experience.

Unit testing from ABL

Accessing the ABL application's server-side functionality directly is useful for doing unit testing without having to bother with the overhead and inconvenience of managing the Web service deployment environment. This form of testing also eliminates some of the ABL logic required to access a Web service. However, it can provide a good measure of confidence in the basic integrity of the application service itself.

Testing from a Web services client

This method allows you to create a client application environment and functionality exactly as you expect real Web service clients to be created, and you can test the application end-to-end using a complete Web service testing infrastructure.

The rapid prototyping capability of ABL can also make it a convenient platform to test the application service as a Web service, depending on the requirements of the Web service. Some client platforms might handle certain types of Web service interaction more easily than others. However, especially where ABL most easily handles a particular Web service application feature, modifying an existing ABL unit test bed to access the AppServer as a Web service is a natural next step in testing Web service functionality.

Otherwise, especially if you expect your primary client base to use another platform, you might want to test on that platform to fully understand what users of that platform need to do in order to use the Web service that you plan to deploy.

To test from a Web services client:

1. Configure the AppServer to support the required application session model:
   - For information on configuring the session-managed operating modes, see *OpenEdge Application Server: Developing AppServer Applications* and the *OpenEdge Management and OpenEdge Explorer* online help.
   - For information on configuring the state-free operating mode (session-free model) see the *OpenEdge Management or OpenEdge Explorer* online help.
2. Define the Web service and generate the Web service mapping (WSM) file using ProxyGen. For more information, see *OpenEdge Development: Open Client Introduction and Programming.*
3. Generate a test WSDL file from ProxyGen when you generate the WSM file, or deploy the WSM file to a WSA instance to obtain a deployed WSDL file. For more information on deploying a Web service, see the sections on deploying and managing Web services in *OpenEdge Application Server: Administration.*
4. Write the test client application, using the WSDL file to help generate client interfaces or to manually write the code to invoke Web service requests. For more information, see Creating OpenEdge SOAP Web services. For information on building an ABL client to access your Web service, see Creating ABL clients to consume SOAP Web services.
5. Once you have an executable test client, ensure that the AppServer and WSA are running, and the WSA instance where you deployed the Web service is enabled to allow client access to the Web service. For more information on running and enabling the WSA for Web service client access, see the sections on working with the WSA and deploying Web services in *OpenEdge Application Server: Administration.*
6. Begin testing the client.

Error information levels

To make it easier to diagnose errors, you can control the amount of information provided for the following sources of Web service error information:

- WSA log file
- Web service SOAP fault response messages
- AdminService log file
- PAS for OpenEdge log file
- NameServer log file

For information on managing logging for the AdminService, NameServer, and in general for all OpenEdge servers managed by the Unified Explorer Framework, see *OpenEdge Getting Started: Installation and Configuration*. For more information on managing logging for an AppServer, see *OpenEdge Application Server: Administration*. The following topics describe how to control logging and SOAP fault information output for the WSA and Web services.

WSA and Web service logging level properties

The following table shows the property files where these settings occur and the default installation settings for basic properties that affect output for each of these information sources.

Table 22: Setting error levels for WSA and Web services

Affected error output	Property files	Default property setting
WSA log file	`ubroker.properties` (WSA properties)	`loggingLevel=2`
	`*.props` (Web service properties)	`serviceLoggingLevel=2`
SOAP fault response messages	`*.props` (Web service properties)	`serviceFaultLevel=2`

Note: For complete information on the log file settings for the WSA log file, including more advanced logging properties, see the OpenEdge Management or OpenEdge Explorer online help and the `unbroker.properties.README` file in the `properties` directory under the OpenEdge installation directory.

Logging information

The properties in Table 22: Setting error levels for WSA and Web services on page 167 have the following functions and value ranges (the greater the value, the more information is provided):

- **`loggingLevel`** — Affects information logged for a single WSA instance. Set this property to change the logging detail for WSA administration, WSDL document retrieval, user authorization, and HTTP request handling. Valid values range between 1 and 4.

- **`serviceLoggingLevel`** — Affects information logged for a single deployed Web service. Set this property to change the logging detail for the processing of a Web service client request. Valid values range between 1 and 4.
- **`serviceFaultLevel`** — Affects the information returned in all SOAP faults from a single deployed Web service. Set this property to change the level of detail returned for client exceptions. Valid values are 2 or 3.

Hints for setting the WSA loggingLevel property

Set the `loggingLevel` property for the WSA instance to the following value:

- **3** — To get information about user authorization errors or to log the start of a new client request for any Web service deployed to this WSA instance.
- **4** — To get detailed information about WSA startup parameters.

Hints for setting the Web service serviceLoggingLevel property

Set the `serviceLoggingLevel` property for the Web service to the following value:

- **4** — To record Web service request parameter values.
- **3** — To track Web service request execution. Use this value during Web service development to provide more information for each Web service request error.
- **2** — To reduce logging overhead when the Web service is running in production. This value only allows severe errors to be recorded that affect the Web service as a whole, and no errors to be recorded for single Web service requests.

During production run time, you might temporarily set the value to 3 or 4 when working with a specific client to resolve an error, then return the logging level to 2 for general client access when the problem has been resolved.

Set logging level properties

Settings to the `serviceLoggingLevel` and `serviceFaultLevel` take effect immediately at run time. You can also set an immediate run-time value for the WSA `loggingLevel` property, as well as a persistent value that takes affect the next time the WSA is started.

To change these settings, use OpenEdge Management or OpenEdge Explorer or the `wsaman` utility. If you are working with a WSA installation on a system that does not have an AdminServer installed, you must edit the `ubroker.properties` file to change the persistent value of `loggingLevel` property.

For more information on setting these logging level properties and their appropriate values using OpenEdge Management and OpenEdge Explorer, see the online help. You can also set the `loggingLevel` property If you are using the `wsaman` utility, see the topics on the `wsaman` utility in *OpenEdge Application Server: Administration*. For more information on the `serviceLoggingLevel` and `serviceFaultLevel` properties, see the Web service properties reference sections of *OpenEdge Application Server: Administration.*

For complete information on OpenEdge general logging capabilities, see *OpenEdge Development: Debugging and Troubleshooting.*

For more information on using log files, see Identifying relevant log files on page 169. For more information on handling SOAP faults, see SOAP faults on page 169.

Identifying relevant log files

A common way to detect software errors of all kinds, not just Web service errors, is to examine log files for error messages. The following table lists OpenEdge log files providing Web-service-related messages. These files all reside in your OpenEdge work directory.

Table 23: OpenEdge log files providing Web service-related messages

This component . . .	Logs messages here . . .
WSA instance	*instance-name*.wsa.log
Web service	*instance-name*.wsa.log
AdminServer	adminserv.log
AppServer	*instance-name*.broker.log*instance-name*.server.log
NameServer	*instance-name*.NS.log

For information on managing logging for the AdminService, NameServer, and in general for all OpenEdge servers managed by the Unified Explorer Framework, see *OpenEdge Getting Started: Installation and Configuration*. For more information on managing logging for an AppServer, see *OpenEdge Application Server: Developing AppServer Applications.*

SOAP faults

When an error occurs while processing a Web service client request, the WSA generates a SOAP fault message and returns it to the client application. The client application should catch all SOAP faults and handle them programmatically, perhaps by displaying an error message to the user or by logging the fault information for review off line. If the client application does not catch the SOAP fault, the behavior of the client application depends on the default error handling of the client software development kit.

Set the serviceFaultLevel property

You can control the amount of information provided with SOAP fault messages by how you set the `serviceFaultLevel` property for a Web service. Any change in value takes effect immediately at run time.

Set the `serviceFaultLevel` property to the following value:

- **2** — To log general error information in a production environment
- **3** — To log error information in a development environment or in a production environment where more detailed information is required

Note that all Web service logging and fault levels are controlled individually for each Web service to further reduce processing overhead. For more information on setting this property, see Error information levels on page 167.

Typical SOAP fault response message

The following is the content of a typical SOAP fault response that appears within the body of a WSA-generated SOAP fault message:

```
<soap:Fault>
  <faultcode>SOAP-ENV:Server</faultcode>
  <faultstring>An error was detected … request. (10893) </faultstring>
  <detail>
    <FaultDetail xmlns="http://servicehost:8080/wsa/wsa1">
      <errorMessage>The urn:OrderSvc:OrderInfo service is unavailable (10921)
      </errorMessage>
      <requestID>2e62cab6b81150d5:-17c6a3c:f1dffbd11b:-8000#1f
      </requestID>
    </FaultDetail>
  </detail>
</soap:Fault>
```

Note that SOAP faults can be returned by the client's own SOAP libraries and might have a different XML definition for the contents encapsulated by the `<detail>` element, depending on the Web service client toolkit that is used. However, a SOAP fault generated by the OpenEdge WSA always includes an `<error Message>` and `<requestID>` element within the `<detail>` element section.

WSA's <errorMessage> element

The SOAP `<faultstring>` element provides only a very general description of the error. For the most effective diagnostic detail, always look at the information provided by the `<errorMessage>` element.

WSA's <requestID> element

Use the information provided by the `<requestID>` element when you contact the Web service deployer for assistance with an error. This information tells the Web service deployer whether more information can be obtained from the WSA log file. For more information on how the WSA uses the information in the `<requestID>` element to log information, see How the WSA logs Web service information on page 172.

Handle SOAP faults programmatically

The client application should handle all SOAP faults. Many SOAP client toolkits convert SOAP faults to client exceptions that can be handled in a `try...catch` block. The following code is a VB.NET fragment from the sample applications that are available on the Documentation and Samples (`doc_samples`) directory of the OpenEdge product DVD:

```
Try
   ' Code to access the Web service
   ...
   Catch soapEx As System.Web.Services.Protocols.SoapException
      Dim detail As String, reqId As String
         detail = parseSoapException(soapEx.Detail, reqId)
         MsgBox(detail, MsgBoxStyle.Critical, soapEx.Message)
End Try
```

In this example, `parseSoapException( )` is a client helper function to parse the SOAP fault detail provided in .NET sample code. You can find more examples like this in both the .NET and Java sample client applications. For more information on these sample applications, see Sample SOAP Web service applications.

Use a SOAP message viewer

To view SOAP messages as they are sent and received, use a SOAP message viewer. The following table lists some examples.

This SOAP message viewer . . .	Is . . .
WSAViewer	Provided with the OpenEdge installation
ProSOAPView	Provided with the OpenEdge installation
Microsoft SOAP Toolkit	Available for free download from Microsoft's Web site

To use a SOAP message viewer:

1. Change the Web service client to send requests to the port of the SOAP message viewer by changing the SOAP end point's URL host and port fields.
2. Configure the SOAP message viewer to forward requests to the host and port of the WSA, where the Web service is deployed, and run the viewer.

Configure and run WSAViewer

To configure and run WSAViewer:

1. Enter the `wsaviewer` command from a Proenv shell using the following syntax:

```
wsaviewer listen-portWSA-hostWSA-port
```

2. Change the Web service URL in the Web service client to access the WSAViewer. Assume that the original Web service URL in the client is as follows:

```
http://bedrockquarry.com:8080/wsa/wsa1
```

   In the client, change this URL to use an agreed-upon viewer listening port:

```
http://bedrockquarry.com:8081/wsa/wsa1
```

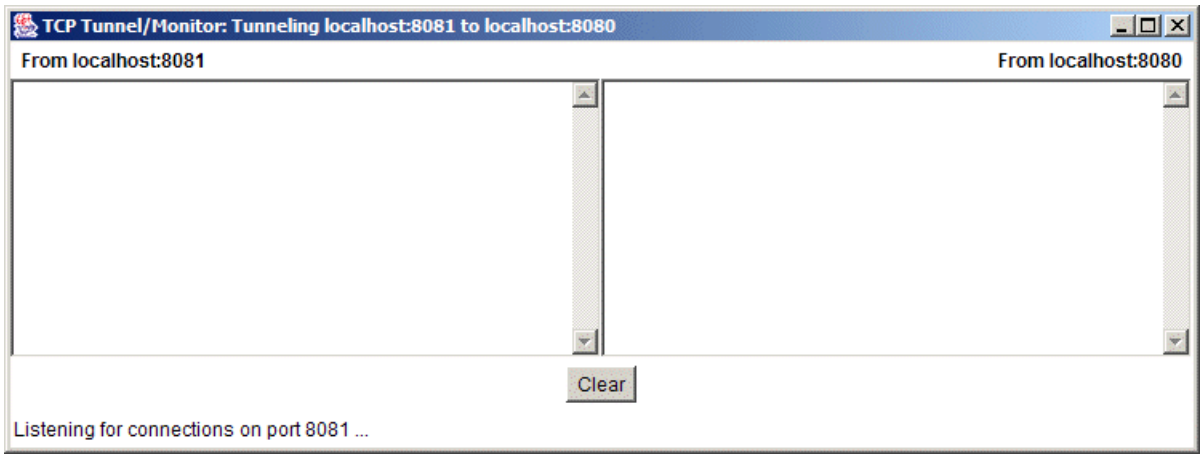
3. To run the WSAViewer, enter this command in the Proenv shell on the WSA machine:

```
wsaviewer 8081localhost8080
```

The WSAViewer runs configured to listen for requests from the reconfigured client interface on port 8081 and forward those requests to port 8080. SOAP responses from the WSA, then, move in the reverse direction.

The following figure shows the main window of the WSAViewer when it first opens.

Figure 6: WSAViewer main window



SOAP requests from the client appear in the left-hand viewer and SOAP responses from the WSA forwarded back to the client appear in the right-hand viewer. A continuous stream of requests and responses is recorded that you can review by using the vertical scroll bars.

ProSOAPView is more general purpose than WSAViewer, and it allows you to trace not only SOAP messages, but also HTTP messages and other document contents exchanged between a client and server. ProSOAPView works as both an HTTP proxy server and an HTTP client that can connect to your choice of another proxy server or the final destination.

Identify errors

The following topics describe how to identify errors and describes some of the more common errors that occur in WSA administration requests and in Web service application requests.

How the WSA logs Web service information

Each time the WSA starts up, each WSA instance receives a unique, alphanumeric identifier (*WSA ID*), which the WSA always places in a log file entry that indicates the WSA is starting up. This WSA ID appears in the log file similar to this example, always appearing after the `"ID"`:

```
ID 2bbafbc35852308b:7a8a02:f18e8ee918:-8000
```

When a WSA instance first receives a request for one of its deployed Web services, the WSA instance assigns the request an alphanumeric identifier (*request ID*) that is unique for the current session of the WSA instance. When the WSA logs information about a Web service request, whether the information concerns processing steps or errors, the WSA always includes its unique request ID in the log entry text using the following format, where *`reqid-value`* is the request ID for the Web service request to which the log entry applies:

```
(reqid:reqid-value)
```

When the WSA returns a SOAP fault to a client, it includes the request ID of the Web service request that triggered the SOAP fault, as well as the WSA ID of the WSA instance where the Web service is deployed. The WSA places these two IDs within the `<requestID>` element of the SOAP fault message according to the following format, where *`wsaid-value`* is the WSA ID and *`reqid-value`* is the request ID:

```
wsaid-value#reqid-value
```

The client can then obtain these two IDs from the `<requestID>` element of the SOAP fault and provide it to the WSA host operator to look up more detailed information in the corresponding entries of the WSA log file. The WSA operator then uses the WSA ID to locate the WSA log file for the corresponding WSA instance. They can now open the log file and search for log file entries that contain the "`(reqid:`*`reqid-value`*`)`" string to find all information related to the specific request and WSA instance.

Errors occurring in WSA administration requests

An error might occur in a WSA administration request. Such errors occur when you use OpenEdge Management or OpenEdge Explorer or the `wsaman` utility. Both these tools are front ends to the AdminServer, which creates SOAP requests as a Web service client, then sends them to the WSA. When an error in a WSA administration request occurs, it is logged. Where it is logged depends on when it occurred, as shown in the following table.

If the error occurred . . .	The error is logged . . .
While the request is being prepared in the AdminServer	In the AdminServer log
While the request is being processed in the WSA	In the WSA instance log

Errors occurring in Web service application requests

A Web service application request is initiated by a client, which creates a SOAP message and sends it to the WSA. The WSA processes the SOAP message, creates a response, and sends the response back to the client. An error can occur on the client side or the server side.

Client-side errors

A client-side error occurs before the request is sent or while it is being processed by the WSA.

An example of an error occurring before the request is sent is a mismatch in interface parameters. For these types of errors, the type of client response depends on the client platform.

Examples of errors occurring while the request is being sent (which involve a session-managed connection) include:

- Forgetting to call the connect method first
- Not sending the correct Object ID in the SOAP header
- Web server not running
- Web service URL incorrectly specified (host or port)
- Network down
- Using HTTP instead of HTTPS when required

These types of errors result in a SOAP fault response and log file entries.

Server-side errors

A server-side error occurs while the request is being processed by the WSA and the error is not related to the contents of the SOAP request. Examples of server-side errors include:

- Forgetting to enable a specific deployed Web service
- Forgetting to enable client access to Web services for the WSA instance
- Configuring or starting an PAS for OpenEdge instance incorrectly—this might involve one or more of the following issues:
  - Invalid Propath
  - Invalid AppService (Application Service name)
  - Missing ABL, or an incorrect version of ABL
- Configuring the Java Servlet Engine (JSE) incorrectly so it does not recognize the WSA

These types of errors result in a SOAP fault response and log file entries.

Sample error scenarios

This section discusses sample error scenarios. These scenarios involve a VB.NET client accessing a Web service whose specification is listed in the following table.

Web service specification	Value
Name	`OrderInfo`
TargetNamespace	`urn:www-progress-com:samples:Orderinfo`
AppObject	`OrderInfo`
ProcObject	`CustomerOrder`
Session Model	`Managed`

Note: These sample scenarios are not necessarily based on the samples available on the Documentation and Samples (`doc_samples`) directory of the OpenEdge product DVD or the Progress Documentation Web site.

Scenario 1: Web service deployed but not enabled

In this scenario, a Web service is deployed but not enabled. At this point:

1. The client sends the following connection request:

```
Connect_OrderInfo("","","")
```

2. The WSA gets the request and determines the Web service is disabled. At this point:

   a. The WSA sends the client a SOAP response containing a SOAP fault.

   b. The log files do not show any error.

   The following is the SOAP response containing the SOAP fault:

```
<?xml version="1.0" encoding="UTF-8" ?>
<soap:Envelope  namespaces defined here…>
  <soap:Body>
    <soap:Fault>
      <faultcode>SOAP-ENV:Server</faultcode>
      <faultstring>An error was detected … request. (10893)
      </faultstring>
      <detail>
        <FaultDetail xmlns="http://servicehost:8080/wsa/wsa1">
          <errorMessage>The urn:www-progress-com:samples:OrderInfo
                        :OrderInfo service is unavailable (10921)
          </errorMessage>
          <requestID>2e62cab6b81150d5:-17c6a3c:f1dffbd11b:-8000#1f
          </requestID>
        </FaultDetail>
      </detail>
    </soap:Fault>
  </soap:Body>
</soap:Envelope>
```

3. The interface translates the SOAP fault into a SOAP exception.
4. The client code catches the SOAP exception.
5. The client displays the following error message (assuming the client application has a user interface):



Note: All client applications should always catch SOAP faults and handle them. For client applications without a user interface, all error information must be written to an application log file to ensure it is not lost. If a .NET client does not do this, the .NET Framework's default exception handler displays the SOAP fault general error information. This might well hide and cause the loss of the more useful error detail information in the SOAP fault.

Scenario 2: ABL updated, but Web service not redeployed

In this scenario, ABL is updated with a different procedure prototype (signature), but the Web service is not updated accordingly. At this point:

1. The client sends the following method request:

```
FindCustomerByNum(3, custNameVar)
```

2. The WSA gets the request and asks the server to run the procedure `FindCustomerByNum.p`.
3. The server:
   a. Tries to run `FindCustomerByNum.p`
   b. Detects a parameter-type mismatch and records the following error message in its log, `*.server.log`:

```
[02/12/11@16:07:01.427-0500] P-000371 T-000370 0 AS --
  Mismatched parameter types passed to procedure   OrderInfo/FindCustomerByNum.p.
 (3230)
```

   c. Returns the error to the WSA
4. The WSA:
   a. Records the following message in its log:

```
[02/12/11@16:07:01.802-0500] P-000120 T-Thread-11 2 OrderInfo ABL-Provider
(reqid:6) Error in SOAP request execution: ABL
ERROR condition: Mismatched parameter types passed to
procedure OrderInfo/FindCustomerByNum.p. (3230) (7211) (10926)
```

   b. Sends the following SOAP containing a SOAP fault back to the client:

```
<?xml version="1.0" encoding="UTF-8" ?>
<soap:Envelope  namespaces defined here…>
  <soap:Body>
    <soap:Fault>
      <faultcode>SOAP-ENV:Server</faultcode>
      <faultstring>An error was detected … request. (10893)
      </faultstring>
      <detail>
        <FaultDetail xmlns="http://servicehost:8080/wsa/wsa1">
          <errorMessage>Error in SOAP request execution: ABL ERROR
            condition: Mismatched parameter types passed to
            procedure OrderInfo/FindCustomerByNum.p.  … (10926)
          </errorMessage>
          <requestID>2e62cab6b81150d5:-87f76e:f20f57227d:-8000#6
          </requestID>
        </FaultDetail>
      </detail>
    </soap:Fault>
  </soap:Body>
</soap:Envelope>
```

Note: This example uses a value of 3 for the `serviceFaultLevel` property.

Notice the correspondence between the `"(reqid:6)"` string in the log file entry and the `"<requestID>...2e62...#6"` string in the SOAP fault message, indicating information for the same request.

5. The interface translates the SOAP fault into a SOAP exception.
6. The client catches the SOAP exception.
7. The client displays the following error message (assuming the client application has a user interface):



Scenario 3: Web service deployed but the server is not running

In this scenario, a Web service is deployed, but its server is not running. At this point:

1. The client sends the following connection request:

```
Connect_Orderinfo("", "", ")
```

2. The WSA:
   a. Receives the request
   b. Determines that the server is not available

c. Records the following in its log:

```
[02/12/11@16:17:27.349-0500] P-000120 T-Thread-11 2 OrderInfo ABL-Provider (reqid:8)
 Error in SOAP request execution: Connect Failure: Application Service asbroker1
 Unknown at NameServer
at Host servicehost Port 5162. (8234) (10926)
```

d. Sends a SOAP message with a SOAP fault back to the client. The message is as follows:

```
<?xml version="1.0" encoding="UTF-8" ?>
<soap:Envelope  namespaces defined here…>
  <soap:Body>
    <soap:Fault>
      <faultcode>SOAP-ENV:Server</faultcode>
      <faultstring>An error was detected … request. (10893)
      </faultstring>
      <detail>
        <FaultDetail xmlns="http://servicehost:8080/wsa/wsa1">
          <errorMessage>Error in SOAP request execution: Connect
            Failure: Application Service asbroker1 Unknown at
            NameServer at Host servicehost Port 5162. (8234) (10926)
          </errorMessage>
          <requestID>2e62cab6b81150d5:-87f76e:f20f57227d:-8000#8
          </requestID>
        </FaultDetail>
      </detail>
    </soap:Fault>
  </soap:Body>
</soap:Envelope>
```

3. The interface translates the SOAP fault into a SOAP exception.
4. The client catches the SOAP exception.
5. The client displays this error message (assuming the client application has a user interface):



IV

Creating ABL Clients to Consume OpenEdge SOAP Web Services

For details, see the following topics:

- Create an ABL Client from WSDL
- Connecting to OpenEdge SOAP Web Services from ABL
- Invoking OpenEdge SOAP Web Service Operations from ABL
- Handling SOAP Message Headers in ABL
- Handling Errors in ABL Requests to OpenEdge SOAP Web Services

11

Create an ABL Client from WSDL

This content describes how to turn WSDL files into the basis for an ABL client that consumes OpenEdge SOAP Web services. This includes understanding how to generate ABL interface documentation from a WSDL file and how OpenEdge maps Web service parameters from the XML Schema types in WSDL to the ABL data types.

For details, see the following topics:

- Basics of an ABL client to consume Web services
- Use the WSDL Analyzer
- Map XML Schema data types to ABL data types

Basics of an ABL client to consume Web services

You have obtained, by one of the methods described in Distributing your WSDL file on page 118, the WSDL file for the Web service that your ABL client will consume. You run the WSDL Analyzer on the file and get pages of sample ABL code. The samples cover all the necessary steps to consume the Web service.

As shown in Consuming SOAP Web service example on page 50, an ABL client does the following to consume a Web service:

1. Connects an ABL server object to the Web service using the `CONNECT( )` method, specifying the location of the WSDL file for run-time access and the name of a port type on the server.
2. Creates a procedure object and associates it with the Web service using the `RUN...SET` syntax.
3. Invokes a Web service operation using the `RUN...IN` syntax, passing in any necessary parameters.
4. Handles any errors or return values.

5. Deletes the procedure object using `DELETE PROCEDURE` when it is no longer needed.
6. Unbinds the Web service from the ABL server object using the `DISCONNECT( )` method when all processing is complete.
7. Deletes the ABL server object using `DELETE OBJECT` when it is no longer needed.

See the *OpenEdge Development: ABL Reference* guide for more information on the methods and statements listed above.

You can find sample code to cover this process in the WSDL Analyzer's output. The connection details Figure 12: WSDL Analyzer port type page (connection details) on page 191 and operation details Figure 13: WSDL Analyzer port type page (operation detail) on page 192 sections of the Port type page provide most of these code samples.

Use the WSDL Analyzer

After you know the location to a WSDL file for a target Web service, use the WSDL Analyzer to provide HTML documentation on the interface to the Web service. The documentation describes the requirements for consuming the Web service using ABL, and includes binding information and ABL prototypes for accessing operations in the Web services. The documentation also includes any internal WSDL comments by the Web service developer to explain elements of the Web service interface. The following sections describe:

- Running the WSDL Analyzer on page 182
- Understanding the WSDL Analyzer output on page 184
- Analyzing wrapped document literal on page 194
- Analyzing complex data on page 195

Running the WSDL Analyzer

To run the WSDL Analyzer, enter the `bprowsdldoc` command on your operating system command line using the following syntax:

```
bprowsdldoc
   [ -h ] | { [ option ] ...wsdl-url-or-filename [ target-directory ] }
```

Note: Use the command window (shell) opened by the `proenv` command tool to enter this command with the correct path settings.

-h

Displays a help message on the usage of this command.

option

Specifies one of the following command options:

```
  -b
| -nohostverify
| -nosessionreuse
| -WSDLUserid username
| -WSDLPassword password
| -proxyhost host
| -proxyport port
| -proxyUserid username
| -proxyPassword password
| -show100style
| -noint64
```

`-b`

Forces documentation of binding names.

`-nohostverify | -nosessionreuse`

Turns off host verification and reuse of session IDs for HTTPS connections.

`-WSDLUserid` *`username`* `| -WSDLPassword` *`password`*

Provides access to a secured WSDL file.

`-proxyhost` *`host`* `| -proxyport` *`port`* `| -proxyUserid` *`username`* `| -proxyPassword` *`password`*

Specifies a proxy for the connection and provides access to a secure proxy.

`-show100style`

Shows procedure and function signatures as documented in the 10.0x releases of OpenEdge. For more information, see Analyzing wrapped document literal on page 194.

`-noint64`

Prior to OpenEdge Version 10.1B, the ABL `INT64` data type did not exist and the WDSL Analyzer mapped XML Schema types of `xsd:long` to the ABL `DECIMAL` data type. Use this option if you want to use the `xsd:long` to ABL `DECIMAL` mapping. Otherwise, `xsd:long` maps to `INT64`. The current version of OpenEdge continues to recognize existing mappings of `xsd:long` to `DECIMAL` as valid whether or not this option is specified.

`wsdl-url-or-filename`

Specifies a URL, Microsoft Uniform Naming Convention (UNC), or local pathname to the WSDL file.

target-directory

Specifies a the target directory where the WSDL Analyzer writes the generated pages. This defaults to the current working directory.

For more information on the `bprowsdldoc` command, see The WSDL Analyzer on page 373.

Understanding the WSDL Analyzer output

The WSDL Analyzer produces hyperlinked HTML pages in the specified target directory. The following sections describe the information for building your ABL client that you can find on each page. All the pages include hyperlinks to the other pages, so you can easily browse through the complete set.

The following table lists the information found on each page of the output.

Table 24: WSDL Analyzer output

Page	Section	Description
Index and Service pages on page 187	WSDL	The document heading followed by any general comments from the WSDL describing the entire WSDL file.
	Location	The URL of the WSDL file. This is always a complete path name (absolute path) to the file.
	Target namespace	The target namespace of the Web service.
	Service-name service	The name of the service followed by any comments included in WSDL `<documentation>` elements about there service.
	Port types (persistent procedures)	A hyperlinked list of the port types defined in the Web service, including any specific comments about them from the WSDL.
	Data types	A hyperlinked list of the complex types defined for the Web service, including any specific comments about them from the WSDL.
Operation index page on page 189	Operation	An index table listing all operations described in the WSDL, including the port type and service for each operation and any specific comments about the operation from the WSDL. The operation names link to the operation detail in the port type page.

Page	Section	Description
Port type page on page 190	Port type (persistent procedure)	The document heading. **Note:** The port type is modelled as a persistent procedure, but is not actually persistent.
	Port-type-name	The defined name of the port type followed by comments in any WSDL `<documentation>` elements that describe the entire port type.
	Summary	Basic connection (binding) information and a list of the operations defined by the port type, including comments in any WSDL `<documentation>` elements on each operation.

Page	Section	Description
Port type page on page 190 (*continued*)	Connection details	Provides information on how to connect to the Web service to use this port type, including the following sections: • **Connection parameters** — ABL syntax for all of the Web service-related parameters that can be included in the connection parameters string passed to the ABL `CONNECT( )` method, and an ABL example of how they might be used. Some of the same startup options used for execution of the WSDL Analyzer also appear in this section, such as those used to specify HTTPS and proxy server connections. • **-Service and -Port descriptions** — A table listing the name of each service and the names of ports for each service that support this port type. For each service and port name, the table also includes comments in any WSDL `<documentation>` elements defined for each service and port. So, for example, if the port type is supported for different applications and in different locations, you might well have a corresponding choice of services and ports to make the connection. • **Example** — Provides a real code example that illustrates how you might connect and set up the Web service to access the operations of the port type. • **Binding descriptions** — If you specify the -b command-line option, this section appears in the document. It shows a table listing the name of each binding that supports this port type. For each binding, the table also includes comments in any WSDL `<documentation>` elements defined for each binding.
	Operation (internal procedure) detail	A series of subsections describing each Web service operation defined for the port type mapped as an internal procedure (and user-defined function, if supported), including: • The operation name • Comments in any WSDL `<documentation>` elements • ABL procedure prototypes (and function prototypes, if also supported) • ABL example • Descriptions of parameters and any return value (for a user-defined function mapping), including SOAP examples for complex types as appropriate for different service and port combinations • Any SOAP request/response headers and SOAP faults as appropriate for different service and port combinations

Page	Section	Description
Data types page on page 193	Data types	The document heading followed by comments in any WSDL `<documentation>` elements that describe the entire types section
	Datatype summary	A hyperlinked alphabetical listing of all the complex types defined for the Web service, including comments in any WSDL `<documentation>` elements as defined for each data type
	Datatype detail	A series of subsections, one for each complex type defined for the Web service, listed in alphabetical order, and each one including comments in any WSDL `<documentation>` elements defined for the complex type, the XML `<schema>` element that defines the type, and an example of a SOAP instance

Index and Service pages

The index page, `index.html`, is the starting page of the documentation describing the Web service interface. This page takes one of two forms, depending on whether the WSDL file defines a single service or multiple services. The page for a single-service Web service includes the port types and data types for that service. The page for a multi-service Web service links to individual Service pages that provide this information separately for each service. Whether on a single page or multiple pages, they provide the information listed in Table 24: WSDL Analyzer output on page 184.

The following figure shows an example of an index page for a WSDL containing only one service.

Figure 7: WSDL Analyzer index page for a single service only



Operation index

WSDL

Author=Progress Education Services, EncodingType=RPC_ENCODED, WSA_Product=10.1A01 - N/A

Location

http://wstraining.progress.com/wsa/wsa1/wsdl?targetURI=urn:OpenEdgeServices:NewCoService

Target namespace

urn:OpenEdgeServices:NewCoService

NewCoServiceService service

No documentation found in WSDL.

Port types (persistent procedures)

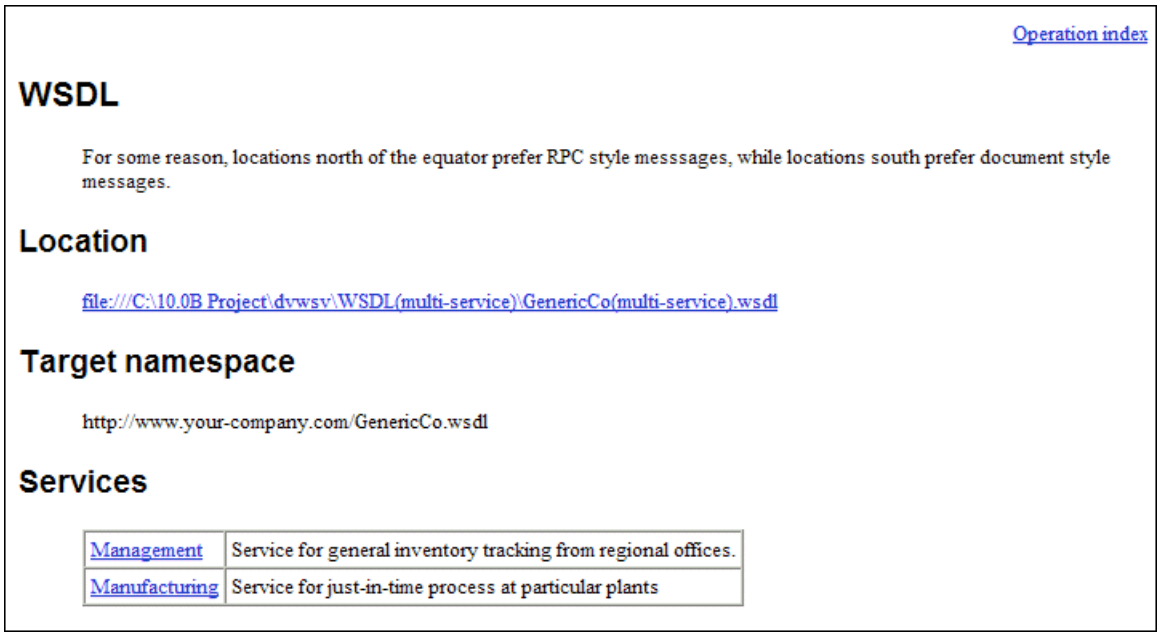
funclibObj	*No documentation found in WSDL.*
NewCoServiceObj	*No documentation found in WSDL.*

Data types

ArrayOfGetInvoiceTotalInfo_InvoiceTotalsRow type	*No documentation found in WSDL.*
FaultDetail type	*No documentation found in WSDL.*
funclibID type	*No documentation found in WSDL.*
GetInvoiceTotalInfo_InvoiceTotalsRow type	*No documentation found in WSDL.*

The following figure shows an example of an index page for a WSDL containing only one service.

Figure 8: WSDL Analyzer index page for multiple services



Operation index

WSDL

For some reason, locations north of the equator prefer RPC style messsages, while locations south prefer document style messages.

Location

file:///C:\10.0B Project\dvwsv\WSDL(multi-service)\GenericCo(multi-service).wsdl

Target namespace

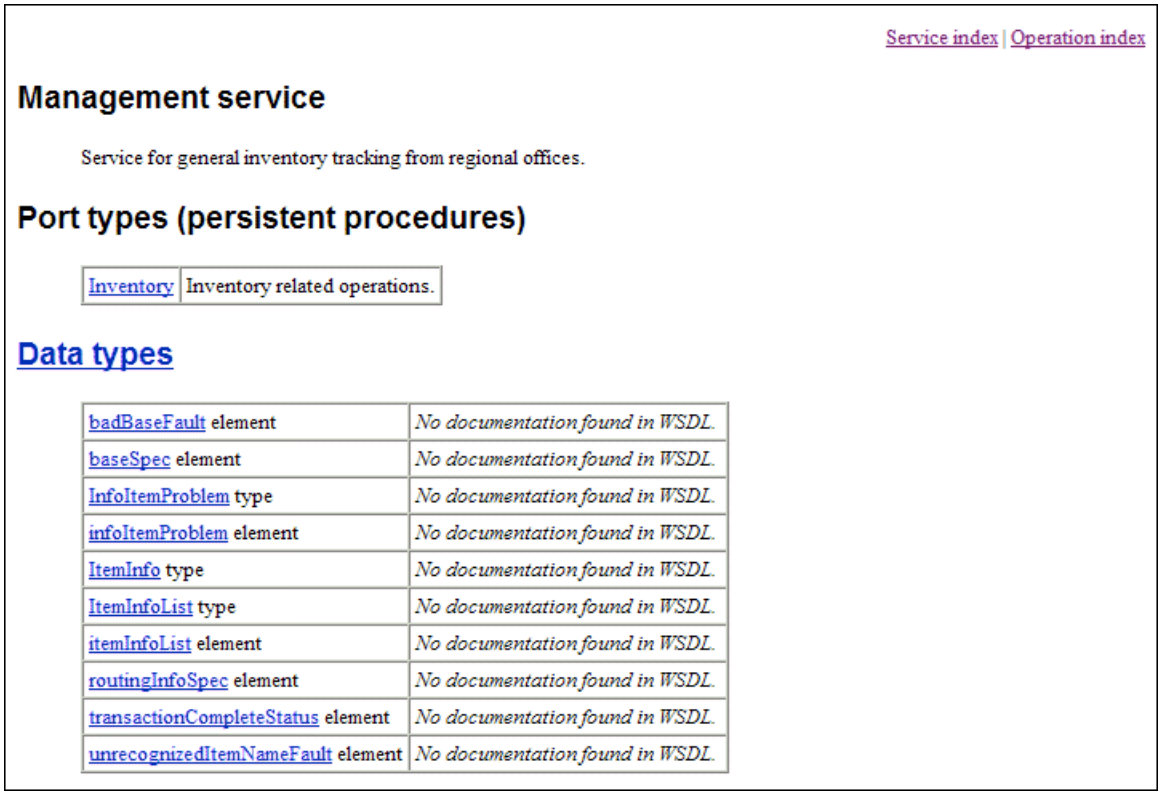
http://www.your-company.com/GenericCo.wsdl

Services

Management	Service for general inventory tracking from regional offices.
Manufacturing	Service for just-in-time process at particular plants

The following figure shows an example of a service page for one of the services shown in Figure 2.

Figure 9: WSDL Analyzer service page for one of multiple services



Service index | Operation index

Management service

Service for general inventory tracking from regional offices.

Port types (persistent procedures)

Inventory	Inventory related operations.

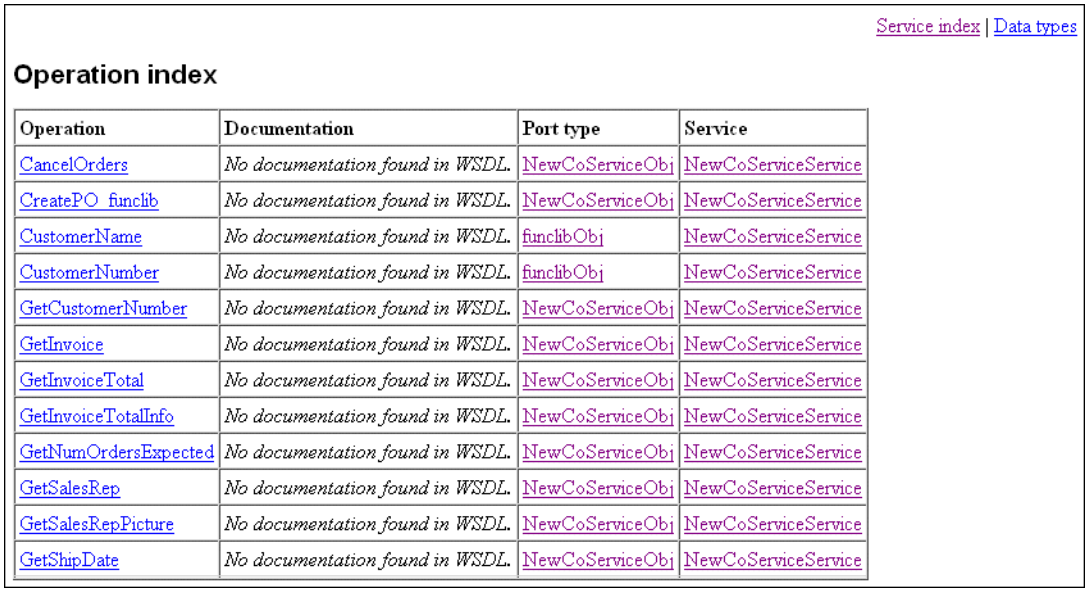
Data types

badBaseFault element	*No documentation found in WSDL.*
baseSpec element	*No documentation found in WSDL.*
InfoItemProblem type	*No documentation found in WSDL.*
infoItemProblem element	*No documentation found in WSDL.*
ItemInfo type	*No documentation found in WSDL.*
ItemInfoList type	*No documentation found in WSDL.*
itemInfoList element	*No documentation found in WSDL.*
routingInfoSpec element	*No documentation found in WSDL.*
transactionCompleteStatus element	*No documentation found in WSDL.*
unrecognizedItemNameFault element	*No documentation found in WSDL.*

Operation index page

The operation index page contains a hyperlinked list of all operations from all port types in all services defined in the WSDL file. The following figure shows an example of this page.

Figure 10: WSDL Analyzer operation index page



Service index | Data types

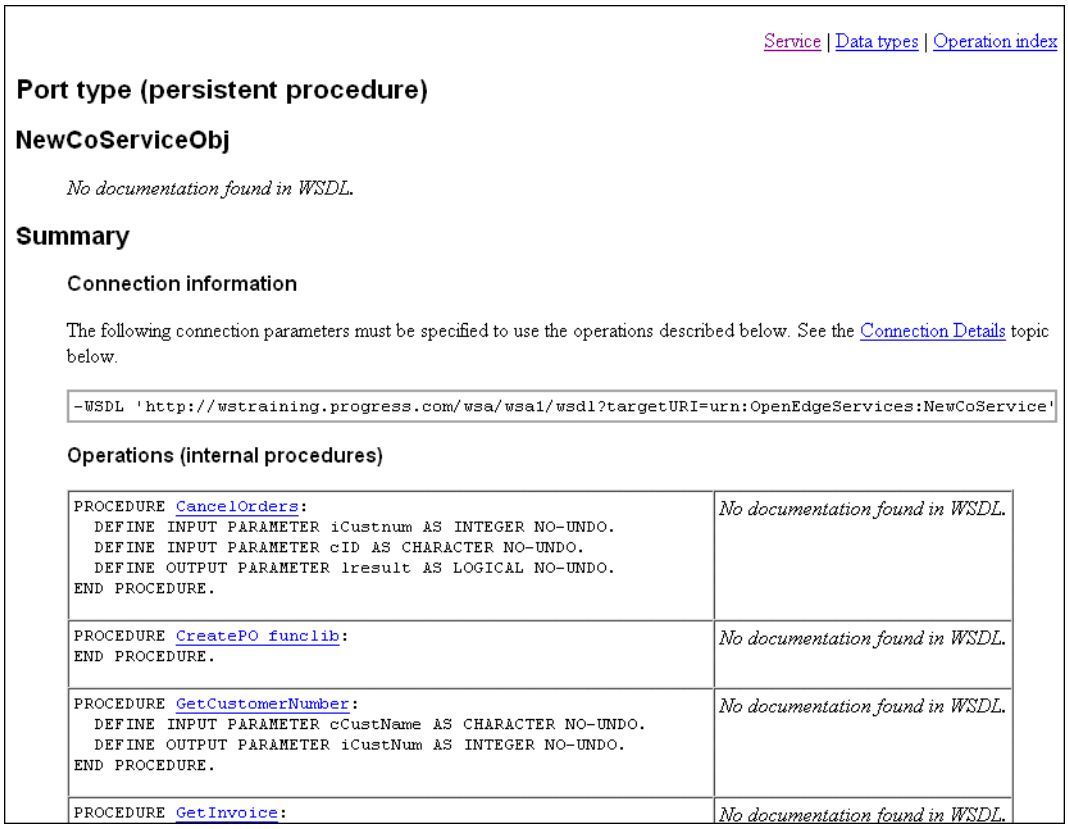
Operation index

Operation	Documentation	Port type	Service
CancelOrders	*No documentation found in WSDL.*	NewCoServiceObj	NewCoServiceService
CreatePO_funclib	*No documentation found in WSDL.*	NewCoServiceObj	NewCoServiceService
CustomerName	*No documentation found in WSDL.*	funclibObj	NewCoServiceService
CustomerNumber	*No documentation found in WSDL.*	funclibObj	NewCoServiceService
GetCustomerNumber	*No documentation found in WSDL.*	NewCoServiceObj	NewCoServiceService
GetInvoice	*No documentation found in WSDL.*	NewCoServiceObj	NewCoServiceService
GetInvoiceTotal	*No documentation found in WSDL.*	NewCoServiceObj	NewCoServiceService
GetInvoiceTotalInfo	*No documentation found in WSDL.*	NewCoServiceObj	NewCoServiceService
GetNumOrdersExpected	*No documentation found in WSDL.*	NewCoServiceObj	NewCoServiceService
GetSalesRep	*No documentation found in WSDL.*	NewCoServiceObj	NewCoServiceService
GetSalesRepPicture	*No documentation found in WSDL.*	NewCoServiceObj	NewCoServiceService
GetShipDate	*No documentation found in WSDL.*	NewCoServiceObj	NewCoServiceService

Port type page

The WSDL Analyzer generates a separate port type page for each port type defined in the WSDL file. The page contains detailed information on how to work with that port type. The following figure shows an example of the beginning of a port type page.

Figure 11: WSDL Analyzer port type page (up to the Summary)



Service | Data types | Operation index

Port type (persistent procedure)

NewCoServiceObj

No documentation found in WSDL.

Summary

Connection information

The following connection parameters must be specified to use the operations described below. See the Connection Details topic below.

```
-WSDL 'http://wstraining.progress.com/wsa/wsa1/wsdl?targetURI=urn:OpenEdgeServices:NewCoService'
```

Operations (internal procedures)

PROCEDURE CancelOrders:
  DEFINE INPUT PARAMETER iCustnum AS INTEGER NO-UNDO.
  DEFINE INPUT PARAMETER cID AS CHARACTER NO-UNDO.
  DEFINE OUTPUT PARAMETER lresult AS LOGICAL NO-UNDO.
END PROCEDURE.
	No documentation found in WSDL.

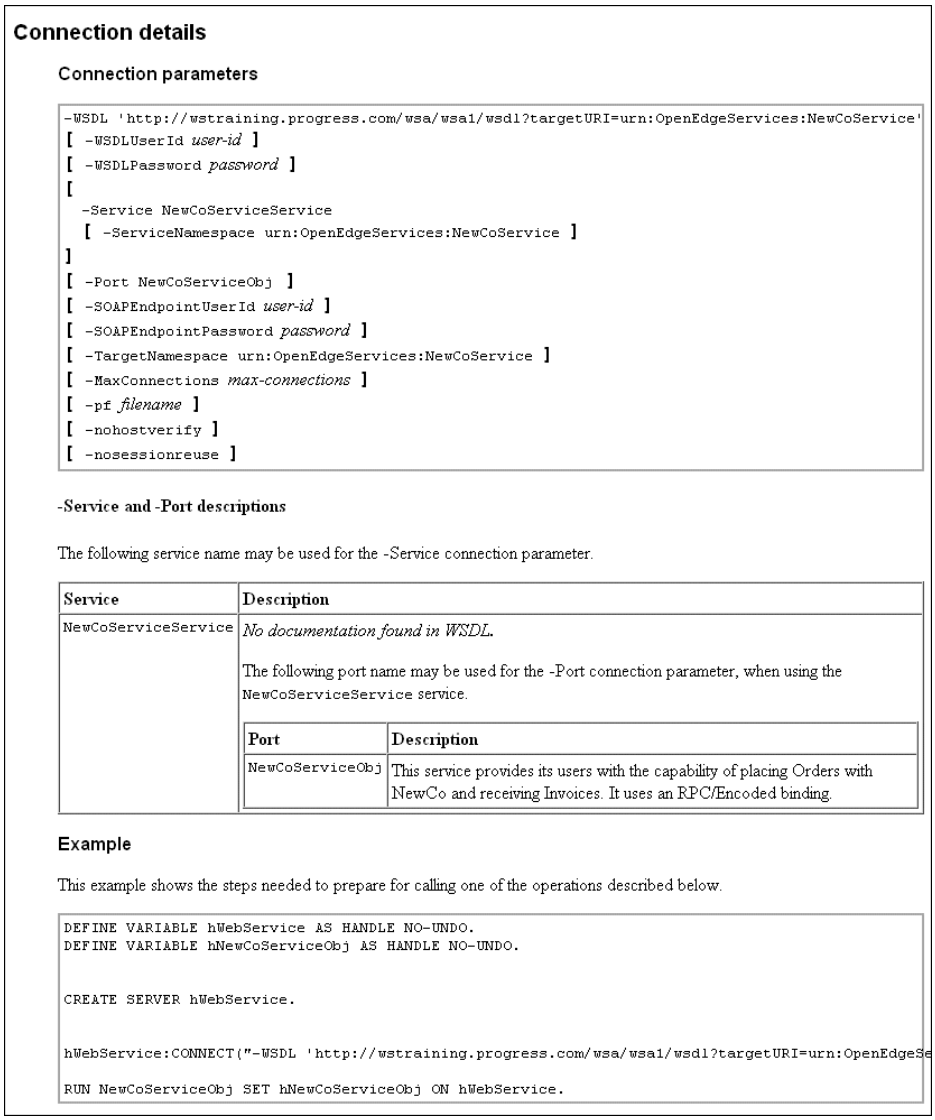
PROCEDURE CreatePO funclib: END PROCEDURE.	*No documentation found in WSDL.*

PROCEDURE GetCustomerNumber:
  DEFINE INPUT PARAMETER cCustName AS CHARACTER NO-UNDO.
  DEFINE OUTPUT PARAMETER iCustNum AS INTEGER NO-UNDO.
END PROCEDURE.
	No documentation found in WSDL.

PROCEDURE GetInvoice:	*No documentation found in WSDL.*

The following figure shows an example of the **Connection details** section of a port type page.

Figure 12: WSDL Analyzer port type page (connection details)



Connection details

Connection parameters

```
-WSDL 'http://wstraining.progress.com/wsa/wsa1/wsdl?targetURI=urn:OpenEdgeServices:NewCoService'
[ -WSDLUserId user-id ]
[ -WSDLPassword password ]
[
  -Service NewCoServiceService
  [ -ServiceNamespace urn:OpenEdgeServices:NewCoService ]
]
[ -Port NewCoServiceObj ]
[ -SOAPEndpointUserId user-id ]
[ -SOAPEndpointPassword password ]
[ -TargetNamespace urn:OpenEdgeServices:NewCoService ]
[ -MaxConnections max-connections ]
[ -pf filename ]
[ -nohostverify ]
[ -nosessionreuse ]
```

-Service and -Port descriptions

The following service name may be used for the -Service connection parameter.

Service	Description
NewCoServiceService	*No documentation found in WSDL.* The following port name may be used for the -Port connection parameter, when using the NewCoServiceService service. Port: NewCoServiceObj — Description: This service provides its users with the capability of placing Orders with NewCo and receiving Invoices. It uses an RPC/Encoded binding.

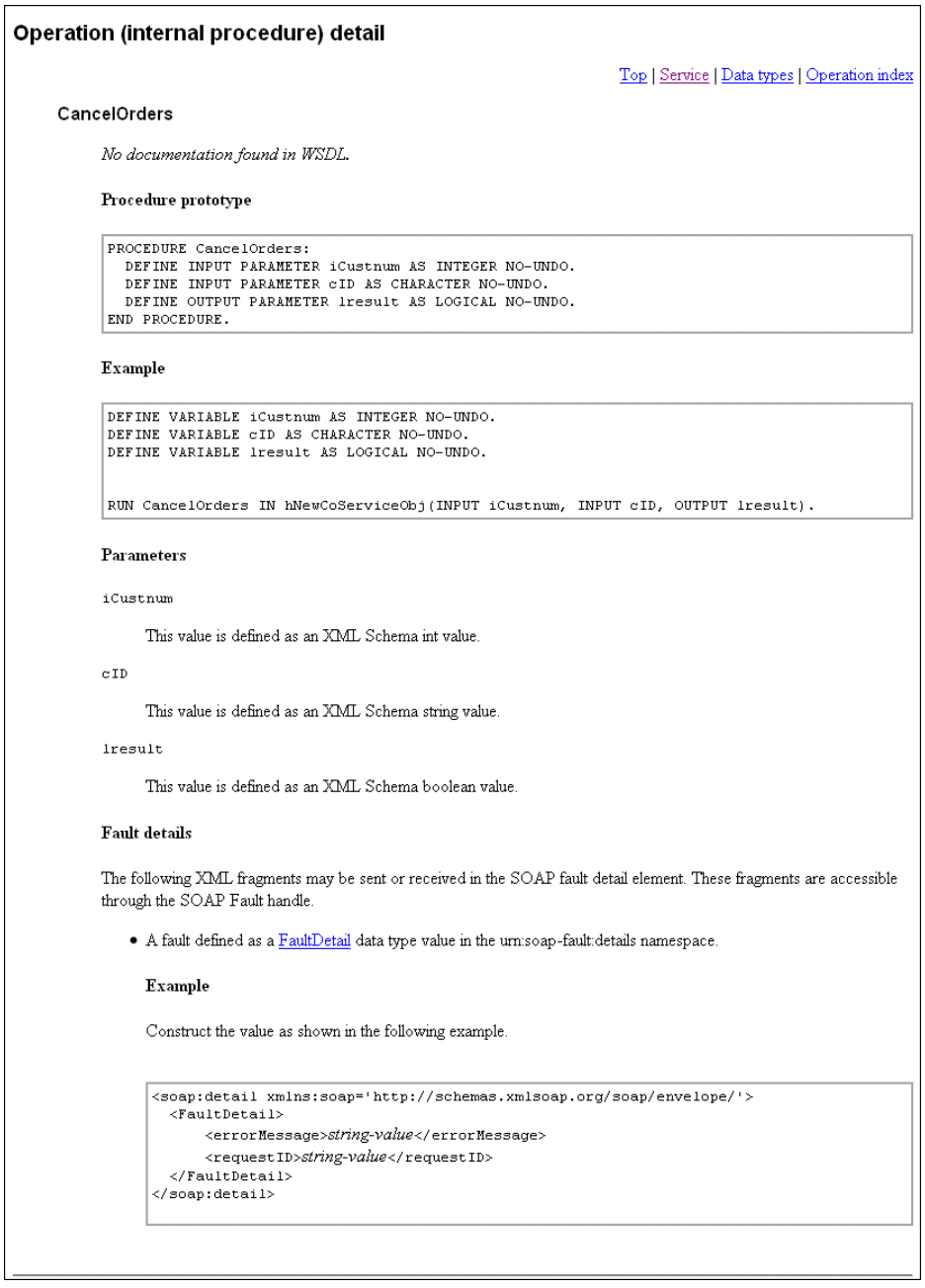
Example

This example shows the steps needed to prepare for calling one of the operations described below.

```
DEFINE VARIABLE hWebService AS HANDLE NO-UNDO.
DEFINE VARIABLE hNewCoServiceObj AS HANDLE NO-UNDO.


CREATE SERVER hWebService.


hWebService:CONNECT("-WSDL 'http://wstraining.progress.com/wsa/wsa1/wsdl?targetURI=urn:OpenEdgeSe

RUN NewCoServiceObj SET hNewCoServiceObj ON hWebService.
```

The following figure shows an example of how the **Operation (internal procedure) detail** section of a port type page describes a Web service operation.

Figure 13: WSDL Analyzer port type page (operation detail)



Operation (internal procedure) detail

Top | Service | Data types | Operation index

CancelOrders

No documentation found in WSDL.

Procedure prototype

```
PROCEDURE CancelOrders:
  DEFINE INPUT PARAMETER iCustnum AS INTEGER NO-UNDO.
  DEFINE INPUT PARAMETER cID AS CHARACTER NO-UNDO.
  DEFINE OUTPUT PARAMETER lresult AS LOGICAL NO-UNDO.
END PROCEDURE.
```

Example

```
DEFINE VARIABLE iCustnum AS INTEGER NO-UNDO.
DEFINE VARIABLE cID AS CHARACTER NO-UNDO.
DEFINE VARIABLE lresult AS LOGICAL NO-UNDO.


RUN CancelOrders IN hNewCoServiceObj(INPUT iCustnum, INPUT cID, OUTPUT lresult).
```

Parameters

`iCustnum`

This value is defined as an XML Schema int value.

`cID`

This value is defined as an XML Schema string value.

`lresult`

This value is defined as an XML Schema boolean value.

Fault details

The following XML fragments may be sent or received in the SOAP fault detail element. These fragments are accessible through the SOAP Fault handle.

- A fault defined as a FaultDetail data type value in the urn:soap-fault:details namespace.

  Example

  Construct the value as shown in the following example.

```
<soap:detail xmlns:soap='http://schemas.xmlsoap.org/soap/envelope/'>
  <FaultDetail>
      <errorMessage>string-value</errorMessage>
      <requestID>string-value</requestID>
  </FaultDetail>
</soap:detail>
```

The WSDL Analyzer maps each Web service operation in a port type to an ABL internal procedure prototype. This allows all Web service operations to be invoked either synchronously or asynchronously as you require. For some Web service operations, the WSDL Analyzer also indicates a mapping to an ABL user-defined function prototype.

The WSDL Analyzer describes both the internal procedure mapping and the user-defined function mapping in the port type page. You can invoke them either as ABL procedures or user-defined functions, depending on your requirements at any given point in your application. However, as with user-defined functions in the native ABL, you cannot use the function to asynchronously invoke the Web service operation.

The port type page also describes how the WSDL Analyzer maps any complex data to ABL temp-tables or ProDataSets. For more information, see Analyzing complex data on page 195.

Data types page

For all the complex types defined in the WSDL file, the WSDL Analyzer generates a single data types page that contains detailed information on each complex type, whether or not they are actually used in the Web service. The following figure shows an example of the information from a data type page.

Figure 14: WSDL Analyzer data types page (summary list)



Service | Operation index

Data types

Datatype summary

ArrayOfGetInvoiceTotalInfo_InvoiceTotalsRow type	*No documentation found in WSDL.*
FaultDetail type	*No documentation found in WSDL.*
funclibID type	*No documentation found in WSDL.*
GetInvoiceTotalInfo_InvoiceTotalsRow type	*No documentation found in WSDL.*

Datatype detail

Top | Service | Operation index

ArrayOfGetInvoiceTotalInfo_InvoiceTotalsRow type

No documentation found in WSDL.

Note: The following schema definition and example may not agree. The example may indicate that all elements are optional, while the schema indicates otherwise. If this is the case, base the construction of your complex data on the example, not the schema fragment. This disparity is a result of the web service using SOAP encoding for its message serialization.

Schema

```
<schema elementFormDefault='unqualified' targetNamespace='urn:OpenEdgeServices:NewCoService:NewCoService'
  <complexType name='ArrayOfGetInvoiceTotalInfo_InvoiceTotalsRow'>
    <complexContent>
      <restriction base='soapenc:Array'>
        <attribute ref='soapenc:arrayType' arrayType='S2:GetInvoiceTotalInfo_InvoiceTotalsRow[]'/>
      </restriction>
    </complexContent>
  </complexType>
</schema>
```

Example

```
<arbitrary soap-enc:arrayType="ns0:GetInvoiceTotalInfo_InvoiceTotalsRow[optional-value-count]"  xmlns:ns0="urn:
    <!-- The following element may appear 0 or more times.
         If optional-value-count is specified above, the number of occurrences must agree with that value.
         If no value appears between the square brackets, then any number of occurrences may appear. -->
    <arbitrary>
      <!-- The following element may have the 'xsi:nil="true"` attribute (it is nillable). -->
      <invoiceNum>int-value</invoiceNum>
      <!-- The following element may have the 'xsi:nil="true"` attribute (it is nillable). -->
      <totalOfOrders>decimal-value</totalOfOrders>
      <!-- The following element may have the 'xsi:nil="true"` attribute (it is nillable). -->
      <shipCharge>decimal-value</shipCharge>
      <!-- The following element may have the 'xsi:nil="true"` attribute (it is nillable). -->
      <totalDue>decimal-value</totalDue>
    </arbitrary>
</arbitrary>
```

Note: This page only describes complex XML data types that cannot be represented as temp-tables or ProDataSets. It does not describe standard XML Schema types. For information on how XML Schema types map to ABL data types, see Map XML Schema data types to ABL data types on page 197. When the WSDL Analyzer identifies a complex type that maps to a temp-table or ProDataSet, it documents the ABL object and an example of its SOAP representation for the appropriate parameter, SOAP header entry, or SOAP fault detail in the port type page. For more information on how the WSDL Analyzer maps and documents temp-table and ProDataSet representations of complex types, see Analyzing complex data on page 195.

Analyzing wrapped document literal

The WSDL Analyzer recognizes and provides special documentation support for a narrow convention of the Doc/Lit SOAP format developed by Microsoft known as *wrapped document literal* (*Wrapped Doc/Lit*). A Web service operation defined according to the Wrapped Doc/Lit convention has a single request (input) parameter and single response (output) parameter. Each parameter in the operation is defined as a complex element that "wraps" one or more elements containing values of the same mode (input or output).

The WSDL Analyzer can document an ABL procedure or function that uses the Wrapped Doc/Lit convention according to one of two possible forms:

- Wrapped form on page 194
- Unwrapped form on page 194

Wrapped form

In a *wrapped* form, the procedure or function mirrors the Wrapped Doc/Lit convention and passes two `LONGCHAR` parameters, `INPUT` and `OUTPUT`, each of which contains the serialized XML data for the corresponding SOAP request or response message. Programming with this definition of the procedure or function requires that you parse or serialize XML for both parameters. For more information on coding with the wrapped form, see Programming options on page 194.

Unwrapped form

In an *unwrapped* form, the procedure or function passes individual `INPUT`, `OUTPUT`, or `INPUT-OUTPUT` parameters that reflect the individual data elements wrapped by the out element for these Wrapped Doc/Lit operation parameters. In this case, the WSDL Analyzer is likely to document each parameter as an ABL data type that maps to a simple XML Schema data type defined in the outer elements of the wrapped parameters. (For more information, see Map XML Schema data types to ABL data types on page 197.) If the definition for an unwrapped parameter embedded within a complex outer element is also a complex element, the WSDL Analyzer might have to document that unwrapped parameter as a complex XML Schema data type mapped to an ABL `LONGCHAR`. However, in many cases, only simple data types are required to implement all of the parameters for a Wrapped Doc/Lit operation. In this case, you have no need to parse any XML in ABL. For more information on coding with the unwrapped form, see the Programming options on page 194.

WSDL Analyzer documentation options

By default, the WSDL Analyzer documents all Wrapped Doc/Lit operations using an unwrapped form. In most cases, this is the simplest form to work with in ABL.

However, versions of the WSDL Analyzer prior to OpenEdge Release 10.1 document Wrapped Doc/Lit operations using only the wrapped form. So, for backward compatibility, you can tell the WSDL Analyzer to document these operations using the wrapped form by specifying the `-show100style` command-line option when you run the WSDL Analyzer (see Running the WSDL Analyzer on page 182).

If any operations within a port type use the Wrapped Doc/Lit convention, the WSDL Analyzer writes a note at the top of the port type page, indicating that you can rerun the WSDL Analyzer with the `-show100style` option to generate the operation signatures as in OpenEdge releases prior to Release 10.1A.

Programming options

The ABL accepts, without restriction, both the wrapped and unwrapped forms for procedures or functions that map to Wrapped Doc/Lit operations. You can use either one or both of the wrapped and unwrapped forms as overloads of a Wrapped Doc/Lit operation (as documented by the WSDL Analyzer) to program that operation in ABL.

For more information on using the programming options that the WSDL Analyzer pages for Wrapped Doc/Lit Web services, see Coding options for wrapped document literal on page 220.

Analyzing complex data

Complex data consists of multiple data values treated as a group. A Web service can exchange complex data with a client using three different SOAP message data elements:

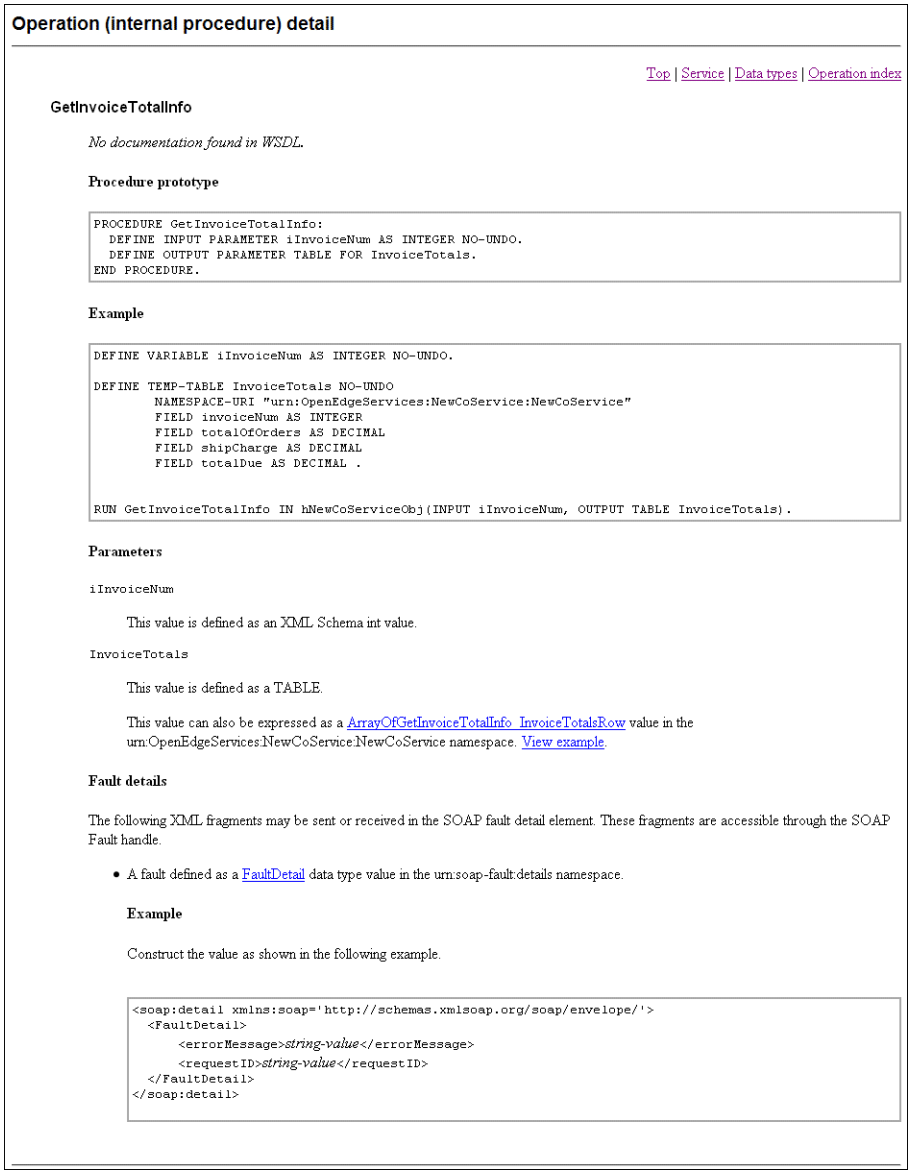
- A Web service operation parameter
- The entries of a SOAP header
- The detail of a SOAP fault

The techniques available for an ABL client to access this complex data depend on the structure and content of the data as determined by the WSDL Analyzer. If the WSDL is for an OpenEdge Web service that uses temp-table or ProDataSet parameters, the WSDL Analyzer indicates that you can access the complex data using an ABL temp-table or ProDataSet and how to define it in your code. If the WSDL Analyzer cannot identify a temp-table or ProDataSet to represent an instance of complex data, it provides an example of the serialized XML SOAP message element, so you can use ABL features to access the XML data as a Document Object Model (DOM) tree or to read and write the data using the Simple API for XML (SAX).

If the WSDL Analyzer identifies an appropriate temp-table or ProDataSet to represent the complex data, you can manage the data in your ABL program more easily than using the ABL DOM or SAX features. Access to such data relies entirely on ABL data types and requires no transformation to and from XML. You always have the option of using the DOM or SAX features to access the XML directly, but you are only required to do this when the WSDL Analyzer cannot identify a temp-table or ProDataSet definition to represent the complex data.

The following figure shows the **Operation (internal procedure) detail** section of a port type page for a procedure that is passing complex data parameters. The WSDL Analyzer has identified a static temp-table definition that can be used for a parameter. So, it specifies the TABLE parameter for the procedure signature.

Figure 15: WSDL Analyzer port type page (TABLE in signature)



Operation (internal procedure) detail

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GetInvoiceTotalInfo

No documentation found in WSDL.

Procedure prototype

```
PROCEDURE GetInvoiceTotalInfo:
  DEFINE INPUT PARAMETER iInvoiceNum AS INTEGER NO-UNDO.
  DEFINE OUTPUT PARAMETER TABLE FOR InvoiceTotals.
END PROCEDURE.
```

Example

```
DEFINE VARIABLE iInvoiceNum AS INTEGER NO-UNDO.

DEFINE TEMP-TABLE InvoiceTotals NO-UNDO
        NAMESPACE-URI "urn:OpenEdgeServices:NewCoService:NewCoService"
        FIELD invoiceNum AS INTEGER
        FIELD totalOfOrders AS DECIMAL
        FIELD shipCharge AS DECIMAL
        FIELD totalDue AS DECIMAL .


RUN GetInvoiceTotalInfo IN hNewCoServiceObj(INPUT iInvoiceNum, OUTPUT TABLE InvoiceTotals).
```

Parameters

iInvoiceNum

This value is defined as an XML Schema int value.

InvoiceTotals

This value is defined as a TABLE.

This value can also be expressed as a ArrayOfGetInvoiceTotalInfo_InvoiceTotalsRow value in the urn:OpenEdgeServices:NewCoService:NewCoService namespace. View example.

Fault details

The following XML fragments may be sent or received in the SOAP fault detail element. These fragments are accessible through the SOAP Fault handle.

- A fault defined as a FaultDetail data type value in the urn:soap-fault:details namespace.

  Example

  Construct the value as shown in the following example.

```
<soap:detail xmlns:soap='http://schemas.xmlsoap.org/soap/envelope/'>
  <FaultDetail>
      <errorMessage>string-value</errorMessage>
      <requestID>string-value</requestID>
  </FaultDetail>
</soap:detail>
```

Web service operation parameter documentation

When the WSDL Analyzer identifies a Web service operation parameter as a static temp-table or ProDataSet, it documents the appropriate TABLE or DATASET parameter in the ABL procedure or user-defined function signature. It provides the ABL definition for the corresponding static temp-table or ProDataSet that you can use in your application. You can then access and manage the TABLE or DATASET parameter as in any ABL application.

If an OpenEdge Web service contains a dynamic temp-table or dynamic ProDataSet parameter, the WSDL Analyzer documents a corresponding TABLE-HANDLE or DATASET-HANDLE parameter in the ABL procedure or user-defined function signature. You can then access and manage the dynamic temp-table or ProDataSet parameter as in any ABL application.

If the WSDL Analyzer cannot identify any case for a temp-table or ProDataSet mapping, it documents the parameter as a LONGCHAR in the ABL procedure or user-defined function signature and provides an example SOAP message element for the complex data. In all cases where the WSDL Analyzer identifies a temp-table or ProDataSet mapping, it also provides a link to documentation containing an example SOAP message element, in case you prefer to work with the XML directly.

For more information on how to use ABL to work with complex data passed as a parameter, see Managing operation parameters on page 216.

SOAP header entry and SOAP fault detail documentation

For a SOAP header entry or SOAP fault detail, the WSDL Analyzer provides similar documentation for complex data. If it can identify a temp-table or ProDataSet that matches the SOAP header entry, it simply provides the appropriate static ABL definition. If a dynamic temp-table or ProDataSet mapping is possible, the WSDL Analyzer also documents this fact with any appropriate explanatory notes.

Note: SOAP headers rarely contain complex data that the WSDL Analyzer can map to a temp-table or ProDataSet.

For these SOAP elements, you never access a temp-table or ProDataSet directly. For a response header, you must access the header entry XML and use an ABL temp-table or ProDataSet READ-XML( ) method to transform the XML into temp-table or ProDataSet data, which you can then access as ABL data types. For a request header, you can create the header data in the corresponding temp-table or ProDataSet and transform it to the header entry XML using a temp-table or ProDataSet WRITE-XML( ) method. For SOAP fault detail, you must access the SOAP fault detail XML and use an ABL temp-table or ProDataSet READ-XML( ) method to transform the XML into temp-table or ProDataSet data, which you can then access as ABL data types. Again, if no temp-table or ProDataSet mapping is possible, you must use the ABL DOM or SAX features to access the XML for a header entry.

For more information on how to use ABL to work with complex data passed as a SOAP header entry, see Handling SOAP Message Headers in ABL on page 225 For more information on how to use ABL to work with complex data passed as SOAP fault detail, see Handling Errors in ABL Requests to OpenEdge SOAP Web Services on page 255.

Map XML Schema data types to ABL data types

The foundation for data types in WSDL is XML Schema, a standard that defines simple data types and a means to aggregate them into more complex types. OpenEdge supports a range of acceptable mappings for all XML Schema types. For a given parameter on a Web service operation, OpenEdge supports a range of ABL data types that can be automatically transformed between OpenEdge and the XML Schema representation. As part of the acceptable mappings, OpenEdge suggests (through the WSDL Analyzer) a recommended ABL data type to use when mapping an ABL parameter to a particular Web service parameter.

This section identifies the mapping options and how they work going from one domain (XML Schema) to the other (ABL) for the following types of data:

- Simple data types on page 198
- Arrays on page 202
- Complex data types on page 202

For more information on how to manipulate these data types (especially complex data types) in ABL, see Invoking OpenEdge SOAP Web Service Operations from ABL on page 213.

Simple data types

Simple data types represent the foundation for all types of data. The mappings for simple data types and how they can be transformed between Web services and ABL provide the basic information for how to work with more complex types of data.

Suggested mappings

The WSDL Analyzer's generated documentation provides recommended mappings between Web service parameters and ABL parameters. These are the mappings that are most semantically useful. Wherever the WSDL file indicates that a parameter of any data type is `nillable`, this means that on the Web service side the parameter can have the null value and on the ABL side the parameter can pass the ABL `Unknown value (?)`.

The following table lists all the simple XML Schema data types in alphabetical order, showing for each one the suggested ABL data type for mapping it.

Table 25: Suggested XML Schema mappings to ABL data types

XML Schema data type	ABL data type	Notes
`anyURI`	`CHARACTER`	–
`base64Binary`	`RAW`	You can use the ABL `BASE64-ENCODE` and `BASE64-DECODE` functions to convert between Base 64 clear text (`CHARACTER` or `LONGCHAR`) and binary data (`RAW` or `MEMPTR`).
`boolean`	`LOGICAL`	–
`byte`	`INTEGER`	On `INPUT`, if the ABL `INTEGER` value is outside the valid range of the XML Schema `byte` type, it is a run-time error.
`date`	`DATE`	On `OUTPUT`, any time zone information is lost. To retain it, use an ABL `CHARACTER` parameter.
`dateTime`	`DATETIME-TZ`	–
`decimal`	`DECIMAL`	The ABL `DECIMAL` type might not hold the entire XML Schema `decimal` value. However, the industry common practice is to map between XML Schema `decimal` and another decimal data type. On `OUTPUT`, if the XML Schema `decimal` value overflows the ABL `DECIMAL` type, it is a run-time error.
`double`	`CHARACTER`	–
`duration`	`CHARACTER`	–
`ENTITIES`	`CHARACTER`	–
`ENTITY`	`CHARACTER`	–
`float`	`CHARACTER`	–

XML Schema data type	ABL data type	Notes
gDay	CHARACTER	–
gMonth	CHARACTER	–
gMonthDay	CHARACTER	–
gYear	CHARACTER	–
gYearMonth	CHARACTER	–
hexBinary	RAW	–
ID	CHARACTER	–
IDREF	CHARACTER	–
IDREFS	CHARACTER	–
int	INTEGER	–
integer	DECIMAL	The ABL DECIMAL type might not hold the entire XML Schema integer value, but it is a better choice than the ABL INTEGER type. On INPUT, if the ABL DECIMAL value is outside the valid range of the XML Schema integer type, it is a run-time error. On OUTPUT, if the value of the XML Schema integer value is outside the valid range of the ABL DECIMAL type, it is a run-time error.
Language	CHARACTER	–
long	INT64	–
Name	CHARACTER	–
NCName	CHARACTER	–
negativeInteger	DECIMAL	The ABL DECIMAL type might not hold the entire XML Schema negativeInteger value, but it is a better choice than the ABL INTEGER type. On INPUT, if the ABL DECIMAL value is outside the valid range of the XML Schema negativeInteger type, it is a run-time error. On OUTPUT, if the value of the XML Schema negativeInteger value is outside the valid range of the ABL DECIMAL type, it is a run-time error.
NMTOKEN	CHARACTER	–

XML Schema data type	ABL data type	Notes
NMTOKENS	CHARACTER	–
nonNegativeInteger	DECIMAL	The ABL DECIMAL type might not hold the entire XML Schema nonNegativeInteger value, but it is a better choice than the ABL INTEGER type. On INPUT, if the ABL DECIMAL value is outside the valid range of the XML Schema nonNegativeInteger type, it is a run-time error. On OUTPUT, if the value of the XML Schema nonNegativeInteger value is outside the valid range of the ABL DECIMAL type, it is a run-time error.
nonPositiveInteger	DECIMAL	The ABL DECIMAL type may not hold the entire XML Schema nonPositiveInteger value, but it is a better choice than the ABL INTEGER type. On INPUT, if the ABL DECIMAL value is outside the valid range of the XML Schema nonPositiveInteger type, it is a run-time error. On OUTPUT, if the value of the XML Schema nonPositiveInteger value is outside the valid range of the ABL DECIMAL type, it is a run-time error.
normalizedString	CHARACTER	–
NOTATION	CHARACTER	–
positiveInteger	DECIMAL	The ABL DECIMAL type may not hold the entire XML Schema positiveInteger value, but it is a better choice than the ABL INTEGER type. On INPUT, if the ABL DECIMAL value is outside the valid range of the XML Schema positiveInteger type, it is a run-time error. On OUTPUT, if the value of the XML Schema positiveInteger value is outside the valid range of the ABL DECIMAL type, it is a run-time error.
qName	CHARACTER	–
short	INTEGER	On INPUT, if the ABL INTEGER value is outside the valid range of the XML Schema short type, it is a run-time error.
string	CHARACTER	–
time	INTEGER	On INPUT, the value is converted with no time zone information.
token	CHARACTER	–

XML Schema data type	ABL data type	Notes
unsignedByte	INTEGER	On INPUT, if the ABL INTEGER value is outside the valid range of the XML Schema unsignedByte type, it is a run-time error.
unsignedInt	DECIMAL	On INPUT, if the ABL DECIMAL value is outside the valid range of the XML Schema unsignedInt type, it is a run-time error. On OUTPUT, if the value of the XML Schema unsignedInt value is outside the valid range of the ABL DECIMAL type, it is a run-time error.
unsignedLong	DECIMAL	On INPUT, if the ABL DECIMAL value is outside the valid range of the XML Schema unsignedLong type, it is a run-time error. On OUTPUT, if the value of the XML Schema unsignedLong value is outside the valid range of the ABL DECIMAL type, it is a run-time error.
unsignedShort	INTEGER	On INPUT, if the ABL INTEGER value is outside the valid range of the XML Schema unsignedShort type, it is a run-time error.

Note: OpenEdge supports a set of alternative ABL data types (in addition to a suggested data type) to represent the value for an XML Schema data type in ABL. These alternative data types essentially force the Web service invocation to cast the value between the specified native ABL representation and the corresponding XML Schema data type. The result of this casting might not preserve as much accuracy as the suggested mapping. For more information, see Data Type Conversion Rules for ABL Calls to SOAP Web Services on page 337.

Interacting with XML Schema data formats

You might need to work directly with an XML Schema value whose format is not represented among the supported formats for the suggested ABL data type mapping; for example, a 51-digit decimal value. To handle this requirement, you can pass an XML Schema-formatted string version of the value into or out of the Web service invocation. OpenEdge automatically passes the XML Schema-formatted value when you map either a CHARACTER or LONGCHAR data type to any XML Schema data type that has a suggested mapping (see Table 25: Suggested XML Schema mappings to ABL data types on page 198) other than CHARACTER or LONGCHAR.

When you pass the XML Schema-formatted value as an INPUT parameter, the Web service invocation incorporates it directly into the generated SOAP message. For an OUTPUT parameter, the invocation copies the XML Schema-formatted value directly from the SOAP message into the CHARACTER or LONGCHAR parameter.

When you pass an XML Schema-formatted value to a Web service, the invocation also validates the format of the value to ensure that it conforms to XML Schema formatting rules for the data type. Note that the invocation does not validate any facets declared in the <schema> element to constrain the value. It ensures that the format of the value you provide is valid according to its base XML Schema data type representation, but not, for example, if the value falls within a given range.

For example, if you pass an ABL CHARACTER as an INPUT parameter for an XML Schema int, the invocation checks to ensure that it contains a properly formatted 32-bit integer value. If you pass an ABL CHARACTER as an OUTPUT parameter for an XML Schema int, the invocation copies the Schema-formatted value directly from the SOAP message into the ABL CHARACTER parameter.

Arrays

OpenEdge maps arrays of simple types to ABL arrays. The WSDL Analyzer determines that it must map to an ABL array when it recognizes a Web service array declaration or the use of the `minOccurs` and `maxOccurs` XML Schema attributes in a parameter type definition. If a SOAP array is declared as unbounded, the WSDL Analyzer maps it to an ABL array with an indeterminate extent.

When it receives a SOAP response that includes a sparse array parameter, OpenEdge creates an ABL array of the appropriate size and fills it. OpenEdge sets each unused entry in the ABL array to the `Unknown value (?)`.

OpenEdge never passes a sparse array as input to a Web service.

For arrays of complex types, the ABL represents them as one of the following data types, depending on the structure and content of the complex data, as determined by the WSDL Analyzer:

- A temp-table parameter, if the WSDL is for an OpenEdge Web service
- A ProDataSet parameter
- A `LONGCHAR` (`LONGCHAR[ ]`) or `CHARACTER` (`CHARACTER[ ]`) array parameter

Depending on how the WSDL Analyzer represents it, you might handle the entire array or individual elements as a complex data type (see Complex data types on page 202). For more information on how the WSDL Analyzer determines the representation of complex data, see Analyzing complex data on page 195.

Complex data types

Complex data types in XML appear in many forms, but share a common feature of representing multiple simple and other complex data types as an aggregate (group). One of the most common complex data types in XML is the XML Schema complex type. An XML Schema complex type is an aggregate of one or more simple types or complex types defined by an enclosing `complexType` XML Schema element.

When the WSDL Analyzer encounters a Web service operation parameter defined with a complex data type, it attempts to identify an ABL data type to represent the parameter that both maps to the parameter exactly and provides the easiest access to the data in ABL. Thus, the WSDL Analyzer might suggest any of the following parameter data types to represent:

- A static or dynamic temp-table (`TABLE` or `TABLE-HANDLE`) parameter, if the WSDL is for an OpenEdge Web service
- A static or dynamic ProDataSet (`DATASET` or `DATASET-HANDLE`) parameter
- A `LONGCHAR` or `CHARACTER` parameter, possibly in array form

Once in ABL, you can work with data from Web service complex data types using the features of the ABL data type used to represent it. For example, if the WSDL Analyzer determines that you can represent a Web service parameter as a temp-table or ProDataSet, you can access the data as a temp-table or ProDataSet with no need to manipulate the SOAP message XML. OpenEdge allows some flexibility in how the simple XML Schema data types of individual data elements map to the ABL fields in a temp-table. The casting rules for these mappings are similar to those for simple data type parameters (see the Simple data types on page 198). For more information, see the sections on mapping between XML Schema and temp-table field data types, in *OpenEdge Development: Programming Interfaces*. For more information on how the WSDL Analyzer analyzes and documents complex data that maps to temp-tables and ProDataSets, see Analyzing complex data on page 195.

If the WSDL Analyzer can only represent the parameter as a `LONGCHAR` or `CHARACTER` (the most likely scenario), you must do one of the following:

- Directly manipulate the serialized XML, as specified by the WSDL Analyzer, in ABL CHARACTER or LONGCHAR variables.
- Convert the serialized XML to a parsed representation using the ABL SAX or DOM read and write methods. For more information, see *OpenEdge Development: Programming Interfaces*.

Whatever technique you use to work directly with the XML for a complex data type parameter in ABL, if you need to pass the parameter back as input to the Web service, you must pass it back as serialized XML. So, if you maintain the data for complex types in an ABL DOM tree (de-serialized) or read it as a stream using SAX, you must serialize it again to a string before passing it back to a Web service as a complex data type parameter. You can do this from a DOM tree, by using a DOM method to convert the DOM tree to a character string, and you can do this in SAX by using SAX write methods to create the XML character string that you use for input.

For more information on how to manage complex data types as input and output parameters of Web service operations and work with the data in ABL, see Managing operation parameters on page 216.

12

Connecting to OpenEdge SOAP Web Services from ABL

This chapter describes the features of OpenEdge SOAP Web service connections and how you can create and manage them in ABL.

For more information on invoking operations in a Web service that you have connected, see the Invoking OpenEdge SOAP Web Service Operations from ABL on page 213.

For details, see the following topics:

- What is a Web service connection?
- Binding to a Web service
- Managing Web service bindings

What is a Web service connection?

Precisely speaking, there is no such thing as a Web service connection. All communication between a Web service client and the Web service is, from a network point of view, connectionless. That is, neither the client host nor the Web service host maintains any knowledge about each other except the other's location, and then only when exchanging messages. Any context or state must be managed explicitly by the application.

However, from the client application point of view, there is definitely a defined relationship between itself and the Web service it is communicating with, and this relationship is more properly defined as a *binding*. A binding retains a *logical connection* between the client application and the Web service by maintaining a continuous association between specified client resources and specified Web service resources. This is the same type of "connection" that an ABL client application maintains between itself and a session-free AppServer with which it is communicating (see *OpenEdge Application Server: Developing AppServer Applications*).

This binding relationship makes it easier for the client to send requests to the Web service and to manage those requests within its own environment until such time as it has no more need for the bound Web service and its resources. At such a time, the client application can logically disconnect (*unbind*) the Web service from its environment in order to free up resources for other tasks.

While the Web service is bound, the process of invoking a Web service request includes telling the client host where to send the application message on the Internet so the Web service can receive and respond to it. This happens every time that the client invokes a Web service request because, as noted previously, the client host maintains no knowledge of the Web service host and its relationship to the client application. This lack of a physical connection provides performance benefits. Given sufficient AppServer resources, a client never needs to wait for an AppServer to service its Web service request, and whenever an AppServer completes a request, it is free to service a request from any other client. This arrangement offers maximum scalability for a given set of AppServer resources over an increasing client load.

To take further advantage of Web service availability on the network, OpenEdge allows the ABL client to make both synchronous and asynchronous requests to a Web service, providing greater flexibility in its own request management. For more information on asynchronous Web service requests, see Managing asynchronous requests on page 222.

Binding to a Web service

Binding to a Web service is a two-step process:

1. Create a server object handle.
2. Execute the `CONNECT( )` method on the server object handle.

Creating a server object handle

To create a server handle for a Web service, you use the same procedure as creating one for an AppServer, as shown in the following example:

```
DEFINE VARIABLE hServer AS HANDLE.
CREATE SERVER hServer.
```

You can now use `hServer` to bind a Web service.

Binding to a server object handle

As for an AppServer, use the `CONNECT( )` method on the server object handle to bind that server object handle to a Web service. This is the basic syntax:

```
CONNECT ( connection-parameters )
```

A Web service binding requires and uses only the *`connection-parameters`* argument, which is a character string containing embedded parameter values to specify the binding. Note that the `CONNECT( )` method is also used to connect AppServer application services. However, if the *`connection-parameters`* string contains any Web service parameters, OpenEdge assumes that the method is binding to a Web service and ignores any AppServer-specific connection parameters in the string.

Connection parameters

The primary function of the connection parameters is to specify the location and transport information for the Web service on the network. Web services provide two separate mechanisms for doing this. OpenEdge supports both mechanisms through the Web service connection parameters.

This is the Web service syntax for the *connection-parameters* string:

```
-WSDL wsdl-document [ -WSDLUserid user-id [ -WSDLPassword password ] ]
{
    {
       [ -Service service-name [ -ServiceNamespace service-namespace ] ]
       [ -Port port-name ]
    }
  |
    {
       [[ -Binding binding-name [ -BindingNamespace binding-namespace ] ]
          -SOAPEndpoint URL-endpoint ]
    }
}
[ -SOAPEndpointUserid user-id
[ -SOAPEndpointPassword password ] ]
[ -TargetNamespace targetNamespace ]
[ -maxConnections num-connections ]
[ -connectionLifetime nSeconds ]
[ -nohostverify ]
[ -nosessionreuse ]
[ -pf filename ]
```

The only fully required element is the `-WSDL` parameter to identify the WSDL document for the Web service. This syntax might seem confusing, since the required elements, `-Service` and `-Port` or `-Binding` and `-SOAPEndpoint`, contain only optional elements. This situation arises because the WSDL file can directly supply some of this information.

Basically a complete binding can be specified by one of these mechanisms:

1. A valid service and port (transport and Web service URL location) specification (the most common mechanism)
2. A valid binding (transport) and SOAP endpoint (Web service URL location) specification (sometimes used to bind a SOAP viewer between the client and the Web service, or to provide a consortia of equivalent Web service locations)

The connection parameters only need to contain enough information to uniquely specify a target. If a WSDL only contains a single service, you can dispense with the `-Service` option. If a WSDL only contains a single port type, you can dispense with the `-Port` option. The same pattern applies for the `-Binding`/`-SOAPEndpoint` options. When a WSDL contains multiple choices for an option, the connection parameters must specify a unique value for that option.

A `CONNECT( )` method fails, if any of the following happen:

- You include both valid -Service/-Port and valid -Binding/-SOAPEndpoint options in the connection parameters.
- The service, port, or binding options do not match the corresponding WSDL entries exactly with respect to namespace, local name, and letter case.
- The WSDL contains multiple services, ports, or bindings, and you fail to specify a valid, unique set of -Service/-Port or -Binding/-SOAPEndpoint options.

The following table provides a short description for each parameter in the Web service connection parameter string, in the order they appear in the syntax. For more information on these parameters, see the CONNECT( ) method entry in *OpenEdge Development: ABL Reference*.

Table 26: Web service connection parameters

Connection parameter	Description
-WSDL *wsdl-document*	URL, UNC, or local file pathname (possibly relative) to the WSDL file that describes the Web service.
-WSDLUserid *user-id*	Username to authenticate access to the WSDL file (overridden by any username specified in the WSDL URL).
-WSDLPassword *password*	Password to authenticate access to the WSDL file (overridden by any password specified in the WSDL URL).
-Service *service-name*	Name of a <service> element in the WSDL.
-ServiceNamespace *service-namespace*	Namespace for *service-name* specified in the -Service parameter.
-Port *port-name*	Name of a <port> element defined in the specified <service> element.
-Binding *binding-name*	Name of a <binding> element in the WSDL.
-BindingNamespace *binding-namespace*	Namespace for *binding-name* specified in the -Binding parameter.
-SOAPEndpoint *URL-endpoint*	URL location for the Web service.
-SOAPEndpointUserid *user-id*	Username to authenticate access to the Web service endpoint (URL). This endpoint can be specified by the -SOAPEndpoint parameter. It can also be implied by the -Service parameter, the -Port parameter, or the -WSDL parameter (if there is only one service containing one port).
-SOAPEndpointPassword *password*	Password to authenticate access to the Web service endpoint.

Connection parameter	Description
`-TargetNamespace` *`targetNamespace`*	The namespace that uniquely identifies a WSDL. It must match the target namespace declared in the document specified by the `-WSDL` parameter. This can be used as a verification check.
`-maxConnections` *`num-connections`*	Maximum number of simultaneous (parallel) connections maintained between the client and Web service for asynchronous requests.
`-connectionLifetime` *`nSeconds`*	The maximum number of seconds that a given connection can be reused for asynchronous requests before it is destroyed.
`-nohostverify`	If specified, turns off host verification for a Transport Layer Security (TLS) connection using HTTPS. Without this parameter specified, the client compares the host name specified in the URL with the Common Name specified in the server certificate, and raises an error if they do not match. With this parameter specified, the client never raises the error. For more information, see the sections on managing the OpenEdge certificate store in *OpenEdge Getting Started: Core Business Services - Security and Auditing*.[11]
`-nosessionreuse`	If specified, the connection does not reuse the TLS session ID when reconnecting to the same Web server using HTTPS.[11]
`-pf` *`filename`*	File containing any parameters specified in the `CONNECT( )` method.

Using HTTPS

When you use HTTPS to make a secure connection to a Web service, you might have to manage the OpenEdge certificate store to contain the necessary digital certificates for TLS verification. For information on managing the OpenEdge certificate store, see *OpenEdge Getting Started: Core Business Services - Security and Auditing.*

Invoking the binding

The following example shows binding an actual Web service using service and port:

[11] These connection parameters affect all TLS connections made using the Web service server handle, including any WSDL file access or Web service access that uses HTTPS.

Binding a Web service in ABL using service and port

```
DEFINE VARIABLE hServer AS HANDLE.
DEFINE VARIABLE lReturn AS LOGICAL.
CREATE SERVER hServer.
lReturn = hServer:CONNECT("-WSDL http://wstraining.progress.com/wsa/wsa1/
                           wsdl?targetURI=urn:OpenEdgeServices:NewCoService
                           -Service NewCoServiceService
                           -Port NewCoServiceObj").
```

The following example shows what binding a Web service using binding and SOAP endpoint might look like:

Binding a Web service in ABL using binding and SOAP endpoint

```
DEFINE VARIABLE hServer AS HANDLE.
DEFINE VARIABLE lReturn AS LOGICAL.
CREATE SERVER hServer.
lReturn = hServer:CONNECT("-WSDL http://ws.acme.com/ws/AcmeCoService.wsdl
                -Binding InventoryBinding
                -SOAPEndpoint http://ws.acme.com:80/soap/servlet/rpcrouter").
```

Binding results

After a successful attempt to bind a Web service, the server object is initialized for the Web service. This means that on the server object handle:

- The `CONNECT( )` method returns the value, `TRUE`, during invocation
- The server object's `SUBTYPE` attribute returns the value, `"WEBSERVICE"`
- The server object's `CONNECTED( )` method returns the value, `TRUE`

Note: A value of `TRUE` does not indicate the state of the HTTP/S connection between the client and Web service. Subsequent requests can fail if there is an HTTP failure at any point between the client and Web service. A `TRUE` value indicates that the WSDL document named in the `-WSDL` parameter was successfully read and any other parameter values (`-Service`, `-Port`, or `-Binding`) correctly match items in that WSDL document.

An attempt to bind a Web service can fail for any of the following reasons:

- A corrupt WSDL file
- A parameter specification in the *`connection-parameters`* string is invalid
- The value specified for the `-TargetNamespace` parameter does not match the target namespace specified in the WSDL document. (This is a version check.)
- The specified WSDL document is not found
- The value for the `-WSDLUserid` or the `-WSDLPassword` parameter is invalid

Managing Web service bindings

Once you bind a Web service to a server object handle using the CONNECT( ) method, the Web service remains bound (*server-handle*:CONNECTED( ) = TRUE) until you invoke the DISCONNECT( ) method on that handle to unbind it. Between these two points you can access the operations defined for the Web service.

To work with additional port types in the same Web service or in different Web services, you must create a separate Web service binding for each port type you want to access. Depending on how you choose to manage Web service binding resources, you can do all this using one or more pairs of server and procedure handles. If your application accesses many port types and Web services, especially if it disconnects and connects Web service bindings frequently, be sure to delete the created objects (especially the procedure objects) when you no longer need them in order to prevent memory leaks in your application.

Accessing a port type for a Web service

While the Web service is bound to a server object, you can create and map a procedure object to the port type supported by the binding in order to invoke its Web service operations using this syntax:

```
RUN portTypeName [ SET hPortType ] ON SERVER hWebService .
```

As a result of executing a RUN statement using this syntax, you can access operations defined by the specified port type (*portTypeName*) in the Web service mapped to the server object handle, *hWebService*. You can invoke these operations by executing them as procedures or user-defined functions on the procedure object handle, *hPortType*, which is now mapped to the port type, *portTypeName*.

The RUN statement accomplishes this mapping by creating a procedure object for the port type and attaching it to the specified procedure object handle:

Accessing a port type for a Web service

```
DEFINE VARIABLE hServer   AS HANDLE.
DEFINE VARIABLE hPortType AS HANDLE.
CREATE SERVER hServer.
lReturn = hServer:CONNECT("-WSDL http://wstraining.progress.com/wsa/wsa1/
                           wsdl?targetURI=urn:OpenEdgeServices:NewCoService
                           -Service NewCoServiceService
                           -Port NewCoServiceObj").
RUN NewCoServiceObj SET hPortType IN hServer.
```

You can now invoke and manage all of the operations in the port type, NewCoServiceObj, defined for the Web service, NewCoServiceService. For more information on using procedure handles to invoke Web service operations, see Invoking operations on page 214.

Accessing multiple port types

If your client makes use of multiple port types from one or more Web services, you can either reuse a single server object or create multiple server objects. The first option limits the resources tied up in server objects. The second option enables you to access multiple port types simultaneously. You must decide which approach best suits your needs.

To reuse a server object to access a different port type, you must first disconnect the server object from its current binding.

To access a different port type in a bound Web service using the same server object handle:

1. Delete the procedure object mapped to the current port type, using the `DELETE PROCEDURE` or `DELETE OBJECT` statement.
2. Unbind (logically disconnect) the server object handle from its current Web service binding using the `DISCONNECT( )` method.
3. Using the `CONNECT( )` method on the same server object handle, bind the server object to the Web service using a binding that supports the next port type.
4. Create and map a new procedure object to the next port type, using the `RUN` statement with the same server object handle, and, if you want, setting the same procedure object handle used to map the previous port type.

You can repeat this procedure for each port type you need to access in the same Web service, or you can map all of the Web service port types at one time using multiple server object and procedure object handles.

Accessing multiple port types simultaneously

If you want to maintain access to two or more port types at the same time (for the same or a different Web service), you must create and bind a Web service to separate server object handles for each port type that you want to access. You can then create and map separate procedure object handles to each port type.

13

Invoking OpenEdge SOAP Web Service Operations from ABL

Invoking a Web service operation can be a simple process of returning a value and using it directly, or it can require a more complex treatment. The more complex treatment can include interacting with the SOAP message headers, handling SOAP faults, parsing and building complex parameters, or simply managing the serialized XML of a simple parameter.

This chapter describes how to invoke and manage the data associated with an operation for all of these requirements.

For details, see the following topics:

- Preparing to invoke operations
- Invoking operations
- Managing operation parameters
- Managing complex data
- Managing asynchronous requests

Preparing to invoke operations

The ABL interface to Web service operations is a type of proxy procedure object that you map to a port type in a Web service binding (see Connecting to OpenEdge SOAP Web Services from ABL on page 205). This *Web service procedure object* provides access to port type's operations much like a proxy procedure object provides access to remote internal procedures and user-defined functions defined by a persistent procedure instantiated on an AppServer (see *OpenEdge Application Server: Developing AppServer Applications*).

Creating a Web service procedure object

You map the port type to the procedure object using a syntax similar to how you instantiate a remote persistent procedure:

```
RUN portTypeName [ SET hPortType ] ON SERVER hWebService [ NO-ERROR ] .
```

For an ABL remote persistent procedure, you actually execute the procedure by name persistently; for a Web service port type, you invoke the operation using the name of the port type from the WSDL (*portTypeName*) that defines the operations you want to run. Otherwise, you can set and access a Web service proxy procedure handle (*hPortType*) the same way as for a remote persistent procedure. Like an AppServer, you use the server object handle bound to the Web service (*hWebService*) to indicate the remote location to receive Web service requests.

Note the lack of parameters in this statement. Where you might pass parameters when instantiating a remote persistent procedure, you cannot pass any parameters when creating a Web service procedure object, and the AVM raises an error if you do so.

All other attributes and methods on a Web service procedure object work much like they do for any proxy procedure object. Any attribute or method that has no meaning in the context of a Web service returns the `Unknown value (?)` or an empty string.

Note: A Web service procedure object supports an additional method, `SET-CALLBACK-PROCEDURE( )`, that is not used on a proxy procedure object. Callback procedures are internal procedures that access information in a SOAP header. For more information on callback procedures, see Specifying SOAP header callback procedures at run time on page 230.

Invoking operations

After you have created a Web service procedure object, you can invoke the operations made available through that object. OpenEdge identifies Web service operations in the ABL by the same names and signatures used to define them in the WSDL file for the Web service, which you specify when you bind the Web service using the `CONNECT( )` method (see Connecting to OpenEdge SOAP Web Services from ABL on page 205).

The WSDL Analyzer determines if you can invoke the operation using only an ABL `RUN` statement, or if you can also invoke it with a user-defined function call:

- If the Analyzer determines that the operation **does not** return a value, it defines the operation as an internal procedure that you **must** call using the `RUN` statement.
- If the Analyzer determines that the operation returns a value, it defines the operation in both of the following ways:

  a) As a user-defined function that you forward reference and invoke as a function

  b) As an internal procedure that you can call using the `RUN` statement

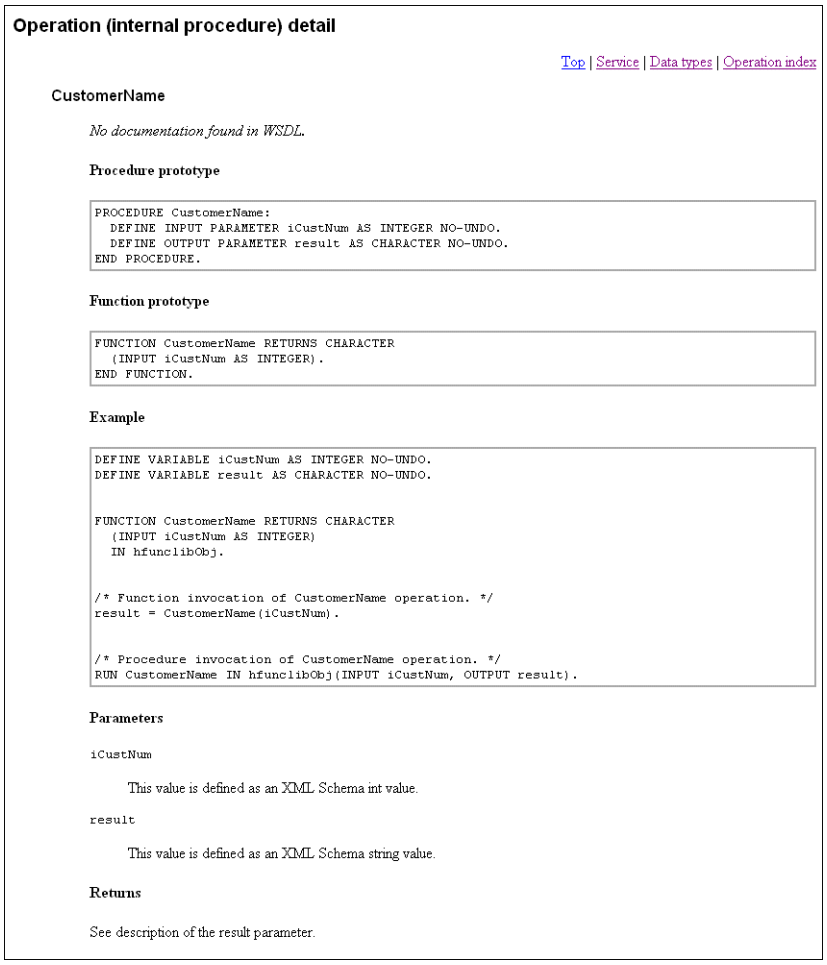
  ---

  Note: You cannot invoke native ABL procedures or user-defined functions interchangeably as one or the other. This feature only applies to Web service operations, and only those Web service operations as specified by the WSDL Analyzer.

The WSDL includes information that indicates if you can model a Web service as a user-defined function. If the WSDL does not indicate that or if there is a restriction in ABL that stops the operation from being called as a user-defined function, the WSDL Analyzer does not create a sample user-defined function. Any attempt to invoke a Web service operation using a method not specified by the WSDL Analyzer returns an error.

The following figure shows a sample operation listing from the WSDL Analyzer's Port type page that can be used as either an internal procedure or as a user-defined function.

Figure 16: WSDL Analyzer sample operation call



Operation (internal procedure) detail

Top | Service | Data types | Operation index

CustomerName

No documentation found in WSDL.

Procedure prototype

```
PROCEDURE CustomerName:
  DEFINE INPUT PARAMETER iCustNum AS INTEGER NO-UNDO.
  DEFINE OUTPUT PARAMETER result AS CHARACTER NO-UNDO.
END PROCEDURE.
```

Function prototype

```
FUNCTION CustomerName RETURNS CHARACTER
  (INPUT iCustNum AS INTEGER).
END FUNCTION.
```

Example

```
DEFINE VARIABLE iCustNum AS INTEGER NO-UNDO.
DEFINE VARIABLE result AS CHARACTER NO-UNDO.


FUNCTION CustomerName RETURNS CHARACTER
  (INPUT iCustNum AS INTEGER)
  IN hfunclibObj.


/* Function invocation of CustomerName operation. */
result = CustomerName(iCustNum).


/* Procedure invocation of CustomerName operation. */
RUN CustomerName IN hfunclibObj(INPUT iCustNum, OUTPUT result).
```

Parameters

iCustNum

This value is defined as an XML Schema int value.

result

This value is defined as an XML Schema string value.

Returns

See description of the result parameter.

Using the RUN statement

This is the general syntax for invoking Web service operations using the RUN statement:

```
RUN operationName IN hPortType [ ASYNCHRONOUS ... ]
  [ ( parameter [ , parameter ]... ) ]
  [ NO-ERROR ] .
```

As indicated, this statement invokes a Web service operation with the specified name (*operationName*) defined in the port type mapped to the specified procedure object handle (*hPortType*), passing any parameters with data types specified in the order they are defined for the operation by the WSDL Analyzer. For an example of this syntax, see the sample WSDL Analyzer code in Figure 16: WSDL Analyzer sample operation call on page 215.

Also, you can invoke any operation using the RUN statement either synchronously or asynchronously. For more information on asynchronous invocation for Web service operations, see Managing asynchronous requests on page 222. For complete information on the RUN statement syntax, see *OpenEdge Development: ABL Reference.*

Using a user-defined function

For a user-defined function invocation, you must first forward reference a prototype mapped to the appropriate Web service procedure handle definition, exactly as you do for a remote user-defined function prototype mapped to a Web service proxy procedure handle.

This is the general syntax for the forward reference to a function prototype:

Syntax

```
FUNCTION operationName [ RETURNS ] dataType
[ ( parameter [ , parameter ] ... ) ]
    IN hPortType .
```

This statement invokes a Web service operation with the specified name (*operationName*) defined in the port type mapped to the specified procedure object handle (*hPortType*), passing any parameters with data types specified in the order they are defined for the operation by the WSDL Analyzer, and passing the operation return parameter with the corresponding data type (*dataType*).

This is the syntax for simple invocation of one user-defined function in a single statement, the same for both Web service operations and user-defined functions:

Syntax

```
return = operationName [ ( parameter [ , parameter ] ... ) ] .
```

This statement invokes a user-defined function with the specified name (*operationName*), passing any parameters with data types specified in the order they are defined for the operation by the WSDL Analyzer, and passing the operation return parameter as the value of the function, which is assigned to a variable of compatible data type. For an example of this syntax, see the sample WSDL Analyzer code in Figure 16: WSDL Analyzer sample operation call on page 215.

As with any function, you can invoke it in any ABL statement where you need to use its value. However, you can only invoke a Web service user-defined function synchronously. For complete information on the FUNCTION statement prototype syntax, see *OpenEdge Development: ABL Reference.*

Managing operation parameters

As described in Data type casting on page 338, the data types that you specify for parameters in the ABL invocations of Web service operations must conform to a set of OpenEdge-supported castings established for corresponding XML Schema data types. The OpenEdge WSDL Analyzer provides all of the information you need to build interfaces between your ABL application and the Web service by documenting all of the Web service operations and how they can be mapped to the ABL, including the suggested (or recommended) ABL data types to use for XML Schema simple data type parameters.

Depending on the results you want to achieve, you might use one of the alternative castings supported by OpenEdge between XML Schema simple data types and ABL data types. Consistent with compatible data types in the ABL, OpenEdge implicitly converts between any XML Schema data type and any ABL data type included in the supported casting. If OpenEdge cannot complete the specified conversion, it generates a run-time error.

You can also map all XML Schema simple data types to the ABL `CHARACTER` or `LONGCHAR` type, because the SOAP messages used to exchange parameter values are XML character data. For XML Schema simple data types where `CHARACTER` is not the suggested ABL data type, using a `CHARACTER` or `LONGCHAR` causes OpenEdge to assume that you are passing the XML Schema-formatted string (the actual string value for the SOAP message) as the value for the parameter. This allows you to perform your own transformation on the value within your ABL application and to manage the value as you see fit. In doing this, you must format the `CHARACTER` or `LONGCHAR` values properly for any `INPUT` parameters to conform with the XML Schema data type defined for the Web service parameter by the WSDL. The only processing that OpenEdge does when passing XML Schema-formatted values is to perform any code page conversion required on the character data (for example, between the `CPINTERNAL` code page setting and UTF-8) and to validate that the format of the data is acceptable for the XML Schema data type. OpenEdge does no range or value checking that might be specified in the WSDL file.

XML Schema complex types are data types that contain multiple XML Schema data elements, possibly including other complex types. You can map complex types to either an ABL `TABLE` or `DATASET` parameter. To manage complex types that cannot be mapped to either an ABL temp-table or ProDataSet, you must work with the serialized XML directly, typically using the XML parsers in the ABL. For more information, see Managing complex data on page 217.

In general, if the invocation of a Web service operation fails for any reason, OpenEdge sets all `OUTPUT` and function return values to the `Unknown value (?)`.

Managing complex data

Wherever you encounter complex data, for a Web service, you have these basic options for accessing and managing the data, depending on the documentation generated by the WSDL Analyzer:

- As an ABL temp-table or ProDataSet
- As a serialized XML string
- As individual simple data types

For more information on how the Analyzer determines the options you can use, see Analyzing complex data on page 195.

Note: The examples in this section are not available on the Documentation and Samples (`doc_samples`) directory of the OpenEdge product DVD or Progress Documentation Web site.

Types of complex data

Complex data that you might need to access includes:

- Complex data type parameters, including complex arrays
- SOAP header entries
- SOAP fault detail

Complex data type parameters

If the Analyzer specifies that you can use a temp-table or ProDataSet to access a Web service parameter, you can access (for `OUTPUT`) and write to (for `INPUT`) the parameter exactly as you do for any temp-table or ProDataSet parameter in the ABL. If the Analyzer provides the temp-table or ProDataSet definition, you can use a static instance and specify the parameter as a `TABLE` or `DATASET`. For a static `OUTPUT` parameter, OpenEdge ensures that the object is created and filled from the parameter element in the SOAP response message. For static `INPUT` parameter, you must create and fill the object, as appropriate, before passing the parameter.

If you must access the parameter as a dynamic temp-table or ProDataSet, you can specify the parameter as a `TABLE-HANDLE` or `DATASET-HANDLE`. For a dynamic `OUTPUT` parameter, OpenEdge ensures that the object is created and filled from the parameter element in the SOAP response message. For dynamic `INPUT` parameter, you must create and fill the object, as appropriate, before passing the parameter.

For an `OUTPUT` parameter that you access as a serialized XML string, you can work with serialized XML in the `CHARACTER` or `LONGCHAR` parameter directly, using ABL string-manipulation statements and functions, or work with it in its parsed form using the ABL SAX reader or DOM parser. In any case, OpenEdge provides the entire `complexData` element for the value, exactly as it appears in the SOAP response message.

For an `INPUT` parameter that you write as a serialized XML string, you can build or maintain the value using the ABL SAX writer or DOM parser, and save the result as a `LONGCHAR` value when you are ready to pass it as an `INPUT` parameter to the Web service.

For more information on using the SAX and DOM features in ABL, see *OpenEdge Development: Programming Interfaces*. For an example of how to handle complex data parameters in ABL, see Complex data example on page 218.

Complex data in SOAP headers and SOAP faults

You can also use techniques available for managing complex data parameters to access and manage the data for SOAP header entries and SOAP fault detail elements. You can get and set this data either as serialized character strings or as DOM trees. For more information, see Handling SOAP Message Headers in ABL on page 225, Handling Errors in ABL Requests to OpenEdge SOAP Web Services on page 255.

Complex data example

The following examples show how you might manage a complex parameter, or any complex data, in this case, an `OUTPUT` parameter as serialized XML. This is a procedure that maps to a Web service operation, `getAddress`. Given a social security number (`ssn`), the operation returns an address (`Address`) as a complex type:

ABL prototype with a complex parameter accessed as serialized XML

```
PROCEDURE getAddress:
  DEFINE INPUT  PARAMETER ssn       AS CHARACTER.
  DEFINE OUTPUT PARAMETER cmAddress AS LONGCHAR.
END PROCEDURE.
```

This is the schema for a `<complexType>` element that returns the address information to the caller. It contains five `string` data type elements representing the components of the address:

Complex type in the WSDL

```
<complexType name="Address">
  <sequence>
    <element name="name" type="xsd:string">
    <element name="street" type="xsd:string">
    <element name="city" type="xsd:string">
    <element name="state" type="xsd:string">
    <element name="zip-code" type="xsd:string">
  </sequence>
</complexType>
```

This sample ABL procedure demonstrates how you can manage this complex type in ABL as a DOM tree. The variable to receive the parameter value, `cmAddress`, is defined as a `LONGCHAR`. After the Web service operation returns a value for `cmAddress`, the `LOAD( )` method on the x-document handle, `hXDoc`, parses and loads the `<complexType>` element from `cmAddress` into the associated x-document object.

Because the schema of the complex type is known, the remaining x-document and x-noderef handle methods simply retrieve the root node from the `"Address"` DOM tree, and pick off the component value (text element) for each of the five component nodes that comprise the complex type, in order, assigning them to the corresponding fields of a database record.

This is the ABL example for handling the parameter as a DOM tree:

Complex type managed in ABL as a DOM tree

```
DEFINE VARIABLE hWS           AS HANDLE.
DEFINE VARIABLE hAddrPortType AS HANDLE.
DEFINE VARIABLE cmAddress     AS LONGCHAR.

CREATE SERVER hWS.

hWS:CONNECT ("-WSDL http://www.zzzcompany.org/ssn.wsdl
              -Service addressSVC
              -Port addressPort").

RUN addressPortType SET hAddrPortType ON SERVER hWS.

RUN getAddress IN hAddrPortType (INPUT "555-55-5555", OUTPUT cmAddress).

DEFINE VARIABLE hXDoc  as HANDLE.
DEFINE VARIABLE hXRoot as HANDLE.
DEFINE VARIABLE hXNode as HANDLE.
DEFINE VARIABLE hXText as HANDLE.

CREATE X-DOCUMENT hXDoc.
CREATE X-NODEREF  hXRoot.
CREATE X-NODEREF  hXNode.
CREATE X-NODEREF  hXText.

hXDoc:LOAD("LONGCHAR", cmAddress, FALSE).

hXDoc:GET-DOCUMENT-ELEMENT(hXRoot).

/* because we know the content, we are just moving straight ahead
   and getting each one of the nodes under the root, then getting its
   TEXT node to get the data we're interested in. */
hXRoot:GET-CHILD(hXNode, 1).
hXNode:GET-CHILD(hXText, 1).

/* let's assume we have a DB table with the appropriate fields */
myTable.name = hXText:NODE-VALUE.

/* ... */
hXRoot:GET-CHILD(hXNode, 5).
hXNode:GET-CHILD(hXText, 1).
myTable.zip-code = hXText:NODE-VALUE.

/* clean up */
/* ...      */

hWS:DISCONNECT( ).
```

Coding options for wrapped document literal

For Wrapped Doc/Lit operations, ABL allows you to use one or both of two alternate forms for accessing the operation INPUT and OUTPUT parameters using ABL procedures and functions. You can either access them in wrapped form as XML strings containing the complex data for each SOAP message (request and response) or you can access them in unwrapped form as several ABL parameters, in many cases, with simple ABL data types. You can overload these forms. That is, you can use both forms for the same operation in the same client session.

Note: In most cases, you will find the unwrapped form easier to use. Using the wrapped form is supported for backwards compatibility.

Using the wrapped form

Suppose you have a Wrapped Doc/Lit operation, `foo`. The one complex input parameter contains a single element with two child elements, `bBoolean` and `iInteger`. The one complex output parameter also contains a single element with two child elements, `iInteger` and `cString`. Using the wrapped form, you might run the `foo` procedure with the `INPUT` parameter (`param1`) set to the XML string as shown in this example:

Wrapped Doc/Lit operation—wrapped form

```
DEFINE VARIABLE param1 AS LONGCHAR NO-UNDO.
DEFINE VARIABLE param2 AS LONGCHAR NO-UNDO.

param1 = "
<ns0:foo xmlns:ns0='http://tempuri.org/'>
  <ns0:bBoolean>true</ns0:bBoolean>
  <ns0:iInteger>17</ns0:iInteger>
</ns0:foo>"

RUN foo IN hWebService (INPUT param1, OUTPUT param2).

DISPLAY "Returned from web service call:" SKIP
  "  param2 = " SKIP param2 NO-LABEL FORMAT "x(200)".
```

On the return, you might display an XML string in the `OUTPUT` parameter (`param2`) as follows:

```
Returned from web service call:
  param2 =
<ns0:fooResponse xmlns:ns0='http://tempuri.org/'>
  <ns0:iInteger>18</ns0:iInteger>
  <ns0:cString>Hello world!</ns0:cString>
</ns0:fooResponse>
```

Clearly, to work with the individual values contained in these parameters, you must treat them as complex data (see Complex data example on page 218).

Using the unwrapped form

Using the unwrapped form for the same Wrapped Doc/Lit operation, `foo`, you can access all the parameter values individually using ABL data types. In this case, the WSDL Analyzer recognizes that there is a single `INTEGER` mapping for a value in both complex input and output parameters of the wrapped operation. So, it prescribes a single `INPUT-OUTPUT` parameter for that `INTEGER` mapping (`iInteger`). It prescribes individual `INPUT` and `OUTPUT` modes for the remaining values, as indicated in this example:

Wrapped Doc/Lit operation—unwrapped form

```
DEFINE VARIABLE bBoolean AS LOGICAL NO-UNDO.
DEFINE VARIABLE iInteger AS INTEGER NO-UNDO.
DEFINE VARIABLE cString AS CHARACTER NO-UNDO.

bBoolean = true.
iInteger = 17.

RUN foo IN hWebService (INPUT bBoolean, INPUT-OUTPUT iInteger,
                        OUTPUT cString).
DISPLAY "Returned from web service call:" SKIP
  "  iInteger = " iInteger NO-LABEL SKIP
  "  cString  = " cString NO-LABEL FORMAT "x(12)".
```

On return, you might display the individual OUTPUT values (`iInteger` and `cString`) as follows:

```
Returned from web service call:
  iInteger = 18
  cString  = Hello world!
```

No further work is required to access these values in ABL.

Managing asynchronous requests

As indicated previously, you can invoke Web service requests asynchronously from ABL. This means that you can invoke a Web service request in such a way that the result is handled independently of the mainline flow of execution. That is, ABL statements following the asynchronous request execute immediately and in order without waiting for the result of the asynchronous request to be available. Instead, the asynchronous request specifies an internal event procedure to handle the result when the result for that asynchronous request becomes available, which is signalled by the activation of a `PROCEDURE-COMPLETE` event.

When it is time to handle the `PROCEDURE-COMPLETE` event, the specified event procedure executes and manages any `OUTPUT` or `INPUT-OUTPUT` parameters that were passed to the asynchronous request when it was invoked. These parameters are returned as `INPUT` parameters to the event procedure, which can store the parameter values or otherwise process the result for use by the mainline program. The mainline program can periodically inspect an asynchronous request object handle (also available to the event procedure), which it sets during invocation of the request, in order to determine if the specified asynchronous request has completed. If the request has completed, the program can then make use of the results as provided by the internal event procedure that handled them.

The model for asynchronous Web service request invocation is very similar to the model for asynchronous remote procedure invocation on a session-free AppServer. This section describes the asynchronous Web service calling model, noting any differences from the asynchronous session-free AppServer calling model. For information on the model for invoking asynchronous requests on a session-free AppServer, see *OpenEdge Application Server: Developing AppServer Applications.*

Note: For certain features that support Web service requests in ABL (for example, error handling), the feature behavior might differ depending on whether the request is synchronous or asynchronous.

Supported asynchronous Web service requests

You can only invoke an asynchronous Web service request as a procedure using the RUN statement. This means that if a Web service operation is invoked as a user-defined function, you can only invoke it synchronously, because all operations that have a return value can only be invoked as user-defined functions, where the value must be made available at the point of invocation. This is consistent with how OpenEdge supports the invocation of asynchronous requests on the AppServer (remote procedures only).

Order of completion

Similar to a session-free AppServer request, the order of completion for an asynchronous Web service request is determined solely by the Web service. The manner in which the ABL client send and response queues for an asynchronous request handle messages is identical for both session-free asynchronous AppServer requests and asynchronous Web service requests. That is, if ABL invokes multiple asynchronous Web service requests, the order of their completion cannot be determined on the Web service or session-free AppServer client. So, you must write your mainline program, and indeed your asynchronous event procedures, to make no assumptions about the order in which multiple asynchronous Web service requests complete.

A subtle distinction between a session-free asynchronous AppServer request and an asynchronous Web service request is the SOAP response callback procedure available for the Web service request. If a SOAP response callback procedure is set for an asynchronous Web service request, it executes after the SOAP response message arrives at the client but before the asynchronous event procedure executes to handle the PROCEDURE-COMPLETE event for the request.

Asynchronous request object handle

OpenEdge maintains an asynchronous request object for each asynchronous request, which maintains the status of the request, including whether and how it has completed (successfully or unsuccessfully). The handle to this asynchronous request object is available to the mainline program and to the event procedure for an asynchronous Web service request in the same way as for an asynchronous AppServer request. The Web service server object handle maintains its own chain of pending asynchronous request object handles (FIRST-ASYNC-REQUEST and LAST-ASYNC-REQUEST attributes), and the PROCEDURE-NAME attribute on each asynchronous request object handle returns the name of its Web service operation as it returns the name of the remote procedure executed for an asynchronous AppServer request.

The following table shows attributes on the asynchronous object handle that have special meaning for Web services.

Attributes on asynchronous request object handle

Attribute	Meaning for Web service requests
ERROR	Returns TRUE within the context of the event procedure when: • You invoke the RETURN ERROR statement within the context of an associated SOAP response header callback procedure. • A SOAP fault is returned for the asynchronous Web service request.
NEXT-SIBLING and PREV-SIBLING	Maintains a chain of asynchronous request object handles for all pending asynchronous requests invoked in the same Web service
PERSISTENT-PROCEDURE	Returns a handle to the procedure object bound to the Web service port type

Attribute	Meaning for Web service requests
PROCEDURE-NAME	Returns the name of the Web service operation invoked asynchronously
QUIT	Always returns FALSE for an asynchronous Web service request
SERVER	Returns a handle to the server object for the Web service where the asynchronous request is executed

Results handling

A few differences exist in the results returned for an asynchronous Web service request compared to an asynchronous AppServer request, as shown in the following table.

Results for asynchronous Web service requests

ABL result elements	Web service request result
ERROR-OBJECT	Returns an object reference to an instance of a class that implements Progress.Lang.SoapFaultError.
ERROR-STATUS system handle	If the ERROR attribute of the asynchronous request object handle is set to TRUE because of a SOAP fault, the ERROR-STATUS:ERROR-OBJECT-DETAIL attribute references a SOAP-fault object handle with information on the SOAP fault.
RETURN-VALUE function	The value for ABL RETURN-VALUE function is never altered directly by the response from a Web service asynchronous request.
STOP condition	The client can raise the STOP condition by executing the CANCEL-REQUESTS( ) method on the Web service server object handle. All outstanding Web service requests are handled in a similar manner to those on an AppServer, except that for any currently executing Web service requests, the result is undefined. OpenEdge disconnects from all ports to currently executing Web service requests, and the exact response depends on how the Web service responds to the lost connection.

14

Handling SOAP Message Headers in ABL

SOAP headers are an optional part of a SOAP message and the requirement to use them depends on the Web service. Many Web services require no client handling of SOAP headers.

If the Web service requires you to handle SOAP headers, especially if you need to modify or examine the contents of a SOAP header, you might need to understand ABL facilities for parsing and managing XML. This includes ABL support for parsing and directly manipulating an XML document in a Document Object Model (DOM) tree or parsing and writing the elements of an XML document using the Simple API for XML (SAX). For more information on these facilities, see *OpenEdge Development: Programming Interfaces.*

In rare instances, you might be able to access the data in a SOAP header as an ABL temp-table or ProDataSet, without the need to directly manage the XML. However, this is only possible if the WSDL Analyzer recognizes complex data in the header that it can map to a temp-table or ProDataSet definition. For more information, see Analyzing complex data on page 195.

The sections in this chapter describe how to define and use specified callback procedures (header handlers) that manage the SOAP headers for SOAP request and response messages.

For details, see the following topics:

- SOAP message headers: an overview
- Defining header handlers
- Invoking a header handler
- Creating and managing SOAP message headers
- Managing memory for SOAP headers
- Attributes and methods for handling SOAP headers

SOAP message headers: an overview

A SOAP request message or a SOAP response message can contain an optional <Header> element that passes non-parameter information about the Web service or the operation that generates the message. This header can contain one or more header entries. A *header entry* contains information that is necessary to properly invoke some or all of the Web service operations.

A header returned by the Web service in a SOAP response message is a *SOAP response header*. A header sent in a SOAP request message by invoking a Web service operation is a *SOAP request header*. There is no difference in the syntax for the two types. However, keeping them conceptually separate helps to clarify how you can manage them. The content of a SOAP request header for a given operation might vary from the content of a SOAP response header for that same operation.

Why are headers necessary if operations already pass data as parameters? Headers can simplify managing data in Web services that require context management, such as user authentication, during the course of Web service interaction. Session-managed OpenEdge Web services use this method for maintaining context. With the use of headers, the mainline of a client application need have no concern about maintaining these states. The Web service provider typically provides specific information about the content of headers and how they must be handled by client applications. The client can then provide special *header handlers*, which are callback procedures that manage the content of these headers for the Web service application.

SOAP header structure

The following XML contains a SOAP header as it might appear inside a SOAP message:

SOAP message with header

```
<soap:Envelope>
   xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xmlns:xsd="http://www.w3.org/2001/XMLSchema">
   . . .
   <soap:Header>
      <q1:OrderInfoID
                  xmlns:q1="http://www.example.com/webservices/OrderInfo"
                  SOAP-ENV:mustUnderstand="1"
                  SOAP-ENV:actor="/WSA">
         <uuid xsi:type="xsd:string">12345-67890-98765-4321</uuid>
      </q1:OrderInfoID>
      <t:Transaction
                  xmlns:t="http://www.example.com/webservices/Transaction"
                  SOAP-ENV:mustUnderstand="1" t:stepnum="1">
         <t:TransID>5</t:TransID>
         <t:SubID>871</t:SubID>
      </t:Transaction>
   </soap:Header>
   <soap:Body ...>
      <parameter-element> ... </parameter-element>
      . . .
   </soap:Body>
</soap:Envelope >
```

As you can see, the <Header> element is only a container for other elements, the application-specific header entry elements. Any parameters generated for an operation in this SOAP message appear in the <Body> element in much the same way.

In this case, the SOAP header contains two header entries, named `q1:OrderInfoID` and `t:Transaction` (where `q1:` and `t:` are namespace prefixes). Each of these elements has a series of attributes and contains one or more child elements. The `<q1:OrderInfoID>` element contains one child element named `uuid`, and the `<t:Transaction>` element contains two child elements, named `t:TransID` and `t:SubID`. All of these element names are application-defined.

Accessing the SOAP header

To access the SOAP header and its elements from your ABL application, you define callback procedures using specific signatures that act as header handlers. When you need to access the headers, you need separate header handlers for each Web service procedure object. A header handler can handle either the SOAP request headers or the SOAP response headers for all operations maintained by that procedure object. A single header handler cannot handle both types of headers. You can specify the handlers for a Web service procedure object by invoking the `SET-CALLBACK-PROCEDURE( )` method on the corresponding procedure handle.

If you want to add additional handlers for the same port type managed by a Web service procedure object, you must map the port type using additional procedure objects.

Every time you invoke an operation for a port type where you have specified header handlers, the handlers execute as part of the operation invocation. For SOAP request messages, the handler intercepts and manages the SOAP headers before the message is sent to the Web service. For SOAP response messages, the handler intercepts and manages the SOAP headers before any message parameters are passed to complete invocation of the operation.

Requirements for header handlers

Using header handlers is not an absolute requirement. The design of the Web service drives the need for managing headers. The only absolute requirement for a header handler is the signature that you must use to define it. You can set and reset the callbacks for header handlers as needed. For example, you might make changes to do the following:

- Specify the correct handlers for different operations and port types
- Add additional header handlers for a single port type by mapping the port type to additional Web service procedure objects
- Remove any previously specified callbacks entirely when you have no need to handle the SOAP headers for an operation or port type

For more information on:

- How to specify callback procedures as header handlers, see Specifying SOAP header callback procedures at run time on page 230.
- The general cycle of operation for header handlers in ABL, see Invoking a header handler on page 233.
- Defining the callback procedures for header handlers, see Defining header handlers on page 231.

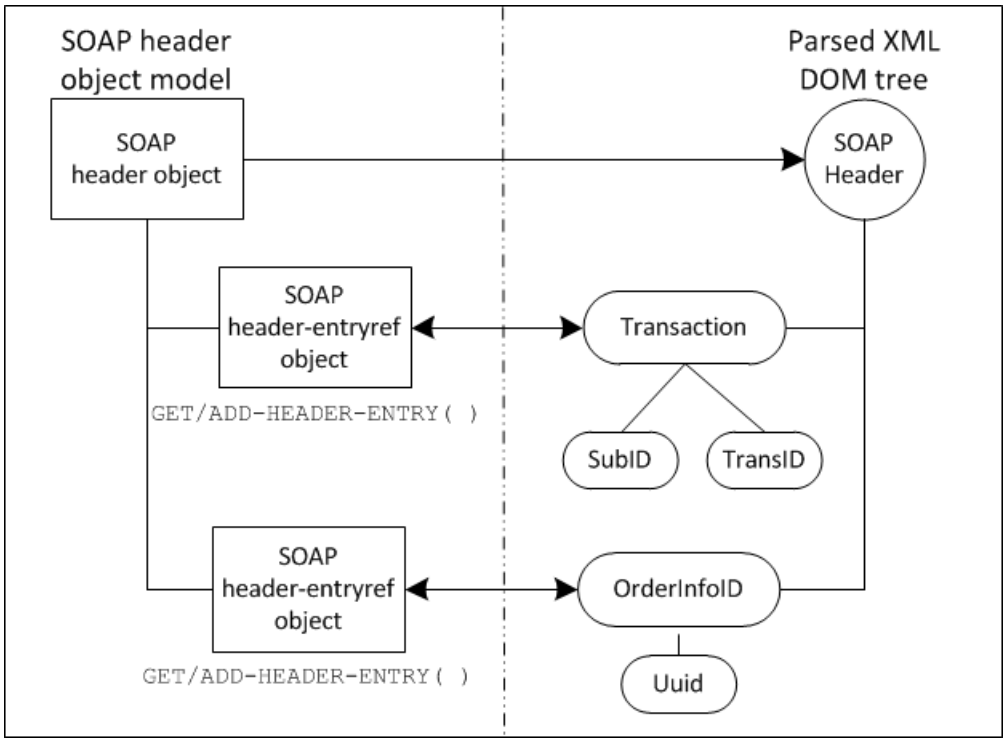
SOAP header object model

The most important part of a header handler signature is a `HANDLE` parameter that references the header of a SOAP message. This handle references a SOAP header object that maps to the parsed XML of the actual SOAP message header in the form of a DOM tree. The SOAP header object implements part of an object model that allows you to directly access the XML content of the SOAP header without having to parse it out of the SOAP message. Figure 1 shows the relationship between the SOAP header object model and the parsed XML DOM tree using the SOAP header described in the preceding section.

The complete SOAP header object model includes two types of objects:

- **SOAP header object** — References the <Header> element of a SOAP message.
- **SOAP header-entryref object** — References one of the header entry elements in a SOAP header as specified by the GET-HEADER-ENTRY( ) method on the SOAP header object. The SOAP header entryref object can also reference a header entry element that you add to the SOAP header using the ADD-HEADER-ENTRY( ) method on the SOAP header object.

Figure 17: Referencing a header entry in the SOAP header object model



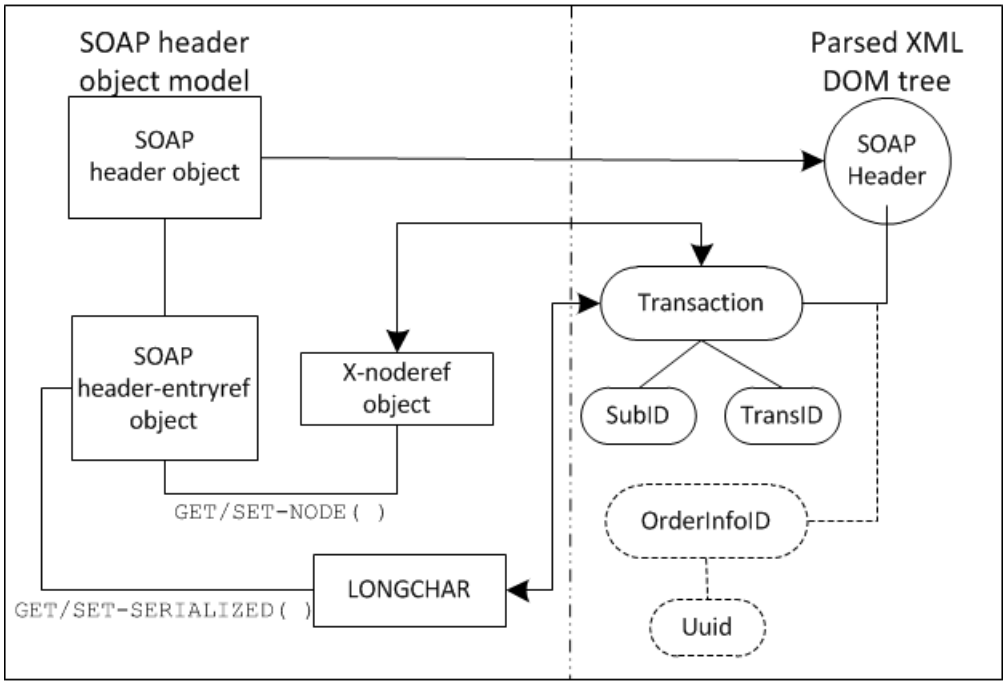
The SOAP header object handle also provides attributes that return information about the name of the header and the number of header entries that the header contains.

In the above figure, one SOAP header-entryref object references the Transaction header entry and another object references the OrderInfoID header entry. When working with a SOAP header, you can also use a single SOAP header-entryref object to reference all of the header entries in a SOAP header, one at a time. The SOAP header-entryref object handle provides several ABL attributes and methods that allow you to inspect and modify the contents of the header entry that it references. The attributes return the values of standard SOAP attributes contained in the header entry element, such as the name and namespace of the header entry.

Accessing SOAP header entries

The SOAP header-entryref object handle provides two methods for accessing the element subtree of the SOAP header entry that it references, as shown in the following figure.

Figure 18: Accessing entry elements in the SOAP header object model



The SOAP header-entryref object handle provides two methods to access the XML in the header entry that it references:

- `GET-NODE( ) method`—assigns an X-noderef object to reference the root node of the header entry in the DOM subtree of the header entry. You can then use this X-noderef object to examine the XML elements by walking and returning values for the nodes of the header entry DOM subtree.
- `GET-SERIALIZED( ) method`—assigns a `LONGCHAR` value that contains the entire header entry as a serialized XML string that you can parse yourself using either the ABL SAX reader or DOM parser.

The SOAP header-entryref object handle also provides two corresponding methods for replacing the entire content of the SOAP header entry that it references:

- `SET-NODE( ) method`—replaces the content of the header entry with the DOM subtree whose root node is currently referenced by a specified X-noderef object.
- `SET-SERIALIZED( ) method`—replaces the content of the header entry with a DOM subtree that it parses from a specified `LONGCHAR` value containing the serialized XML for the header entry that you can build and write using a DOM tree or the ABL SAX writer.

For more information on these objects and all the attributes and methods that they support, see Creating and managing SOAP message headers on page 235.

In the rare instances when the WSDL Analyzer identifies a temp-table or ProDataSet definition that maps to the header entry, you can use the `GET-SERIALIZED( )` and `SET-SERIALIZED( )` methods in conjunction with the `READ-XML( )` and `WRITE-XML( )` methods of the documented ABL object (temp-table or ProDataSet) to access or build the header entry.

Accessing a SOAP response header

To access a SOAP response header entry as a temp-table or ProDataSet:

1. Set a LONGCHAR with the header entry XML using the GET-SERIALIZED( ) method.
2. Load the temp-table or ProDataSet from the LONGCHAR using the READ-XML( ) method.

Creating a SOAP request header

To create a SOAP request header entry from a temp-table or ProDataSet:

1. Write the header entry from the temp-table or ProDataSet to a LONGCHAR using the WRITE-XML( ) method.
2. Replace the header entry with the serialized XML in the LONGCHAR using the GET-SERIALIZED( ) method.

For more information on temp-table and ProDataSet XML methods, see *OpenEdge Development: Programming Interfaces.*

Specifying SOAP header callback procedures at run time

For an AppServer, all information about remote requests is either passed with parameters or obtained using the attributes and methods of various handles related to the request. For a Web service, most information about Web service requests is passed with parameters, but some information is also contained within other elements of the SOAP message, such as the SOAP header. The SET-CALLBACK-PROCEDURE( ) method allows you to specify internal procedures that can access the content of the SOAP header element in a SOAP message as part of the invocation of a Web service operation that generates the message.

The SET-CALLBACK-PROCEDURE( ) method registers an internal procedure with a specified *ABL callback*, a designation that causes the internal procedure (*callback procedure*) to execute in response to some ABL core action, such as in this case, sending and receiving SOAP messages. For Web services, this method supports two types of ABL callbacks:

- **"REQUEST-HEADER"** — Identifies a SOAP request header callback procedure. This procedure executes just after you invoke a Web service operation and just before OpenEdge sends the SOAP request message to the Web service. It allows you to create or pass an existing SOAP header for use as the SOAP header of an out-going SOAP request message.
- **"RESPONSE-HEADER"** — Identifies a SOAP response header callback procedure. This procedure executes just after OpenEdge receives the message sent by the Web service in response to processing the Web service operation that you invoked, and just before it makes any output or return parameters available to the ABL calling context. It allows you to examine the SOAP header of an in-coming SOAP message.

Note: While this header callback procedure executes for either a normal SOAP response message or a SOAP fault message generated for the Web service request, a SOAP header is only available in a SOAP response that is not a SOAP fault.

A single Web service procedure object can support only one request header callback and one response header callback at one time. This means that for a single procedure object, you must use the same callbacks for all operations invoked on that procedure object. However, if you want greater flexibility to use different callbacks for the same set of operations, you can use the RUN*portTypeName* statement to create an additional Web service procedure object for the same port type. You can then invoke the SET-CALLBACK-PROCEDURE( ) method on the new procedure object to assign a different set of callback procedures for use by that same port type. By creating additional Web service procedure objects this way, you can then assign as many callback procedures for a single port type as you want.

Using the SET-CALLBACK-PROCEDURE( ) method

This is the syntax for the SET-CALLBACK-PROCEDURE( ) method:

Syntax

```
SET-CALLBACK-PROCEDURE (callback-name, internal-procedure
            [ , procedure-context ])
```

The parameters include:

- ***callback-name*** — A character string value of "REQUEST-HEADER" or "RESPONSE-HEADER" to identify the type of callback.
- ***internal-procedure*** — A character expression containing the name of the internal procedure you want executed for the specified callback. To unregister a callback definition, pass an empty string ("").
- ***procedure-context*** — (Optional) A procedure object handle that points to an active procedure context that contains the specified internal procedure. This is typically a persistent procedure instantiated in the current OpenEdge session or the method calling context (THIS-PROCEDURE). If not specified, it is the value of THIS-PROCEDURE.

In general, you can define the internal procedure for a callback in any procedure context that is guaranteed to be active at the time you execute the SET-CALLBACK-PROCEDURE( )method, and that remains active until after the callback procedure is executed by OpenEdge. The time of this execution depends on the type of request:

- **Synchronous Web service requests** — For either a SOAP request header callback or a SOAP response header callback, the procedure context must remain active until the operation invocation has completed execution.
- **Asynchronous Web service requests** — For a SOAP request header callback, the procedure context must remain active until the operation invocation has completed execution. For a SOAP response header callback, the procedure context must remain active until activation of the PROCEDURE-COMPLETE event for the request and any results have been returned to the PROCEDURE-COMPLETE event procedure.

Defining header handlers

An ABL application does most of the work for accessing or creating a SOAP header in the two header handlers that you can invoke for Web service operations. These include a callback procedure for handling the SOAP response message header and another callback procedure for handling the SOAP request message header for the operation. This is the syntax for defining the signatures for these two procedures:

- SOAP response header callback procedure:

Syntax

```
PROCEDURE response-header-procname :
  DEFINE INPUT PARAMETER hSOAPHeader AS HANDLE .
  DEFINE INPUT PARAMETER cOperationNamespace AS CHARACTER .
  DEFINE INPUT PARAMETER cOperationLocalName AS CHARACTER .
END PROCEDURE .
```

- SOAP request header callback procedure:

Syntax

```
PROCEDURE request-header-procname :
  DEFINE OUTPUT PARAMETER hSOAPHeader AS HANDLE .
  DEFINE INPUT  PARAMETER cOperationNamespace AS CHARACTER .
  DEFINE INPUT  PARAMETER cOperationLocalName AS CHARACTER .
  DEFINE OUTPUT PARAMETER lDeleteOnDone AS LOGICAL .
END PROCEDURE .
```

These are the parameters:

- ***response-header-procname*** — The name of a response header handler procedure. Specified as a character expression to the SET-CALLBACK-PROCEDURE( ) method along with the "RESPONSE-CALLBACK" setting.
- ***request-header-procname*** — The name of a request header handler procedure. Specified as a character expression to the SET-CALLBACK-PROCEDURE( ) method along with the "REQUEST-CALLBACK" setting.
- ***hSOAPHeader*** — A handle to a SOAP header object that encapsulates the header of the SOAP message that is about to be sent (request header) or that has just been received (response header). In a response header handler, the SOAP header object has no content if the NUM-HEADER-ENTRIES attribute on the object handle returns the value 0; otherwise it contains one or more SOAP header entries. In a request header handler, this is an OUTPUT parameter, therefore if the outgoing SOAP message requires a SOAP header, you must either build a SOAP header for this parameter to reference or provide an existing SOAP header saved from a previous response callback.
- ***cOperationNamespace*** — Contains the namespace portion of the operation's qualified name. Use this parameter together with the *cOperationLocalName* parameter if you need to identify the operation for which the SOAP message is being sent or received.
- ***cOperationLocalName*** — Contains the local-name portion of the operation's qualified name. Use this parameter together with the *cOperationNamespace* parameter if you need to identify the operation for which the SOAP message is being sent or received.
- ***lDeleteOnDone*** — (Request callback only) Tells OpenEdge to delete the SOAP header object and all of the parsed XML after the SOAP header has been inserted into the out-bound SOAP message. For more information on the scope of these objects, see Managing memory for SOAP headers on page 250.

For both types of callback procedure you can use the INPUT parameters, *cOperationNamespace* and *cOperationLocalName*, to determine the Web service operation for which the message is generated. You might use this information either to determine how to parse the SOAP response header based on the invoked operation or to build a SOAP request header that is specific to the invoked operation.

If you need to pass context between the code that invokes a Web service operation and a header callback procedure, you can pass the context information as you might for any internal procedure:

- Use procedure variables global to the calling code, if the callback procedure is defined within the context of the calling code.
- Use the PRIVATE-DATA attribute on the procedure context handle (THIS-PROCEDURE) of the header handler.

Defining a response header handler

The response header handler receives a SOAP header object as an input parameter. This object references the SOAP header entries returned by the Web service for an operation. You might need to save the entire SOAP header for use in a subsequent request, or you might need to save specific information from one or more individual header entries for validation or some other application purpose. Such requirements dependent entirely on the Web service. However, when your application no longer needs the input header itself, you must delete the SOAP header object explicitly.

Caution: After receiving a response message for which a header handler has been defined, OpenEdge creates a SOAP header object for input to the header handler even if the message contains no SOAP header. Your application must manage the lifetime of this response header object even if it does nothing else except delete the object (typically done in the response header handler). To avoid having to manage SOAP header objects for response messages that do not contain headers, do not define a response header handler for these response messages or unregister any that you have defined. For more information, see Using the SET-CALLBACK-PROCEDURE( ) method on page 231.

Defining a request header handler

The main function of a request header handler is to build a SOAP `<Header>` element appropriate for the operation. You can do this by creating a SOAP header object and associating with it the required number of SOAP header entries. The handler has an `OUTPUT` parameter (*`hSOAPHeader`*) that you can use to pass the SOAP header that you have built to OpenEdge to insert into the outgoing SOAP message. Any changes you make in the handler to the SOAP header object or its constituent SOAP header-entryref objects are integrated into the SOAP message when the handler completes execution. Thus, if the SOAP header that you return in this procedure contains SOAP header entries, OpenEdge sends out the SOAP message containing a corresponding header element. If you do not set the SOAP header object `OUTPUT` parameter (*`hSOAPHeader`*), OpenEdge does not include a header in the outgoing SOAP message.

If you create a SOAP header in the handler, with potentially multiple SOAP header entries, you are responsible for cleaning up the memory that is used for it. As an aid for deleting this object, and its memory, you can set the *`lDeleteOnDone`* parameter for output. Setting this parameter to `TRUE`, directs OpenEdge to delete the SOAP header object after OpenEdge has copied the object's contents to the outgoing message. Otherwise, your application must manage the lifetime of this object and determine when the object gets destroyed.

Caution: Do not explicitly delete the header object within the context of the request header handler (before it completes). If you do this, OpenEdge never gets the header to include in the SOAP request message.

Invoking a header handler

The following procedure fragment shows how ABL might specify and invoke a header handler for the SOAP message described in the previous sections, in this case returned as a SOAP response message:

Invocation of a header handler

```
/*** PROCEDURE: Start transactions on an order. ***/
DEFINE INPUT PARAMETER OrderNum AS INTEGER.
DEFINE OUTPUT PARAMETER hOrderSvc AS HANDLE.
DEFINE OUTPUT PARAMETER gcUUID AS CHARACTER.

/* Create hOrderSvc server handle and connect to order Web service. */
. . .

/* Create hPortType procedure handle and map port type to it. */
. . .

/* Set up response header handler. */
hPortType:SET-CALLBACK-PROCEDURE( "RESPONSE-HEADER",
                                  "TransactionResponseHandler",
                                  THIS-PROCEDURE ).
/* Start a transaction on an order. */RUN startTransaction( "ORDER", OrderNum ) IN
hPortType NO-ERROR.

. . .
```

This fragment specifies the response header handler for an internal procedure named `TransactionResponseHandler` that is defined in the current external procedure context. Then, it invokes a `startTransaction` procedure as the first operation. As the name and parameters imply, this operation begins a transaction on the order (perhaps automatically retrieved or created, as necessary) with the specified order number.

Assume the SOAP response message returned by this operation has a header containing database object and transaction state information for the transaction that was started. The example SOAP message, in SOAP header structure on page 226, contains just such information, including an ID for the order (the `<q1:OrderInfoID>` element) and some values identifying the transaction that is managing the order (the `<t:Transaction>` element).

The following internal procedure defines the `TransactionResponseHandler` callback procedure for the header handler. In this case, the handler locates the `<uuid>` element in the `OrderInfoID` header entry within the SOAP header referenced by the SOAP header object handle parameter, `hSOAPHeader`. It then saves the `uuid` string value to an `OUTPUT` parameter(`gcUUID`)defined globally in the calling procedure context. This is all accomplished using methods and attributes of the SOAP header object, SOAP header entry object, and x-noderef objects to access the parsed XML DOM tree of the SOAP header:

Definition of a header handler procedure

```
/*
  This response handler looks for a header entry named "OrderInfoID" and
  assumes that it contains an element named "uuid". The handler saves away
  the value of "uuid". This routine assumes that the SOAP header is no longer
  needed after the callback completes.
*/
PROCEDURE TransResponseHandler:
  DEFINE INPUT PARAMETER hSOAPHeader AS HANDLE.
  DEFINE INPUT PARAMETER cOperationNamespace AS CHARACTER.
  DEFINE INPUT PARAMETER cOperationLocalname AS CHARACTER.

  DEFINE VARIABLE hsheEntry AS HANDLE.
  CREATE SOAP-HEADER-ENTRYREF hsheEntry IN WIDGET-POOL "soap".

  DEFINE VARIABLE hxnTemp AS HANDLE.
  DEFINE VARIABLE hxnWorkRoot AS HANDLE.
  DEFINE VARIABLE hxnTemp2 AS HANDLE.

  CREATE X-NODEREF hxnTemp IN WIDGET-POOL "soap".
  CREATE X-NODEREF hxnTemp2 IN WIDGET-POOL "soap".
  CREATE X-NODEREF hxnWorkRoot IN WIDGET-POOL "soap".

  /* Walk the SOAP-HEADER's list of header entries, */
  /* looking for the "OrderInfoID" header entry     */
  DEFINE VARIABLE idx AS INTEGER.
  REPEAT idx = 1 TO hSOAPHeader:NUM-HEADER-ENTRIES:
    hSOAPHeader:GET-HEADER-ENTRY(hsheEntry, idx).
    IF hsheEntry:LOCAL-NAME = "OrderInfoID" AND
       hsheEntry:NAMESPACE-URI =
                 "http://www.example.com/webservices/OrderInfo"
    THEN DO:
      /* Get the X-noderef side of the hsheEntry so we can navigate its
        body.    */
      hsheEntry:GET-NODE(hxnWorkRoot).
      hxnWorkRoot:GET-CHILD(hxnTemp, 1). /* hxnTemp is now uuid node */
      hxnTemp:GET-CHILD(hxnTemp2,1). /* hxnTemp2 is text node of uuid */
      gcUUID = hxnTemp2:NODE-VALUE.  /* save the text content */
    END.
  END.
  /* Delete all objects created in this procedure. */
  DELETE WIDGET-POOL "soap".
  /* Delete the SOAP header freeing all of its memory. */
  DELETE OBJECT hSOAPHeader.
END PROCEDURE.
```

Creating and managing SOAP message headers

Depending on the requirements of the Web service, you can work with SOAP headers in several different ways. Three basic use cases that a Web service might require for handling SOAP headers in a client application include:

1. Re-using a SOAP header for a response message that you must return unchanged in a subsequent request message
2. Re-using a SOAP header for a response message that you must return in a subsequent request message, but modified with additional or updated header entries
3. Building a unique SOAP header from scratch to provide as output from the request header handler

As described previously (see SOAP header object model on page 227), ABL represents a SOAP message header as:

- One SOAP header object
- One SOAP header-entryref object to access each SOAP header entry
- One X-noderef object to access a selected SOAP header entry as a DOM subtree, thus modeling the underlying XML of the header entry for access by ABL one node at a time

Depending on the situation, you might need to work only at the level of the SOAP header object with no need to inspect the contents, or you might need to access individual SOAP header entries and their individual XML elements.

Thus, the following sections describe examples of each of the three basic use cases presented in this section that you are most likely to encounter when managing SOAP headers as part of Web service access:

- Reusing an unchanged SOAP response header on page 236
- Modifying a reused SOAP response header on page 239
- Using a client-created SOAP request header on page 245

Note: All of these examples are based on a fictitious Web service (`HeaderExample`), using code that has been run against a working version of the Web service. In the code examples, listed steps refer to the numbers in comments, such as **`/*2b*/`** or **`/*9*/`**.

Reusing an unchanged SOAP response header

This example shows how you might handle a SOAP header that you first encounter in the response message returned from the Web service, then use unchanged as the SOAP header for the next request. This is an example of the header returned from the Web service:

SOAP response header to be reused

```
<soap:Envelope>
  . . .    <soap:Header>
     <AuthHeader xmlns="http://ServiceHost/SOAPHeader">
       <AccessID>XYZZY</AccessID>
     </AuthHeader>
   </soap:Header>
  . . .
</soap:Envelope >
```

It contains one header entry, `AuthHeader`, that contains a value used as an access key (`AccessID`). This type of header might be used when the Web service and client maintain a consistent context for each other between requests.

This is the mainline of a procedure that invokes the Web service to reuse the response header:

Invoking a request that reuses an unchanged SOAP response header

```
/* SOAPHeader1.p
 * Calls a fictitious Web service, first to request access, which gets back
 * a SOAP response header containing an AccessID, and sends the response
 * header back as part of a new request using the required access
 * credential that allows the Web service to respond appropriately to
 * the follow-up request.
 * The Web service has only one service and port available.   *//*1*//* Define local
variables */
DEFINE VARIABLE hWebSrvc    AS HANDLE.
DEFINE VARIABLE hPortType   AS HANDLE.
DEFINE VARIABLE cResponse   AS CHARACTER FORMAT "x(72)".
DEFINE VARIABLE g_header    AS HANDLE.

/* Create the Web service server object */
CREATE SERVER hWebSrvc.

/* Connect to the Web service */
hWebSrvc:CONNECT("-WSDL
                  http://ServiceHost/SOAPHeader/HeaderExample.asmx?wsdl").

/* Get the method, set the port type */
RUN HeadersSoap SET hPortType ON hWebSrvc.
/*2*/
/* Associate the req. & resp. callbacks with the port type */
hPortType:SET-CALLBACK-PROCEDURE("REQUEST-HEADER", "ReqHandler").
hPortType:SET-CALLBACK-PROCEDURE("RESPONSE-HEADER", "RespHandler").
/*3*/
/* Invoke the Web service with no header and display the results */
RUN OpenAccess IN hPortType (OUTPUT cResponse).
DISPLAY cResponse LABEL "WS response" WITH FRAME aaa.
/*4*/
/* Go again with the AccessID set from previous response header */
cResponse = "".
RUN HelloWorld IN hPortType (OUTPUT cResponse).
DISPLAY cResponse LABEL "WS response" WITH FRAME bbb.
```

```
/*5*/
DELETE OBJECT g_header.
DELETE OBJECT hPortType.
hWebSrvc:DISCONNECT().
DELETE OBJECT hWebSrvc.
/*************** Internal Procedures ***************/
```

The code in the preceding example:

1. Defines several mainline variables, including a global handle to reference the reused SOAP header (`g_header`).
2. Registers the request header (`ReqHandler`) and response header (`RespHandler`) handlers after connecting to the Web service and instantiating the `HeaderSoap` port type procedure object.
3. Runs the `OpenAccess` procedure to invoke the Web service operation that returns the `AccessID` value in the SOAP response header (see Response header handler for returning a header for reuse on page 238).
4. Runs the `HelloWorld` procedure to invoke the next Web service operation, passing back the SOAP response header to the Web service unchanged as the SOAP request header (see Request header handler for reusing a header on page 238).
5. Cleans up the global objects maintained in its context and disconnects from the Web service. Note that one of the objects it deletes is the original SOAP response header saved by the response header handler during execution of the `OpenAccess` procedure.

Response header handler for returning a header for reuse

This is the SOAP response header handler (RespHandler) that returns the header that is reused for passing around the AccessID value:

Response header handler saving a SOAP response header for reuse

```
PROCEDURE RespHandler: /*1*/
  DEFINE INPUT PARAMETER hHeader    AS HANDLE.
  DEFINE INPUT PARAMETER cNamespace AS CHARACTER.
  DEFINE INPUT PARAMETER cLocalNS   AS CHARACTER.
  /* If the g_header global variable is valid coming in, it has already been
    set in a previous response, therefore, delete the unnecessary response
    header object. Otherwise, set g-header to the response header object to
    pass back to the request header handler on subsequent requests. */

  IF NOT VALID-HANDLE(g_header) THEN /*2a*/ /* first response */
    g_header = hHeader.
  ELSE DO: /*2b*/ /* all subsequent responses */
    DELETE OBJECT hHeader.   END.
END PROCEDURE.
```

The code in the preceding example:

1. Receives the SOAP response header using the hHeader parameter
2. Tests if the global header handle (g_header) already references a valid object, and:
   a) If it does not reference an object, the handler must be running as part of the initial call to OpenAccess and thus saves the input SOAP header object (hHeader) to the global context (g_header) for use by subsequent requests. From this moment forward, all requests to the Web service discard the header object input to the response handler as unnecessary.
   b) If it does reference an object, the handle must already reference a SOAP response header returned in a prior request (the call to OpenAccess) and has no need of a subsequent response header. It therefore deletes the unnecessary SOAP header object returned to the handler through the hHeader parameter in order to prevent a memory leak accumulating in subsequent requests.

Request header handler for reusing a header

This is the SOAP request header handler (ReqHandler) that reuses the initial SOAP response header to pass the AccessID value between the client and Web service:

Request header handler reusing a saved SOAP response header

```
PROCEDURE ReqHandler: /*1*/  DEFINE OUTPUT PARAMETER hHeader    AS HANDLE.
  DEFINE INPUT  PARAMETER cNamespace AS CHARACTER.
  DEFINE INPUT  PARAMETER cLocalNS   AS CHARACTER.
  DEFINE OUTPUT PARAMETER lDeleteOnDone AS LOGICAL.

  /* The IF test determines if this is the first request. If it is, then
    g_header is not set and hHeader is set to ? to ensure that no header is
    sent. g_header gets set when the response header is returned, so a
    subsequent pass through this code takes the previous response header and
    sends it as the current request header. */

  IF NOT VALID-HANDLE (g_header) THEN DO: /*2a*/ /* first request */
    hHeader = ?.
    lDeleteOnDone = TRUE.
  END.
  ELSE DO: /*2b*/ /* all subsequent requests */
    hHeader = g_header.
    lDeleteOnDone = FALSE.
  END.
END PROCEDURE.
```

The code in the preceding example:

1. Sends the SOAP request header for the `HelloWorld` request (and any request run after running `OpenAccess`)
2. Tests if the global header handle (`g_header`) references a valid object, and:
   a) If it does not reference an object, the request handler must be running as part of the initial call to `OpenAccess` and sets the output parameters to ensure that no initial SOAP request header is sent.
   b) If it does reference an object, the handler passes the global header object as output using the request header parameter (`hHeader`) and ensures that the object is not deleted (saving it for use in any further request).

Modifying a reused SOAP response header

This example shows how you might handle a SOAP header that you first encounter in the response message returned from the Web service, then modify it as the SOAP header for the next request. The response header and its handler are identical to what is used in the header reuse example (see Reusing an unchanged SOAP response header on page 236). This is an example of the header returned from the Web service after a password is added:

SOAP request header built from a modified SOAP response header

```
<SOAP-ENV:Envelope
  . . .
    <SOAP-ENV:Header>
      <ns0:AuthHeader xmlns:ns0="http://ServiceHost/SOAPHeader">
        <ns0:AccessID>XYZZY</ns0:AccessID>
        <ns0:Password>Administrator</ns0:Password>
      </ns0:AuthHeader>
    </SOAP-ENV:Header>
  . . .
</SOAP-ENV:Envelope>
```

Note that the client adds the <Password> element as a sibling to the <AccessID> element in the existing AuthHeader header entry. Another approach is to create and add a new Password header entry as a sibling to the AuthHeader header entry itself. Again, the actual approach depends on the Web service itself, in this case the HeaderExample Web service. This type of header modification might be used when the Web service and client maintain a consistent context for each other between requests and the operation involved requires authorization or authentication or some other additional context information.

The following code is the mainline of a procedure that invokes the Web service to reuse the initial SOAP response header by adding a password node to it before passing it back as a SOAP request header:

1. Defines several mainline variables, including handles to access the global reused SOAP header (g_header) and its XML, and a variable to hold the password value (cPassword).
2. Registers the request header (ReqHandler) and response header (RespHandler) handlers after connecting to the Web service and instantiating the HeaderSoap port type procedure object.
3. Runs the OpenAccess procedure to invoke the Web service operation that returns the AccessID value in the SOAP response header (see Response header handler for returning a header for reuse on page 238).

Invoking a request that modifies a reused SOAP response header

```
/* SOAPHeader2.p
  An addition to SOAPHeader1.p.
  Calls a ficticious Web service. The first operation (OpenAccess) sends
  nothing in the request headers and gets back a SOAP response header
  containing an AccessID. The second operation (HelloWorld) sends the AccessID
  back in its request header. (No additional information is received in the
  response header.) The third operation (HelloSecureWorld) adds a Password
  node to the existing AccessID entry in its request header. This Password
  node is added as a sibling of the AccessID element and NOT as a new SOAP
  header entry. (Once again no additional information is received in the
  response header.) The Web service has only one service and port available.
*/
/*1*/
/* Define local variables */
DEFINE VARIABLE hWebSrvc      AS HANDLE.
DEFINE VARIABLE hPortType     AS HANDLE.
DEFINE VARIABLE cResponse     AS CHARACTER FORMAT "x(72)".
DEFINE VARIABLE hXdoc         AS HANDLE.
DEFINE VARIABLE hXnoderef1    AS HANDLE.
DEFINE VARIABLE hXnoderef2    AS HANDLE.
DEFINE VARIABLE hXtext        AS HANDLE.
DEFINE VARIABLE cPassword     AS CHARACTER INIT ?.
DEFINE VARIABLE g_header      AS HANDLE.

/* Create the Web service server object */
CREATE SERVER hWebSrvc.

/* Connect to the WS */
hWebSrvc:CONNECT("-WSDL
                  http://ServiceHost/SOAPHeader/HeaderExample.asmx?wsdl").

/* Get the method, set the port type */
RUN HeadersSoap SET hPortType ON hWebSrvc.
/*2*/
/* Associate the req. & resp. callbacks with the port type */
hPortType:SET-CALLBACK-PROCEDURE("REQUEST-HEADER", "ReqHandler").
hPortType:SET-CALLBACK-PROCEDURE("RESPONSE-HEADER", "RespHandler").
/*3*/
/* Invoke the Web service with no header and display the results */
RUN OpenAccess IN hPortType (OUTPUT cResponse).
DISPLAY cResponse LABEL "WS response" WITH FRAME aaa.
/*4*/
/* Go again with the AccessID set from previous response */
cResponse = "".
RUN HelloWorld IN hPortType (OUTPUT cResponse).
DISPLAY cResponse LABEL "WS response" WITH FRAME bbb.
/*5*/
/* Go again with the AccessID set from previous response */
/* header together with an added Username and Password   */
cResponse = "".
cPassword = "Administrator".
RUN HelloSecureWorld IN hPortType (OUTPUT cResponse).
DISPLAY cResponse LABEL "WS response" WITH FRAME ccc.
```

```
/*6*/
DELETE OBJECT g_header.
DELETE OBJECT hPortType.
hWebSrvc:DISCONNECT().
DELETE OBJECT hWebSrvc.

/**************** Internal Procedures ***************/
```

4. Runs the `HelloWorld` procedure to invoke the next Web service operation, passing back the SOAP response header to the Web service unchanged as the SOAP request header (see Request header handler for reusing and modifying a header on page 242).
5. Runs the `HelloSecureWorld` procedure to invoke the next Web service operation, passing back the password-modified SOAP response header as the Web service SOAP request header (see Request header handler for reusing and modifying a header on page 242).

   Note: The header handler processing for Step 4 is different from Step 5, to reflect that the initial SOAP response header is unchanged for one request and modified for the next.

6. Cleans up the global objects maintained in its context and disconnects from the Web service. Note that one of the objects it deletes is the original SOAP response header saved by the response header handler during execution of the `OpenAccess` procedure.

Request header handler for reusing and modifying a header

This is the SOAP request header handler (`ReqHandler`) that reuses the initial SOAP response header and adds a `Password` value to the existing `AuthHead` header entry to pass along with the `AccessID` value between the client and Web service:

Request header handler modifying a saved SOAP response header

```
PROCEDURE ReqHandler:   /*1*/
  DEFINE OUTPUT PARAMETER hHeader       AS HANDLE.
  DEFINE INPUT  PARAMETER cNamespace    AS CHARACTER.
  DEFINE INPUT  PARAMETER cLocalNS      AS CHARACTER.
  DEFINE OUTPUT PARAMETER lDeleteOnDone AS LOGICAL.

  /* The IF test determines if this is the first call through this code. If
    it is, then g_header is not set and hHeader is set to ? to ensure that no
    header is sent. g_header gets set when the response header is returned,
    so a subsequent pass through this code takes the previous response header
    and sends it as the current request header, possibly modified to
    authenticate a secure request. */

  IF NOT VALID-HANDLE (g_header) THEN DO:   /*2a*/ /* first request */
    hHeader = ?.
    lDeleteOnDone = TRUE.
  END.
  ELSE DO:   /*2b*/ /* all subsequent requests */
    hHeader = g_header.
    lDeleteOnDone = FALSE.
    /* Password node data are added to the existing SOAP header if a secure
      operation is being executed */
    IF cPassword <> ? THEN DO: /*3*/
      /*3a*/  /* Build a new x-doc to contain the Password data */
      CREATE X-DOCUMENT hXdoc.
      CREATE X-NODEREF  hXnoderef1.
      CREATE X-NODEREF  hXnoderef2.
      CREATE X-NODEREF  hXtext.

      /* Add the Password data as a child of the existing header entry */
      DEFINE VARIABLE hHeaderEntryref AS HANDLE.   /*3b*/
      DEFINE VARIABLE ClientNS AS CHARACTER
        INIT "http://ServiceHost/SOAPHeader".
      CREATE SOAP-HEADER-ENTRYREF hHeaderEntryref.

      hHeader:GET-HEADER-ENTRY(hHeaderEntryref, 1).   /*3c*/
      hHeaderEntryref:GET-NODE(hXnoderef1).

      hXdoc:IMPORT-NODE(hXnoderef2, hXnoderef1, TRUE).   /*3d*/
       IF hXnoderef2:NUM-CHILDREN > 1 THEN DO: /* Get rid of previous */
        hXnoderef2:GET-CHILD(hXnoderef1,2). /* Password data     */
        hXnoderef1:DELETE-NODE().
       END.

       hXdoc:APPEND-CHILD(hXnoderef2).   /*3e*/
       hXdoc:CREATE-NODE-NAMESPACE(hXnoderef1, ClientNS, "Password",
                                   "ELEMENT").

       hXnoderef2:APPEND-CHILD(hXnoderef1).   /*3f*/
      hXdoc:CREATE-NODE(hXtext, "", "text").
       hXnoderef1:APPEND-CHILD(hXtext).
      hXtext:NODE-VALUE = cPassword.

      /* Replace the existing header entry using a deep copy of the new version
        from the x-doc that has the Password node added */
      hHeaderEntryref:SET-NODE(hXnoderef2).   /*3g*/

      /* Procedure/header cleanup */
      cPassword = ?.   /*3h*/  /* Use current password until replaced */
      DELETE OBJECT hHeaderEntryref.
      DELETE OBJECT hXdoc.
      DELETE OBJECT hXnoderef1.
      DELETE OBJECT hXnoderef2.
      DELETE OBJECT hXtext.
    END.
  END. /* all subsequent requests */
END PROCEDURE.
```

The code in the preceding example:

1. Sends the SOAP request header for the `HelloWorld` and `HelloSecureWorld` requests (and any request run after running `OpenAccess`).
2. Tests if the global header handle (`g_header`) references a valid object, and:
   a. If it does not reference an object, the request handler must be running as part of the initial call to `OpenAccess` and sets the output parameters to ensure that no initial SOAP request header is sent
   b. If it does reference an object, the handler passes the global header object as output using the request header parameter (`hHeader`) and ensures that the object is not deleted (saving it for use in any further request)
3. Tests if a password has been specified for the current Web service request, indicated by any `cPassword` value that is not the `Unknown value (?)`. If the current Web service request is nonsecure (as with the `HelloWorld` operation), all work has been done and the request handler can end. If the current Web service request is secure (as with the `HelloSecureWorld` operation), the request handler adds the password information to the SOAP request header, as follows:

   Note: After the first secure request, all future requests (secure or nonsecure) send a request header that includes password information because the password information is never deleted until replaced by a newly-specified password.

   a. Creates the XML x-document and x-noderef objects to manipulate the SOAP header
   b. Creates the SOAP header entryref object (`hHeaderEntryref`) to access SOAP header entries and defines the namespace (`ClientNS`) used for defining the SOAP header entry for this request
   c. Returns the existing header entry from the saved global SOAP header object using the `GET-HEADER-ENTRY( )` method on the SOAP header object and accesses the XML root node of the entry using the `GET-NODE( )` method on the SOAP header entryref object

      Note: The handler is adding the password information to an existing SOAP header entry. If it was adding a new header entry to hold the information, it would invoke the `ADD-HEADER-ENTRY( )` method to add the header entry to contain the new XML for it.

   d. Imports the header entry root node into an x-document object in order to access and modify the XML for the header entry, and also deletes any password data from a previous secure request before adding the currently-specified password data
   e. Adds the <Password> element as a sibling of the <AccessID> element
   f. Adds the <Password> element value
   g. Replaces the entire existing header entry in the global SOAP header object with the header entry updated in the x-document object
   h. Sets the password value (`cPassword`) to unknown (?), which retains the current password in the header entry until it is explicitly changed in `cPassword`, then deletes all of the helper XML and SOAP header entryref objects created in the header handler

Using a client-created SOAP request header

This example shows how you might create a SOAP header internally to use as an initial SOAP request header, as opposed to recycling a header previously received in a SOAP response message (described in previous examples). This is an example of the header created by the client for the Web service:

SOAP request header created entirely by the client

```
<SOAP-ENV:Envelope
  . . .
    <SOAP-ENV:Header>
      <ns0:AuthHeader xmlns:ns0="http://ServiceHost/SOAPHeader">
        <ns0:UserName>Scott</ns0:UserName>
        <ns0:Password>Administrator</ns0:Password>
      </ns0:AuthHeader>
    </SOAP-ENV:Header>
  . . .
</SOAP-ENV:Envelope>
```

The client creates a header very similar to the headers described in the previous examples. The `<UserName>` and `<Password>` elements, in this case, provide user authentication for each Web service request. The Web service requires this authentication for every Web service request.

The following code is the mainline of a procedure that invokes the Web service to create the initial SOAP request header containing a username and password node. This code:

1. Defines several mainline variables, including handles to access the global SOAP header (`g_header`) created for requests and its XML, and variables to hold the username (`cUsername`) and password (`cPassword`) values.
2. Builds the global request header used for all requests (see Procedure to create a SOAP request header on page 247).
3. Registers the request header (`ReqHandler`) handler after connecting to the Web service and instantiating the `HeaderSoap` port type procedure object.
4. Runs the `HelloMyWorld` procedure to invoke a Web service operation, passing back the global SOAP request header created by the client (see Request header handler for passing a globally-created header object on page 249).
5. Cleans up the global objects maintained in its context and disconnects from the Web service. Note that one of the objects it deletes is the global SOAP request header create by the client.

Invoking a request that creates a SOAP request header on the client

```
/* SOAPHeader3.p
  Calls a ficticious web service, passes it a username and password through
  a SOAP message request header, and gets back a string. The Web service has
  only one service and port available. */

/*1*/
/* Define local variables */
DEFINE VARIABLE hWebSrvc      AS HANDLE.
DEFINE VARIABLE hPortType     AS HANDLE.
DEFINE VARIABLE cUsername     AS CHARACTER INIT "Scott".
DEFINE VARIABLE cPassword     AS CHARACTER INIT "Administrator" .
DEFINE VARIABLE cResponse     AS CHARACTER FORMAT "x(72)".
```

```
DEFINE VARIABLE hXdoc         AS HANDLE.
DEFINE VARIABLE hXnoderef1    AS HANDLE.
DEFINE VARIABLE hXnoderef2    AS HANDLE.
DEFINE VARIABLE hXAttribute   AS HANDLE.
DEFINE VARIABLE hXtext        AS HANDLE.
DEFINE VARIABLE g_header      AS HANDLE.
/*2*/
/* Build global SOAP request header */
RUN BuildRequestHeader (OUTPUT g_header).

/* Create the Web service server object */
CREATE SERVER hWebSrvc.

/* Connect to the WS */
hWebSrvc:CONNECT("-WSDL
                    http://ServiceHost/SOAPHeader/HeaderExample.asmx?wsdl").

/* Get the method, set the port type */
RUN HeaderSoap SET hPortType ON hWebSrvc.
/*3*/
/* Associate the request callback with the port type */
hPortType:SET-CALLBACK-PROCEDURE("REQUEST-HEADER", "ReqHandler").
/*4*/
/* Invoke the web service and display the results */
RUN HellowMyWorld IN hPortType (OUTPUT cResponse).
DISPLAY cResponse LABEL "WS Response" WITH FRAME aaa.
/*5*/
DELETE OBJECT g_header.
DELETE OBJECT hPortType.
hWebSrvc:DISCONNECT().
DELETE OBJECT hWebSrvc.

/*************** Internal Procedures ***************/
```

Procedure to create a SOAP request header

This is the procedure (`BuildRequestHeader`) that creates the global SOAP request header that the client sends in all requests to the Web service:

Procedure to create a SOAP request header

```
/*1*/
PROCEDURE BuildRequestHeader:
  /* Define procedure parameter */
  DEFINE OUTPUT PARAMETER hHeader AS HANDLE.
  /*2*/
  DEFINE VARIABLE hHeaderEntryref AS HANDLE.
  DEFINE VARIABLE ClientNS AS CHARACTER
    INIT "http://ServiceHost/SOAPHeader".
  /*3*/
  /* Create SOAP header and server objects */
    CREATE SOAP-HEADER hHeader.
    CREATE SOAP-HEADER-ENTRYREF hHeaderEntryref.
  /*4*/
  /* Create x-doc objects to build header */
    CREATE X-DOCUMENT hXdoc.
    CREATE X-NODEREF hXAttribute.
    CREATE X-NODEREF hXnoderef1.
    CREATE X-NODEREF hXnoderef2.
    CREATE X-NODEREF hXtext.
  /*5*/
  /* Create the header entry */
    hHeader:ADD-HEADER-ENTRY(hHeaderEntryref).
```

```
  /*6*/
  /* Create the header namespace data */
  hXdoc:CREATE-NODE-NAMESPACE(hXnoderef1, ClientNS, "AuthHeader",
                              "ELEMENT").
  hXdoc:CREATE-NODE-NAMESPACE(hXAttribute, "http://www.w3.org/2000/xmlns/",
                              "xmlns", "ATTRIBUTE").
 hXAttribute:NODE-VALUE = ClientNS.
  hXnoderef1:SET-ATTRIBUTE-NODE(hXAttribute).
  hXdoc:INSERT-BEFORE(hXnoderef1, ?).
  /*7*/
  /* Create the Username/Password data */
 hXdoc:CREATE-NODE-NAMESPACE(hXnoderef2, ClientNS, "UserName", "ELEMENT").
  hXnoderef1:APPEND-CHILD(hXnoderef2).
  hXdoc:CREATE-NODE(hXtext,"","text").
  hXnoderef2:APPEND-CHILD(hXtext).
 hXtext:NODE-VALUE = cUsername.
  /*8*/
 hXdoc:CREATE-NODE-NAMESPACE(hXnoderef2, ClientNS, "Password", "ELEMENT").
  hXnoderef1:APPEND-CHILD(hXnoderef2).
  hXdoc:CREATE-NODE(hXtext, "", "text").
  hXnoderef2:APPEND-CHILD(hXtext).
 hXtext:NODE-VALUE = cPassword.
  /*9*/
  /* Fill the header entry using a deep copy */
 hHeaderEntryref:SET-NODE(hXnoderef1).
  /*9*/
  /* Fill the header entry using a deep copy */
 hHeaderEntryref:SET-NODE(hXnoderef1).
  /*10*/
  /* Procedure/header cleanup */
 DELETE OBJECT hXdoc.
 DELETE OBJECT hXAttribute.
 DELETE OBJECT hXnoderef1.
 DELETE OBJECT hXnoderef2.
 DELETE OBJECT hXtext.
 DELETE OBJECT hHeaderEntryref.
END PROCEDURE.
```

The code in the preceding example:

1. Defines a single output parameter to return the global SOAP header object that it creates to the client mainline context
2. Defines a handle variable (`hHeaderEntryref`) to reference the SOAP header entryref object, and a variable (`ClientNS`) that specifies the namespace for the SOAP header entry that it creates
3. Creates the global SOAP header object that references the XML for the header using the `CREATE SOAP-HEADER` statement, and creates the SOAP header entryref object that references the XML for the header entry using the `CREATE SOAP-HEADER-ENTRYREF` statement
4. Creates the x-document and x-noderef objects required to build the XML to be added as the header entry for the global SOAP header
5. Adds a header entry to the newly created SOAP header object, referenced by the `hHeaderEntryref` object, using the `ADD-HEADER-ENTRY( )` method
6. Creates the root node (`<AuthHeader>` element) for the header entry in the working x-document object

   Note: The namespace attribute specifying `http://www.w3.org/2000/xmlns/` is a requirement of the DOM. For more information, see the information on XML support in *OpenEdge Development: Programming Interfaces.*

7. Creates the `<UserName>` element as a child node of the header entry
8. Creates the `<Password>` element as a second child node of the header entry
9. Assigns the header entry in the global SOAP header object to the XML for the `<AuthHeader>` element of the x-document object using the `SET-NODE( )` method

   Note: You must call the `ADD-HEADER-ENTRY( )` method before calling the `SET-NODE( )` method to populate an entry. If you do not, you are essentially overwriting the XML of the same entry over and over.

10. Cleans up by deleting all the helper objects created in the procedure before returning to the client mainline

Request header handler for passing a globally-created header object

This is the SOAP request header handler (`ReqHandler`) that passes the global SOAP request header created by the client and the Web service for each request:

Request header handler passing a client-created SOAP request header

```
PROCEDURE ReqHandler: /*1*/
  /* Define procedure parameters */
  DEFINE OUTPUT PARAMETER hHeader       AS HANDLE.
  DEFINE INPUT  PARAMETER cNamespace    AS CHARACTER.
  DEFINE INPUT  PARAMETER cLocalNS      AS CHARACTER.
  DEFINE OUTPUT PARAMETER lDeleteOnDone AS LOGICAL.
  /*2*/
  /* Pass in global header reused for every request */
  hHeader = g_header.
  lDeleteOnDone = FALSE.
END PROCEDURE.
```

The code in the preceding example:

1. Sends the SOAP request header for the `HelloMyWorld` request (and any subsequent request).
2. Passes the global SOAP header the request header output parameter and ensures that it is not deleted until the client mainline has finished with it.

Managing memory for SOAP headers

SOAP headers require two types of memory in ABL (see SOAP header object model on page 227):

- Memory used for the SOAP header and SOAP header entry data that SOAP header and SOAP header-entryref objects reference, that is, the underlying XML.
- Memory used by the SOAP header object, including the memory for SOAP header entries referenced by SOAP header-entryref objects, even if this header object memory does not reference any underlying XML.

SOAP header object model and DOM relationships

The manner in which a SOAP header object encapsulates the XML for a SOAP header is similar to how the ABL Document Object Model (DOM) allows an x-document object to encapsulate the XML of a general XML document. The manner in which a SOAP header-entryref object references a SOAP header entry is similar to how the ABL DOM allows an x-noderef object to reference the individual elements and attributes of a general XML document. Similar dependencies exist for managing the memory for objects in each reference model.

A SOAP header entry (XML sub-tree) must be associated with the SOAP header-entryref object handle. None of the object's methods (see Table 30: SOAP header-entryref object attributes on page 252) can be called successfully unless there is an underlying SOAP header entry.

SOAP header objects can be created in the ABL application in two ways:

- Implicitly by OpenEdge for the header of an incoming SOAP response message
- Explicitly by the application using a variation of the `CREATE` statement

No matter how the application creates these objects, the application is responsible for explicitly deleting these and any other objects that it creates during a session, including the SOAP header-entryref objects used to reference the header entries in a SOAP header object and any X-document and X-noderef objects used to parse and build the XML structures that occupy memory for the underlying XML.

Memory for the SOAP header object model and DOM

The following table summarizes the available ABL elements and how they can help you to manage memory for SOAP headers.

Table 27: ABL to manage object memory for SOAP headers

ABL element	Applied to object	Deletes the ABL object	Deletes all underlying XML DOM objects
Setting the *lDeleteOnDone* OUTPUT parameter of the request header handler to TRUE (see the Defining header handlers on page 231	SOAP header object	Yes	Yes

ABL element	Applied to object	Deletes the ABL object	Deletes all underlying XML DOM objects
DELETE OBJECT statement	SOAP header object	Yes	Yes
	X-document object	Yes	Yes
	SOAP header-entryref object	Yes	No
	X-noderef object	Yes	No
DELETE-HEADER-ENTRY( ) method	SOAP header-entryref object	No	Yes
DELETE-NODE( ) method	X-noderef object	No	Yes[12]

Caution: Be sure that you always delete the underlying XML for a SOAP header-entryref object before you delete the SOAP header-entryref object itself. If you lose all reference to the underlying XML before deleting it, its memory becomes lost to your application. If this occurs as part of an iterative process, it represents a memory leak that could cause your application to crash.

Attributes and methods for handling SOAP headers

As described in previous sections, the two ABL objects provided for managing SOAP headers include:

- **SOAP header object** — For accessing the name and header entries of a SOAP header
- **SOAP header-entryref object** — For accessing each header entry in a SOAP header

Each of these objects provide attributes and methods that manage header access according to a SOAP header object model defined for ABL. This object model maps to the SOAP header XML in a manner analogous to the way x-document and x-noderef objects allow you to access XML through the Document Object Model (DOM) supported in ABL. In fact, the attributes and methods that implement the SOAP header object model provide access to the XML of a header by making it available to the standard XML support in ABL, such as the DOM, and by allowing the XML to be exchanged between the two SOAP header representations (SOAP object model and XML).

For more information on the SOAP header object model, see SOAP header object model on page 227. The following sections describe all of the attributes and methods available for each object in the SOAP header object model.

SOAP header object attributes and methods

The following table briefly describes all of the attributes on the SOAP header object that are unique to the object or have special application to the SOAP header object.

[12] This includes any child sub-trees of the deleted X-noderef object.

Table 28: SOAP header object attributes

Attribute	Type	Description
NAME	CHARACTER	Returns the qualified name of the SOAP header ("*namespacePrefix*:HEADER")
NUM-HEADER-ENTRIES	INTEGER	Returns the number of entries attached to the SOAP header
TYPE	CHARACTER	Returns the handle type, "SOAP-HEADER"

The following table briefly describes all of the methods on the SOAP header object.

Table 29: SOAP header object methods

Method	Type	Description
ADD-HEADER-ENTRY (*hHeaderEntryRef*)	LOGICAL	Adds a new entry to its list of pointers and associates it with the existing Header-EntryRef object specified. A specified SOAP header-entryref object handle (*hHeaderEntryRef*) references the new header entry.
GET-HEADER-ENTRY (*hHeaderEntryRef*, *index*)	LOGICAL	Associates a specified SOAP header-entryref object handle (*hHeaderEntryRef*) with an index-specified entry (*index*) in the associated SOAP header.

For more information on these attributes and methods, see *OpenEdge Development: ABL Reference.*

SOAP header-entryref object attributes and methods

The following table briefly describes all of the attributes on the SOAP header-entryref object that are unique to the object or have special application to the SOAP header-entryref object.

Note: As indicated in Table 30: SOAP header-entryref object attributes on page 252 and Table 31: SOAP header-entryref object methods on page 253, certain members are associated with a specific SOAP version. To determine which SOAP version is in use, use the SOAP-VERSION attribute of the server object handle.

Table 30: SOAP header-entryref object attributes

Attribute	Type	Description
ACTOR	CHARACTER	(SOAP Version 1.1 only) Returns the value of the actor attribute specified in the associated SOAP header entry, which identifies the recipient of the message. Replaced in SOAP Version 1.2 by the ROLE attribute, and assumes the value of that attribute if used in the context of a SOAP 1.2 connection.
LOCAL-NAME	CHARACTER	Returns the unqualified part of name specified for the associated SOAP header entry element.
MUST-UNDERSTAND	LOGICAL	Returns the value of the mustUnderstand attribute specified in the associated SOAP header entry.

Attribute	Type	Description
NAME	CHARACTER	Returns the qualified name of the SOAP header entry ("*namespacePrefix*:*localName*").
NAMESPACE-URI	CHARACTER	Returns the namespace URI prefixed to the associated SOAP header entry element's name.
ROLE	CHARACTER	(SOAP Version 1.2 only) Returns the value of the role attribute specified in the associated SOAP header entry, which identifies the recipient of the message. Replaces the ACTOR attribute used in SOAP Version 1.1.
TYPE	CHARACTER	Returns the handle type, "SOAP-HEADER-ENTRYREF".

The following table briefly describes all of the methods on the SOAP header-entryref object.

Table 31: SOAP header-entryref object methods

Method	Type	Description
DELETE-HEADER-ENTRY ( )	LOGICAL	Deletes the underlying SOAP header entry and all of its content, but does not delete the SOAP header-entryref object used to reference the deleted header entry.
GET-NODE (*handle*)	LOGICAL	Returns a handle (*handle*) to an X-noderef object that references the root node of a DOM tree containing the parsed XML for the underlying SOAP header entry.
GET-SERIALIZED ( )	LONGCHAR	Returns the XML for the underlying SOAP header entry in serialized form.
SET-ACTOR (*string*)	LOGICAL	(SOAP Version 1.1 only) Sets the value (*string*) of the actor attribute in the underlying SOAP header entry. With SOAP Version 1.2, use SET-ROLE.
SET-MUST-UNDERSTAND (*logical*)	LOGICAL	Sets the value (*logical*) of the mustUnderstand attribute in the underlying SOAP header entry.
SET-NODE (*hXnoderef*)	LOGICAL	Replaces the header entry referenced by this SOAP header-entryref object with a specified DOM sub-tree (parsed XML) that is assumed to represent a SOAP header entry element. The method performs a deep copy of the XML sub-tree specified by the X-noderef object handle (*hXnoderef*).

Method	Type	Description
SET-ROLE (*string*)	LOGICAL	(SOAP Version 1.2 only) Sets the value (*string*) of the role attribute in the underlying SOAP header entry. With SOAP Version 1.1, use SET-ACTOR.
SET-SERIALIZED (*longchar*)	LOGICAL	Replaces the header entry referenced by this SOAP header-entryref object with serialized XML (*longchar*) that is then parsed into a DOM sub-tree that represents a SOAP header entry element. The XML is assumed to be valid for a SOAP header entry.

Note: All of the methods and functions listed in Table 31: SOAP header-entryref object methods on page 253 return TRUE only if there is an underlying SOAP header entry (XML sub-tree) associated with the object handle.

For more information on these attributes and methods, see *OpenEdge Development: ABL Reference*.

15

Handling Errors in ABL Requests to OpenEdge SOAP Web Services

As described previously, the ERROR condition can result from a Web service request by:

1. A SOAP fault returned by the Web service
2. An ABL internal error raised by OpenEdge
3. An application error intentionally raised by the ABL application (using the RETURN ERROR statement) in a SOAP request header callback procedure or a SOAP response header callback procedure

The following chapter sections focus on how to handle SOAP faults and generally how to debug Web service requests.

For details, see the following topics:

- Handling SOAP faults
- Detecting a SOAP fault
- Managing a SOAP fault
- Examples of ABL accessing a SOAP fault
- Debugging ABL applications that call Web services

Handling SOAP faults

When a Web service operation fails after the request arrives at the Web service, it might generate a SOAP fault. This is a special SOAP response message that contains a single fault element in the body, and a namespace qualified and usually identified by a <SOAP:Fault> or <SOAP-ENV:Fault> tag. This is a typical SOAP fault message, with the most common SOAP fault elements:

Sample SOAP fault message

```
<SOAP-ENV:Body>
  <SOAP-ENV:Fault>
    <faultcode>VersionMismatch.Additionalinfo</faultcode>
    <faultstring>The message does not conform to expected
                 version</faultstring>
    <faultactor>http://www.stockvendor.com</faultactor>
    <detail>
      <e:badver xmlns:e=http://www.stockvendor.com/>
        <message>Expect version 2 request, received previous
                 version</message>
        <errorcode>523</errorcode>
      </e:badver>
    </detail>
  </SOAP-ENV:Fault>
</SOAP-ENV:Body>
```

These three child elements of this SOAP fault are mostly application-defined, but typically provide the following information:

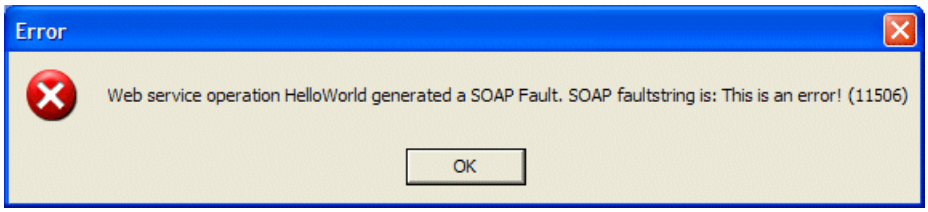
- **<faultcode>** — Coded fault identifier, such as an error number or specially formatted string to identify the fault.
- **<faultstring>** — Single string value containing a simple description of the fault.
- **<faultactor>** — (Optional) Single string value identifying the Universal Resource Identier (URI) of the Web service that caused the fault. This is less common, as it is usually apparent what Web service has generated the SOAP fault.
- **<detail>** — (Optional) Contains elements completely defined by the Web service, but which provide much more specific information about the fault.

Detecting a SOAP fault

ABL has two error handling models: traditional error handling and structured error handling. The sections below describe how to handle a SOAP fault using each model. For more complete information on error handling, see *OpenEdge Development: ABL Error Handling*.

SOAP faults with traditional error handling

When the Web service returns a SOAP fault, OpenEdge responds depending on how the request is coded. As with ABL errors, if you do not specify the NO-ERROR option on a RUN statement that invokes a Web service operation or if the operation is invoked using a user-defined function, OpenEdge converts the SOAP fault into a standard ABL error message displayed as follows:



The error box displays the operation that generated the SOAP fault and the contents of the `<faultstring>` element in the SOAP fault message.

If the statement that invokes a Web service operation traps an error using the `NO-ERROR` option, this message and the information for any SOAP fault detail appears in the `ERROR-STATUS` system handle, and as with all ABL errors remains available until the next statement is invoked using the `NO-ERROR` option. The following table lists the `ERROR-STATUS` handle attribute that help you to detect and return the information for a SOAP fault. All other attributes and methods on this handle work as they do for any ABL error condition.

Table 32: ERROR-STATUS handle attributes

Attribute	Type	Description
`ERROR`	`LOGICAL`	Indicates that an `ERROR` condition was returned as a result of processing a Web service request
`ERROR-OBJECT-DETAIL`	`HANDLE`	References the SOAP-fault object for any Web service request that returns a SOAP fault trapped using ABL `NO-ERROR` option

Once you have detected an error (`ERROR-STATUS:ERROR=TRUE`), you can determine if it is the result of a SOAP fault using the `ERROR-OBJECT-DETAIL` attribute. If a SOAP fault caused the error, this attribute returns a handle to a SOAP-fault object containing the SOAP fault information. Otherwise, it has the `Unknown value (?)`.

Note that Web service operations that are invoked as user-defined functions **do not raise** the `ERROR` condition. For a SOAP fault resulting from an operation invoked as a user-defined function, `ERROR-STATUS:ERROR` is `FALSE`. But, in this case, `ERROR-STATUS:NUM-MESSAGES` is greater than zero.

SOAP faults with structured error handling

You can also trap the error using a `CATCH` block, which is the error handler for the ABL structured error handling model. In this scenario, the AVM generates an error object based on the built-in `Progress.Lang.SoapFaultError` class. The `SoapFault` property of the class contains a handle to the built-in SOAP-fault object. Recall that the SOAP-fault object is the ABL representation of a SOAP fault. Thus, `SoapFaultError` error object is a wrapper for the same SOAP-fault object you could also have accessed using the `NO-ERROR` option and the `ERROR-OBJECT-DETAIL` attribute of the `ERROR-STATUS` system handle.

This is the basic structure of a block with a `CATCH` block:

```
DO ON ERROR UNDO, THROW:
  /* Web service call, do not use the NO-ERROR option. */
  CATCH mySoapErrorObject AS Progress.Lang.SoapFaultError:
    /* Access and interrogate the SOAP-fault object wrapped by the error
       object. */
  END CATCH.
END /* DO */
```

Examples of ABL accessing a SOAP fault on page 261 provides more detailed information.

Structured error handling represents errors as objects. ABL includes a hierarchy of classes that allow all error types to be represented as objects. The following table summarizes the class representing all system errors and its subclass that represents SOAP errors.

Table 33: System error classes

Class	Members	Description
`Progress.Lang.SysError`	Inherits the `Progress.Lang.ProError` members: • `CallStack` property • `NumMessages` property • `Severity` property • `GetMessage( )` method • `GetMessageNum( )` method	A subclass of `Progress.Lang.ProError` that represents (with its subclasses) all ABL system errors
`Progress.Lang.SoapFaultError`	Inherits the `Progress.Lang.ProError` members and adds: • `SoapFault`	A subclass of `Progress.Lang.SysError` that contains a reference to a Web service `SoapFault` object

The following table describes the properties and methods of the `Progress.Lang.SoapFaultError` class.

Table 34: SoapFaultError class members

Member	Description
`CallStack` property	Returns the contents of the call stack at the time the error object was thrown as a string. If the `ERROR-STACK-TRACE` attribute of the `SESSION` handle is false, then this property returns the `Unknown value (?)`. To enable the call stack, set `SESSION:ERROR-STACK-TRACE` property to `TRUE` directly, or use the `-errorstack` session startup parameter.
`NumMessages` property	In ABL, an error is represented as a pair of values. The message number is a unique number identifying the particular error. The error message is a string which describes the error. This property indicates how many error number and error message the error object contains.
`Severity` property	The `Severity` property is not used by ABL system errors. It is provided as a mechanism for you to use to assign severity rankings to your various application errors (`Progress.Lang.AppError`).

Member	Description
`GetMessage( MessageIndex )` method	Returns the error message for the indexed error in the error object, beginning with one (1). If there is no error message at the indicated index, the method returns the empty string.
`GetMessageNum( MessageIndex )` method	Returns the error message number associated with the indexed error in the error object. For `Progress.Lang.SysError` objects and subclasses, the method returns the Progress message number for the system generated error. If there is no error message at the index, the method returns the empty string.
`SoapFault`	Identifies the `SOAP-FAULT` object handle that contains a SOAP fault message detail. If the ABL application invokes a Web service operation that returns a SOAP fault message, the AVM creates a `SOAP-FAULT` object. Use the `SOAP-FAULT-DETAIL` attribute of the `SOAP-FAULT` object handle to access the SOAP fault message detail. see Managing a SOAP fault on page 259 for more information about the `SOAP-FAULT` object.

Managing a SOAP fault

On detecting a SOAP fault, OpenEdge automatically creates a SOAP-fault object for it. This object contains information from each child element of the response message `<Fault>` element. Like the `ERROR-STATUS` handle information, OpenEdge makes this object available only until the next statement executes with the `NO-ERROR` option.

Note: As indicated in the following table, certain members are associated with a specific SOAP version. To determine which SOAP version is in use, use the `SOAP-VERSION` attribute of the server object handle.

The following table lists the attributes on the SOAP-fault object, which contains no methods.

Table 35: SOAP-fault object attributes

Attribute	Type	Description
`SOAP-FAULT-ACTOR`	`CHARACTER`	(SOAP Version 1.1 only) Returns the value of the `<faultactor>` element of the SOAP fault message, which is a URI that identifies the Web service returning the fault. Replaced in SOAP Version 1.2 by the combination of `SOAP-FAULT-ROLE` and `SOAP-FAULT-NODE`.
`SOAP-FAULT-CODE`	`CHARACTER`	Returns the value of the `<faultcode>` element of the SOAP fault message, which identifies the fault.
`SOAP-FAULT-DETAIL`	`HANDLE`	References the SOAP fault-detail object, which contains more application-specific error information.

Attribute	Type	Description
SOAP-FAULT-MISUNDERSTOOD- HEADER	CHARACTER	(SOAP 1.2 only) Returns the list of fully qualified names of SOAP headers, if any, for which mandatory processing (as designated by the SOAP-ENV:mustUnderstand attribute) failed.
SOAP-FAULT-NODE	CHARACTER	(SOAP 1.2 only) Returns the URI of the SOAP node that generated the SOAP-fault object, if available. In combination with SOAP-FAULT-ROLE, replaces the SOAP-FAULT-ACTOR attribute used in SOAP Version 1.1.
SOAP-FAULT-ROLE	CHARACTER	(SOAP 1.2 only) Returns the URI that identifies the role in which the node that generated the SOAP-fault object was operating when the fault occurred. In combination with SOAP-FAULT-NODE, replaces the SOAP-FAULT-ACTOR attribute used in SOAP Version 1.1.
SOAP-FAULT-STRING	CHARACTER	Returns the value of the <faultstring> element of the SOAP fault message, which provides a human-readable description of the fault.
SOAP-FAULT-SUBCODE	CHARACTER	(SOAP 1.2 only) Returns the list of fully qualified sub-code names for the SOAP-fault object.
TYPE	CHARACTER	Returns the handle type, "SOAP-FAULT".

As you can see, these attributes provide access to all the elements of a SOAP fault you might encounter.

Because the <detail> element has essentially no standard definition, and can contain any elements that the Web service chooses to generate, OpenEdge provides another object, the SOAP fault-detail object, to return this information to the ABL application. If the SOAP fault message contains a <detail> element, the SOAP-FAULT-DETAIL attribute on the SOAP-fault object handle returns a handle to the SOAP fault-detail object that is generated for it. Otherwise, this attribute returns the Unknown value (?). As is the case with the SOAP-fault object, OpenEdge makes the SOAP fault-detail object available only until the next ABL statement that executes with the NO-ERROR option.

The following table describes the single attribute of the SOAP fault-detail object:

Table 36: SOAP fault-detail object attributes

Attribute	Type	Description
TYPE	CHARACTER	Returns the handle type, "SOAP-FAULT-DETAIL"

The following table lists the methods of the SOAP fault-detail object.

Table 37: SOAP fault-detail object methods

Method	Type	Description
GET-NODE( )	LOGICAL	Returns a handle to an X-noderef object that references the root node (SOAP <detail> element) of a DOM tree containing the parsed XML for the underlying SOAP detail information
GET-SERIALIZED( )	LONGCHAR	Returns the XML for the underlying SOAP fault detail information in serialized form

The GET-NODE( ) and GET-SERIALIZED( ) methods provide access to the elements of the SOAP fault detail information in exactly the same way as they provide access to SOAP header entries for a SOAP header. For more information, see Handling SOAP Message Headers in ABL on page 225.

The general approach to managing SOAP fault detail elements is identical to retrieving and scanning the header entries of a SOAP response header. The structure of elements that make up the SOAP fault detail information is completely undefined. For more information, see the documentation available for the Web service you are accessing.

As with SOAP headers, if the WSDL Analyzer can identify a temp-table or ProDataSet definition that maps to the SOAP fault detail, you can use the GET-SERIALIZED( ) method in conjunction with the READ-XML( ) method of the documented ABL object (temp-table or ProDataSet) to access the SOAP fault detail data. However, this is unlikely, and you most often must access the data using a DOM tree or the ABL SAX reader. For more information on how the Analyzer might identify a temp-table or ProDataSet to access the SOAP fault detail, see Analyzing complex data on page 195. For more information on the ABL DOM, SAX, and temp-table/ProDataSet XML features, see *OpenEdge Development: Working with XML.*

Examples of ABL accessing a SOAP fault

The first two examples run an operation on a fictitious Web service that returns a SOAP fault identical to the one described in the beginning of this section (see the Handling SOAP faults on page 256). They access and examine the SOAP fault message as described in the following steps. The first example uses traditional error handling, and the second uses structured error handling.

The third example shows how to access and examine a class-based error object returned from an asynchronous call.

Traditional error handling example

The code in the following example:

1. Uses the ABL VALID-HANDLE function to determine if a given ERROR condition (ERROR-STATUS:ERROR = TRUE) is caused by a SOAP fault by testing the validity of the handle returned by the ERROR-STATUS:ERROR-OBJECT-DETAIL attribute
2. Assigns a handle variable (hSoapFault) to any valid SOAP-fault object returned by the ERROR-STATUS:ERROR-OBJECT-DETAIL attribute for code readability

---

Note: You can also use the ERROR-STATUS:ERROR-OBJECT-DETAIL handle attribute directly to work with the SOAP-fault object.

---

3. Examines the values of SOAP fault elements, as required, using appropriate attributes (`SOAP-FAULT-CODE`) on the SOAP-fault object handle
4. Uses the ABL `VALID-HANDLE` function to determine if this SOAP fault has SOAP fault detail by testing the validity of the handle returned by `hSoapFault:SOAP-FAULT-DETAIL`
5. Assigns a handle variable (`hSoapFaultDetail`) to the SOAP fault-detail object returned by the `hSoapFault:SOAP-FAULT-DETAIL` attribute for code readability

   Note: You can also use the `ERROR-STATUS:ERROR-OBJECT-DETAIL:SOAP-FAULT-DETAIL` handle attribute directly to work with the SOAP fault-detail object.

6. Returns the root node of the underlying SOAP fault `<detail>` element by using the `hSoapFaultDetail:GET-NODE( )` method to assign the root node to the x-noderef object referenced by the handle variable `hxnoderef`
7. Can now use the methods and attributes of the x-noderef object handle (`hxnoderef`) and additional handle variables to walk the XML DOM subtree referenced by `hxnoderef` to examine the content of the SOAP fault `<detail>` element as specified by the WSDL for the Web service

Table 38: Sample SOAP fault procedure

```
DEFINE VARIABLE hWS           AS HANDLE.
DEFINE VARIABLE hStockPortType AS HANDLE.
DEFINE VARIABLE price          AS DECIMAL.

CREATE SERVER hWS.
/* Create a WebServicePortType object, using server & port information. */

hWS:CONNECT( "-WSDL http: //www.stockvend.com/application/wsdl/stock.wsdl
              -Service stockSVC
              -Port stockPort" ).
RUN stock SET hStockPortType ON SERVER hWS.

RUN getPrice IN hStockPortType( INPUT "error", OUTPUT price ) NO-ERROR.
IF ERROR-STATUS:ERROR THEN DO:
/*1*/
  /* Error occurred on the RUN. Did the Web service generate the error or was
     it an internal ABL error? */
  IF VALID-HANDLE( ERROR-STATUS:ERROR-OBJECT-DETAIL ) THEN DO:
    DEFINE VARIABLE hSoapFault as HANDLE.
/*2*/
    hSoapFault = ERROR-STATUS:ERROR-OBJECT-DETAIL.
/*3*/
    IF INDEX( "VersionMismatch", hSoapFault:SOAP-FAULT-CODE ) > 0 THEN DO:

/*4*/
      IF VALID-HANDLE( hSoapFault:SOAP-FAULT-DETAIL ) THEN DO:

        DEFINE VARIABLE hSoapFaultDetail as HANDLE.
/*5*/
        hSoapFaultDetail = hSoapFault:SOAP-FAULT-DETAIL.

        DEFINE VARIABLE hxnoderef AS HANDLE.
        CREATE X-NODEREF hxnoderef.
/*6*/
        hSoapFaultDetail:GET-NODE( hxnoderef ).
/*7*/
        /* From here the application can walk the detail XML and retrieve the
           relevant information. */

        . . .

      END. /* Examine SOAP-FAULT-DETAIL */
    END. /* Return SOAP-FAULT-CODE info */
  END. /* Examine ERROR-OBJECT-DETAIL */
END.

DELETE PROCEDURE hStockPortType.
hWS:DISCONNECT( ).
```

Structured error handling example

The code in the following example:

1. Encloses the logic in a simple block to demonstrate the placement and syntax of the CATCH block. In this simple example, if an error other than a system error occurred in the block, the error would be thrown to the enclosing block, which is the main block of the procedure (.p) file.
2. Handles any Progress.Lang.SoapFaultError error object generated by the AVM with the first CATCH block. This class is essentially a wrapper for the built-in SOAP-fault object.
3. Assigns a handle variable (hSoapFault) to the SOAP-fault object returned by the AVM for code readability.
4. Examines the values of SOAP fault elements, as required, using appropriate attributes (SOAP-FAULT-CODE) on the SOAP-fault object handle.
5. Uses the ABL VALID-HANDLE function to determine if this SOAP fault has SOAP fault detail by testing the validity of the handle returned by hSoapFault:SOAP-FAULT-DETAIL.
6. Assigns a handle variable (hSoapFaultDetail) to the SOAP fault-detail object returned by the hSoapFault:SOAP-FAULT-DETAIL attribute for code readability.
7. Returns the root node of the underlying SOAP fault <detail> element by using the hSoapFaultDetail:GET-NODE( ) method to assign the root node to the x-noderef object referenced by the handle variable hxnoderef.
8. Use the methods and attributes of the X-noderef object handle (hxnoderef) and additional handle variables to walk the XML DOM subtree referenced by hxnoderef to examine the content of the SOAP fault <detail> element as specified by the WSDL for the Web service.
9. Delete or throw the error object in the application code once it is handled by a CATCH block. Unhandled error objects are deleted automatically by the AVM.
10. Handles any system error (other than SoapFaultError) raised in the ON ERROR block with the second CATCH block. Because SoapFaultError is a subtype of SysError, the CATCH block handling SoapFaultError must occur before the more general CATCH block for all SysError objects.
11. Executes the FINALLY block whether the second CATCH block succeeded or failed. This makes the FINALLY block a good place to put clean up code.

Sample SOAP fault procedure

```
DEFINE VARIABLE hWS AS HANDLE.
DEFINE VARIABLE hStockPortType AS HANDLE.
DEFINE VARIABLE price AS DECIMAL.

/*1*/
DO ON ERROR UNDO, THROW:

  CREATE SERVER hWS.

  /* Create a WebServicePortType object, using server & port information. */
  hWS:CONNECT( "-WSDL http: //www.stockvend.com/application/wsdl/stock.wsdl
                -Service stockSVC
                -Port stockPort" ).

  RUN stock SET hStockPortType ON SERVER hWS.

  RUN getPrice IN hStockPortType( INPUT "error", OUTPUT price ).

/*2*/
  /* This CATCH handles SoapFaultErrors and ignores all other system errors.*/
  CATCH mySoapErrorObject AS Progress.Lang.SoapFaultError:
```

```
/*3*/
    DEFINE VARIABLE hSoapFault AS HANDLE.
    hSoapFault = mySoapErrorObject:SoapFault.

/*4*/
    IF INDEX("VersionMismatch", hSoapFault:SOAP-FAULT-CODE) > 0 THEN DO:

/*5*/
      IF VALID-HANDLE( hSoapFault:SOAP-FAULT-DETAIL ) THEN DO:

/*6*/
        DEFINE VARIABLE hSoapFaultDetail as HANDLE.
        ASSIGN hSoapFaultDetail = hSoapFault:SOAP-FAULT-DETAIL.

        DEFINE VARIABLE hxnoderef AS HANDLE.
        CREATE X-NODEREF hxnoderef.

/*7*/
        hSoapFaultDetail:GET-NODE( hxnoderef ).

/*8*/
        /* From here the application can walk the detail XML and retrieve the
           relevant information. */

/*9*/
        DELETE OBJECT mySoapErrorObject.
      END. /* Return SOAP-FAULT-CODE info */
    END. /* Examine SOAP-FAULT-DETAIL */
  END CATCH.

/*10*/
  CATCH mySystemErrorObject AS Progress.Lang.SysError:
    /* Handle any other system error. Since SysError is a superclass of
       SoapFaultError, this CATCH would also handle SoapFaultError if the
       more specific CATCH block did not come first. */
    DELETE OBJECT mySysErrorObject.
  END CATCH.

/*11*/
  FINALLY:
    DELETE PROCEDURE hStockPortType.
    hWS:DISCONNECT( ).
  END FINALLY.

END /* DO ON ERROR */
```

Asynchronous call error handling example

As mentioned in Results handling on page 224, class-based error objects returned from an asynchronous call are handled slightly differently:

1. Note that, in contrast to comment 2 in the Traditional error handling example on page 261, the code retrieves the error object from the `ERROR-OBJECT` attribute of the asynchronous call handle (`hRequest`).
2. The `ERROR-OBJECT` attribute returns a reference to an object that implements the `Progress.Lang.Error` interface. To access information beyond the attributes inherited from `Progress.Lang.Error`, the object referenced by `myerr` is cast to the more specific type of object returned, `Progress.Lang.SoapFaultError`.
3. Checks the `numMessages` property of `soaperr` (part of `Progress.Lang.Error`'s implementation) and displays messages as necessary.
4. Uses the ABL `VALID-HANDLE` function to determine the `SoapFault` property of `soaperr` points to a valid Soap-Fault object handle. If so, the information in the handle's attributes is displayed.
5. Uses the ABL `VALID-HANDLE` function again to determine if the SOAP fault has SOAP fault detail by testing the validity of the handle returned by `hSoapFault:SOAP-FAULT-DETAIL`. If so, it assigns a reference to the handle to the variable `SOAPFaultDetail`.

Sample asychronous error procedure

```
DEFINE VARIABLE hWS AS HANDLE.
DEFINE VARIABLE hWebSrvc AS HANDLE NO-UNDO.
DEFINE VARIABLE hPortType AS HANDLE NO-UNDO.
DEFINE VARIABLE hSOAPFault AS HANDLE NO-UNDO.
DEFINE VARIABLE hSOAPFaultDetail AS HANDLE NO-UNDO.
DEFINE VARIABLE i AS INTEGER NO-UNDO.
DEFINE VARIABLE cResponse AS CHARACTER NO-UNDO.
DEFINE VARIABLE hRequest AS HANDLE NO-UNDO.

CREATE SERVER hWebSrvc.
hWebSrvc:CONNECT("-pf soap.pf").

RUN ErrorServiceSoap SET hPortType ON hWebSrvc.

/* Get a SOAP fault */
/* HelloWorld2 always throws an exception with detailed contents. */

RUN HelloWorld2 IN hPortType ASYNCHRONOUS SET hRequest
  EVENT-PROCEDURE "procDone" IN THIS-PROCEDURE (OUTPUT cResponse).

WAIT-FOR PROCEDURE-COMPLETE OF hRequest.

DELETE OBJECT hRequest.
DELETE OBJECT hPortType.
hWebSrvc:DISCONNECT().
DELETE OBJECT hWebSrvc.

PROCEDURE procDone:
  DEFINE INPUT PARAMETER cResponse AS CHARACTER.
  DEFINE VARIABLE myerr AS Progress.Lang.Error.
  DEFINE VARIABLE soaperr AS Progress.Lang.SoapFaultError.

  IF hRequest:ERROR THEN DO:
    MESSAGE "An error occurred when running HelloWorld2".

/*1*/
    myerr = SELF:ERROR-OBJECT.
/*2*/
    soaperr = CAST (myerr, Progress.Lang.SoapFaultError).

/*3*/
    IF soaperr:NumMessages > 0 THEN DO:
      DO i = 1 TO soaperr:NumMessages:
        MESSAGE "SoapFault Error: " soaperr:GetMessage(i).
      END.
/*4*/
    IF VALID-HANDLE(soaperr:SoapFault) THEN DO:
      MESSAGE "soaperr:SOAPFAULT is a valid handle".
      hSOAPFault = soaperr:SoapFault.
      MESSAGE
        "Fault Code: "   hSOAPFault:SOAP-FAULT-CODE        SKIP
        "Fault String: " hSOAPFault:SOAP-FAULT-STRING      SKIP
        "Fault Actor: "  hSOAPFault:SOAP-FAULT-ACTOR       SKIP
        "Error Type: "   hSOAPFault:TYPE SKIP.

/*5*/
      IF VALID-HANDLE(hSOAPFault:SOAP-FAULT-DETAIL) THEN DO:
        SOAPFaultDetail = hSOAPFault:SOAP-FAULT-DETAIL.
      END.
    END.
  END.
  END.
END PROCEDURE.
```

Debugging ABL applications that call Web services

If an ABL application error appears (from error messages, for example) to result from attempts to access a Web service, you generally follow three phases of investigation to isolate the problem.

To investigate a problem related to using a Web service:

1. Determine if the WSDL file is still valid for the Web service you are accessing.

   This is particularly necessary if you access the WSDL file at a location other than the URL specified by the Web service provider, for example using a local file system that stores a separate copy that you have made from the original. It is also very possible that the Web service provider has changed the URL or target namespace to reference the WSDL file. If this is the case, you must run the WSDL Analyzer against the new WSDL file to identify any changes that might affect your code. For more information, see Use the WSDL Analyzer on page 182.

   This is a good first step to diagnose any Web service access failure.

2. If the WSDL file appears to be valid, use a SOAP message viewer at run time to compare the content of SOAP request and response messages with what the application expects and what the WSDL file specifies.

   OpenEdge provides a set of SOAP viewers included with the installation, and many other viewers are available. This chapter describes three of them to varying levels of detail.

3. If you suspect a problem with SOAP request and response messages, you can debug sample SOAP messages for selected operations by creating them in local files. Specify the SOAP addresses of these files using Microsoft UNC pathnames in the WSDL Bindings for the selected operations.
4. Debug the ABL code, possibly using the OpenEdge Debugger. For more information on the Debugger, see *OpenEdge Development: Debugging and Troubleshooting.*

SOAP Viewers

The following table lists some tools that you can use to view Web service messages as they are exchanged between the client and the Web service.

Table 39: Web service message viewers

This SOAP message viewer . . .	Is . . .
WSAViewer	Provided with the OpenEdge installation
ProSOAPView	Provided with the OpenEdge installation
Microsoft SOAP Toolkit	Available for free download from Microsoft's Web site

The Microsoft SOAP Toolkit contains a variety of tools for working with SOAP messages in Windows platforms. One advantage of WSAViewer and ProSOAPView is that they run on all supported OpenEdge platforms.

Using WSAViewer

WSAViewer is a basic tool for viewing the SOAP messages between a given source and destination, which you determine at startup. As such, it functions as a "man in the middle" between the client and the Web service. It is useful if you are only interested in viewing the content of the SOAP request and response. The simplicity of this tool makes it handy to use when debugging OpenEdge Web services for which viewing the well-defined SOAP formats is the primary focus. For more information on this tool, see Test and debug OpenEdge SOAP Web Services on page 165.

Using WSAViewer with an ABL client

To use WSAViewer with an ABL client, you have two options:

- Change the connection parameters in your Web service `CONNECT( )` method to send all SOAP messages to WSAViewer. WSAViewer then forwards them to the actual Web service.
- Startup the ABL client using the `-proxyhost` and `-proxyport` startup parameters to redirect the SOAP messages to WSAViewer. Specify `-proxyhost` using the host name where the viewer is running (typically `localhost`), and specify `-proxyport` using the port on which WSAViewer listens for SOAP request messages (the *`listen-port`* value specified for WSAViewer as shown in the following syntax).

The syntax to start the viewer is the same when working with any Web service as it is when working with the OpenEdge Web Services Adapter (WSA):

Syntax

```
wsaviewer listen-portwebservice-hostwebservice-port
```

The *`listen-port`* is the port on which WSAViewer listens for SOAP request messages. The *`webservice-host`* is the host name of the Web service and the *`webservice-port`* is the host port on which the Web service listens for SOAP request messages.

Suppose you enter the following command line to start the viewer to listen on `localhost` at port 8080 and pass SOAP request messages to the Web service, `www.stockvend.com`, listening on port 80:

```
wsaviewer 8080 www.stockvend.com 80
```

You might code your OpenEdge Web service `CONNECT( )` method like this:

```
DEFINE VARIABLE hWS AS HANDLE.
CREATE SERVER hWS.
hWS:CONNECT("-WSDL http://www.stockvend.com/application/wsdl/stock.wsdl
             -Binding StockQuoteObj
             -SOAPEndpoint http://localhost:8080/application/stockquotes").
```

The `CONNECT( )` method still gets the WSDL file directly from `www.stockvend.com`, but all SOAP messages go through WSAViewer on their way to the Web service and back to the client.

A

Developing a .NET Client to Consume OpenEdge SOAP Web Services

This appendix describes the basic tasks to develop a .NET client application to consume an OpenEdge Web service, as detailed in the following sections.

For details, see the following topics:

- What is Microsoft .NET?
- Using .NET as your Web services client
- VB.NET sample Web service specifications
- Creating the VB.NET client interface
- Developing the VB.NET client application
- Creating .NET DataSets from ProDataSet parameters
- Learning more about writing .NET clients

What is Microsoft .NET?

Briefly, Microsoft .NET supports the following features:

- As described by Microsoft, .NET is a robust platform for developing the next generation of applications.
- It is built using industry standards, such as XML and SOAP.

- The .NET platform supports many languages, including:
  - Visual Basic .NET
  - Visual C# .NET
- The .NET API, including data type support, is the same for all languages.
- .NET provides a single development environment, Visual Studio® .NET, to work with all its supported languages.
- .NET supports all of the SOAP formats that are supported by OpenEdge Web services.

Using .NET as your Web services client

To create a .NET Web service client application, you perform a standard set-up procedure at the start of application development.

To create your Web service client application using Visual Studio.NET:

1. Choose a .NET language and create a new project.
2. Add a Web reference for the Web service by specifying the WSDL file location. This automatically creates a .NET interface.
3. Add logic to the client to create interface objects and call interface methods.

Most sections of this chapter use Visual Basic (VB.NET) to demonstrate client development with .NET. Creating .NET DataSets from ProDataSet parameters on page 288 uses C# instead. Compiling and running .NET applications with Visual Studio is straightforward. .NET compiles the application automatically when you run it from Visual Studio .NET.

VB.NET sample Web service specifications

The following table describes the specifications for a sample Web service and interface used to illustrate client development with VB.NET.

Table 40: VB.NET sample Web service specifications

Property or component	Value or name	Object type
Web reference	`OrderService`	–
URL	`http://servicehost:80/wsa/wsa1`	–
Session model	Managed	–
TargetNamespace	`urn:OrderSvc:OrderInfo`	–

Property or component	Value or name	Object type
WSDL objects	`OrderInfoObj`	AppObject
	`CustomerOrderObj`	ProcObject
	`OrderInfoID`	AppObject ID
	`CustomerOrderID`	ProcObject ID
	`OrderDetailsRow`	Temp-table `OrderDetails`

Note: This sample is available on the Documentation and Samples (`doc_samples`) directory of the OpenEdge product DVD or Progress Documentation Web site.

Creating the VB.NET client interface

The following sections describe tasks and features for creating the VB.NET client interface:

- Adding a Web reference on page 273
- Reference.vb: Web service client interface on page 274
- Reference.vb: Open Client objects on page 274
- .NET data type mapping on page 274
- Accessing parameter data on page 275
- TABLE (static temp-table) parameters on page 275
- TABLE-HANDLE (dynamic temp-table) parameters on page 276
- Sample interface object prototypes in Reference.vb on page 277
- Sample common interface method prototypes in Reference.vb on page 278
- Sample ABL and VB.NET interface method prototypes on page 279

These sections review information presented in previous sections of the manual, to provide context for understanding the VB.NET environment.

Adding a Web reference

Adding a Web reference essentially generates the client interface.

To generate a client interface:

1. Enter the URL for the WSDL file. The `TargetURI` can be set to either the Web service friendly name (AppObject name, by default) or the TargetNamespace for the Web service, as in the following examples:

```
http://servicehost:80/wsa/wsa1/wsdl?targetURI=OrderInfo

http://servicehost:80/wsa/wsa1/wsdl?targetURI=urn:OrderSvc:OrderInfo
```

2. Rename the Web reference you added to the project appropriately (for example, from `servicehost` to `OrderService`). Select the **Show All Files** toolbar button (or choose **Project** > **Show All Files**) to locate the Web reference file, `Reference.vb` under the renamed Web reference.

Reference.vb: Web service client interface

The client interface generated from the WSDL has objects for:

- Every Open Client object, for example, `OrderInfo` and `CustomerOrder`
- The object ID for each Open Client object (except a session-free AppObject); for example, `OrderInfoID` and `CustomerOrderID`
- Every temp-table, for example, `OrderDetailsRow`

Reference.vb: Open Client objects

Each Open Client object class usually contains:

- The URL of the WSA
- Methods defined in the WSDL for the object
- A member variable for its own object ID, such as `OrderInfoID` in the sample
- Member variables for the object IDs of any objects created using `CreateXX_*` methods (SubAppObjects and ProcObjects), such as `CustomerOrderID` in the sample

Each object is named as follows:

- It takes the WSDL service name if the Web service has only one object (AppObject), such as `OrderInfoService`.
- It takes the WSDL `<binding>` element names, such as `OrderInfoObj` and `CustomerOrderObj`, if the Web service has more than one object.

.NET data type mapping

The following table lists the data-type mappings for parameters between ABL and .NET.

Table 41: Supported .NET data types

ABL data type	.NET data type
CHARACTER	String

ABL data type	.NET data type
COM-HANDLE	Long
DATASET	Object
DATASET-HANDLE	Object
DATE	Date
DATETIME	DateTime
DATETIME-TZ	DateTime
DECIMAL	Decimal
INT64	Int64
INTEGER (32 bit)	Integer
LOGICAL	Boolean
LONGCHAR	String
MEMPTR	Byte( )
RAW	Byte( )
RECID (32 or 64 bit)	Long
ROWID	Byte( )
TABLE	Object
TABLE-HANDLE	Object
WIDGET-HANDLE	Long

Accessing parameter data

The interface automatically generates parameter data for VB.NET client variables:

- For scalar parameters, the client does not need to do any special additional processing to use them.
- TABLE, TABLE-HANDLE, DATASET and DATASET-HANDLE parameters require extra processing for the client to use them.

TABLE (static temp-table) parameters

For TABLE parameters:

- Client interfaces contain an object for each WSDL <complexType> definition of a TABLE row. For example, the OrderDetailsRow class is declared as follows:

```
Public Class OrderDetailsRow...
```

- The client interface represents the TABLE parameters as arrays of these row objects.

The following table lists the data type mappings for TABLE columns between ABL and .NET.[13]

Table 42: .NET data types for TABLE parameter columns

ABL data type	.NET data type
BLOB	Byte( )
CHARACTER	String
CLOB	String
COM-HANDLE	Long
DATE	Date
DATETIME	DateTime
DATETIME-TZ	DateTime
DECIMAL	Decimal
INT64	Int64
INTEGER (32 bit)	Integer
LOGICAL	Boolean
RAW	Byte( )
RECID (32 or 64 bit)	Long
ROWID	Byte( )
WIDGET-HANDLE	Long

TABLE-HANDLE (dynamic temp-table) parameters

For TABLE-HANDLE parameters, the client must create (for input) and parse (for output) the XML Schema and data for the TABLE-HANDLE.

[13] This information also applies to the constituent temp-tables in a static ProDataSet parameter.

The following table lists the typical data type mappings for TABLE-HANDLE columns between ABL and .NET.[14]

Table 43: .NET data types for TABLE-HANDLE parameter columns

ABL data type	.NET data type
CHARACTER	String
DATE	Date
DECIMAL	Decimal
INT64	Int64
INTEGER (32 bit)	Integer
LOGICAL	Boolean
RAW	Byte( )

When passing a TABLE-HANDLE parameter, the interface or the client views it with different object types, depending on the Web service SOAP format:

- For RPC/Encoded:
  - The interface represents the parameter as an Object type
  - The client represents the parameter as a System.Array type
- For Doc/Lit, both the interface and the client represent the parameter as a System.Xml.XmlElement type.

Sample interface object prototypes in Reference.vb

The Web reference file (Reference.vb) defines the sample interface objects using the following Class declarations. Note the member variables:

- Object ID classes

  OrderInfoID:

```
Public Class OrderInfoID Inherits SoapHeader
   Public UUID As String
End Class
```

  CustomerOrderID:

```
Public Class CustomerOrderID Inherits SoapHeader
   Public UUID As String
End Class
```

[14] This information also applies to the constituent temp-tables in a dynamic ProDataSet parameter.

- AppObject class

  `OrderInfoObj:`

```
Public Class OrderInfoObj
   Public OrderInfoIDValue As OrderInfoID
   Public CustomerOrderIDValue As CustomerOrderID
   ...
End Class
```

Note: The methods in this class declaration are not shown.

- ProcObject class

  `CustomerOrderObj:`

```
Public Class CustomerOrderObj
   Public CustomerOrderIDValue As CustomerOrderID
   ...
End Class
```

Note: The methods in this class declaration are not shown.

Sample common interface method prototypes in Reference.vb

The Web reference file (`Reference.vb`) defines the sample common interface methods for managing Web service objects using the following Sub declarations:

- Common `OrderInfoObj` AppObject methods

  `Connect_OrderInfo( ):`

```
Public Sub Connect_OrderInfo(
             ByVal userId As String,
             ByVal password As String,
             ByVal appServerInfo As String)
```

  `Release_OrderInfo( )`:

```
Public Sub Release_OrderInfo( )
```

- Common `CustomerOrderObj` ProcObject methods

  `Release_CustomerOrder( ):`

```
Public Sub Release_CustomerOrder( )
```

Sample ABL and VB.NET interface method prototypes

The following examples show ABL prototypes and how the sample `Reference.vb` file maps them to the equivalent VB.NET method prototypes.

Note: The object ID in the SOAP headers are not shown in the VB.NET method prototypes.

Non-persistent procedure

- ABL:

```
/* FindCustomerByNum.p */

DEFINE INPUT PARAMETER CustomerNumber AS INTEGER.
DEFINE OUTPUT PARAMETER CustomerName AS CHARACTER.
```

- VB.NET `OrderInfoObj` (AppObject) method:

```
Public Sub FindCustomerByNum(
              ByVal CustomerNumber As Integer,
              ByRef CustomerName As String)
```

Persistent procedure

- ABL:

```
/* CustomerOrder.p */

DEFINE INPUT PARAMETER custNum AS INTEGER.
```

Note: This procedure returns a value using the ABL `RETURN` statement.

- VB.NET `OrderInfoObj` (AppObject) method:

```
Public Function CreatePO_CustomerOrder
                  (ByVal custNum As Integer) As String
```

User-defined function

- ABL:

```
/* CustomerOrder.p */

FUNCTION GetTotalOrdersByNumber RETURNS INTEGER
   (Threshold AS DECIMAL) :
```

- VB.NET `CustomerOrderObj` (ProcObject) method:

```
Public Function GetTotalOrdersByNumber
                   (ByVal Threshold As Decimal) As  Integer
```

Internal procedure passing a TABLE parameter

- ABL:

```
/* CustomerOrder.p */

PROCEDURE GetOrderDetails :
     DEFINE OUTPUT PARAMETER TABLE FOR OrderDetails.
```

- VB.NET `CustomerOrderObj` (ProcObject) method:

```
Public Sub GetOrderDetails(
              ByRef OrderDetails( ) As OrderDetailsRow)
```

TABLE definition

- ABL:

```
/* CustomerOrder.p */

DEFINE TEMP-TABLE OrderDetails
   FIELD OrderNum LIKE Order.OrderNum
   FIELD SalesRep LIKE Order.SalesRep
   FIELD OrderDate LIKE Order.OrderDate
   FIELD ShipDate LIKE  Order.ShipDate
   FIELD TotalDollars AS DECIMAL
   FIELD OrderStatus LIKE Order.OrderStatus.
```

- VB.NET `OrderDetailsRow` object:

```
Public Class OrderDetailsRow
   Public OrderNum As Integer
   Public SalesRep As String
   <. . .> Public OrderDate As Date
   <. . .> Public ShipDate As Date
   Public TotalDollars As Decimal
   Public OrderStatus As String
```

External procedure passing a TABLE-HANDLE parameter

- ABL:

```
/* DynTT.p */

DEFINE INPUT-OUTPUT PARAMETER TABLE-HANDLE ttHandle.
```

- VB.NET RPC/Encoded method:

```
Public Sub DynTT(ByRef ttHandle As Object)
```

- VB.NET Doc/Lit and RPC/Literal method:

```
Public Function DynTT(ByRef ttHandle As System.Xml.XmlElement) As String
```

Developing the VB.NET client application

Once you have added the Web reference and generated the client interface for the Web service, you can develop the client application. The typical tasks for developing a VB.NET client include:

- Creating the Web service on page 282
- Running a non-persistent (external) procedure on page 282
- Creating server-side context for a ProcObject (running a persistent procedure) on page 283
- Running an internal procedure or user-defined function on page 283
- Creating a SubAppObject on page 283
- Releasing an object on page 284
- Running a procedure with a TABLE parameter on page 284
- Processing the data from a TABLE parameter on page 285

- Running a procedure with a TABLE-HANDLE parameter on page 285
- Preparing schema and data for input TABLE-HANDLE parameter on page 286
- Processing schema and data for output TABLE-HANDLE parameter on page 287
- Extra processing for RPC/Encoded TABLE-HANDLE parameters on page 287
- Handling errors on the client on page 288

Note: For more information on the concepts and procedures that underlie these tasks, see , "Creating OpenEdge REST Web Services."

OpenEdge comes installed with complete sample client applications that access OpenEdge Web services. For more information, see Sample SOAP Web service applications on page 52.

Creating the Web service

To create the Web service:

1. Create the AppObject:

```
' There is no communication with the WSA at this time
Dim WS_OrderService As OrderService.OrderInfoObj
WS_OrderService = New OrderService.OrderInfoObj( )
```

2. Call the connect method on the AppObject (session managed only):

```
' Connect to the Progress Session Managed Web Service
WS_OrderService.Connect_OrderInfo("", "", "")
```

Note: Note that the value of the `OrderInfoIDValue` is extracted from the SOAP response header automatically by the interface. This value is then assigned to the `OrderInfoIDValue` member variable of the AppObject (`WS_OrderService`).

Running a non-persistent (external) procedure

The following example shows how you might invoke the sample FindCustomerByNum( ) method:

```
' Send a request to the AppServer to get the Customer Name
' and display in the UI
WS_OrderService.FindCustomerByNum(custNum, custName)
If custName <> Nothing Then
       lblCustName.Text = custName
```

Note: The `OrderInfoIDValue` is automatically inserted in the SOAP request header by the interface.

Creating server-side context for a ProcObject (running a persistent procedure)

To create the context for a ProcObject on the AppServer and run the persistent procedure:

1. Create the ProcObject by invoking the CreatePO_CustomerOrder( ) method on the AppObject:

```
' There is no communication with the WSA at this time
Dim WS_custOrder As OrderService.CustomerOrderObj
WS_custOrder = New OrderService.CustomerOrderObj( )

' Run the persistent procedure CustomerOrder.p on the AppServer
WS_OrderService.CreatePO_CustomerOrder(custNum)
```

Note: `OrderInfoIDValue` is automatically inserted in the SOAP request header by the interface, and the AppObject `CustomerOrderIDValue` member variable is also filled in automatically by the interface.

2. Copy the ProcObject ID from the AppObject to the ProcObject:

```
' Save the ProcObjectID in the ProcObject – copy from AppObject
WS_custOrder.CustomerOrderIDValue =
                   WS_OrderService.CustomerOrderIDValue
```

Running an internal procedure or user-defined function

The following example shows how you might invoke the `GetTotalOrdersByNumber( )` method on the ProcObject to run a user-defined function:

```
' Run the user-defined function GetTotalOrdersByNumber in
‘ CustomerOrder.p on the AppServer
intResult = WS_custOrder.GetTotalOrdersByNumber(1000000.0)
```

Note: The `CustomerOrderIDValue` is automatically inserted in the SOAP request header by the interface.

Methods for running an internal procedure are essentially the same as those for running a user-defined function.

Creating a SubAppObject

To create a SubAppObject:

1. Create the SubAppObject and evoke the `CreateAO_Payroll( )` method:

```
' There is no communication with the WSA at this time
Dim WS_Payroll As OrderService.PayrollObj
WS_Payroll = New OrderService.PayrollObj( )

' Create the SubAppObject
WS_OrderService.CreateAO_Payroll( )
```

Note: The `OrderInfoIDValue` will automatically be put into the SOAP request header by the interface, and the `PayrollIDValue` AppObject member variable is filled in automatically by the interface.

2. Copy the SubAppObject ID from the AppObject to the SubAppObject:

```
' Save the SubAppObjectID in the SubAppObject copy from AppObject
WS_Payroll.PayrollIDValue =
      WS_OrderService.PayrollIDValue
```

Releasing an object

For releasing an object:

- Every Open Client object except for a session-free AppObject has a release method.
- The syntax is the same for all objects, as in the following example that releases the `CustomerOrder` object, which happens to be a ProcObject:

```
' Tell the AppServer to release the Persistent Proc
If Not (WS_custOrder.CustomerOrderIDValue Is Nothing) Then
        WS_custOrder.Release_CustomerOrder( )
        WS_custOrder.CustomerOrderIDValue = Nothing
End If
```

Running a procedure with a TABLE parameter

This example shows how you might invoke a method that passes a `TABLE` parameter, by calling the sample method, `GetOrderDetails( )`:

```
' Run the internal procedure GetOrderDetails in CustomerOrder.p.
' OUTPUT parameter is the OrderDetails TEMP-TABLE
Dim WS_OrderDetails(-1) As OrderService.OrderDetailsRow
WS_custOrder.GetOrderDetails(WS_OrderDetails)
```

Note: The `CustomerOrderIDValue` is automatically inserted in the SOAP request header by the interface.

Processing the data from a TABLE parameter

This example shows how you might process data from a TABLE parameter:

```
' Loop through the rows to obtain some of the column values
Dim i As Integer
Dim OrderNum As Integer
Dim OrderStatus As String
Dim TotalDollars As Decimal

For i = 0 To WS_OrderDetails.Length - 1
    OrderNum = WS_OrderDetails(i).OrderNum
    OrderStatus = WS_OrderDetails(i).OrderStatus
    TotalDollars = WS_OrderDetails(i).TotalDollars
Next i
```

Running a procedure with a TABLE-HANDLE parameter

This example shows how you might invoke a method on a Doc/Lit Web service that takes a TABLE-HANDLE parameter, by calling the sample method, DynTT( ):

```
Imports System.Xml
. . .

Dim dynTTEl as XmlElement
' Code to create XML document representing dynTTEl goes here

' Run the non-persistent procedure DynTT.p.
‘ INPUT-OUTPUT parameter is a TABLE-HANDLE
wsObj.DynTT(dynTTEl)

' Code to process the output TABLE-HANDLE from DynTT.p goes here
```

Preparing schema and data for input TABLE-HANDLE parameter

This example shows how you might prepare the schema and data for an input TABLE-HANDLE parameter by building up the XML element nodes for the SOAP message from existing XML Schema and XML data files:

```
Dim schemaDoc As XmlDocument = New XmlDocument( )
Dim dataDoc As XmlDocument = New XmlDocument( )
Dim dataSetDoc As XmlDocument = New XmlDocument( )
Dim root As XmlElement
Dim schemaNode As XmlNode
Dim dataNode As XmlNode

' Load XML Schema(.xsd) and Data(.xml) files into XmlDocuments
schemaDoc.Load("ttEmp.xsd")
dataDoc.Load("empData.xml")

' Load the outer element into the dataSetDoc XmlDocument
dataSetDoc.LoadXml("<DataSet></DataSet>")
root = dataSetDoc.DocumentElement
root.SetAttribute("xmlns", "")

' Insert schema and data nodes as children of the dataSetDoc root node
schemaNode =  dataSetDoc.ImportNode(schemaDoc.DocumentElement, True)
dataNode = dataSetDoc.ImportNode(dataDoc.DocumentElement, True)

root.AppendChild(schemaNode)
root.AppendChild(dataNode)

dynTTEl = dataSetDoc.DocumentElement( )
```

Processing schema and data for output TABLE-HANDLE parameter

This example shows how you might process the data from an output TABLE-HANDLE parameter by walking the output XML Schema and XML data to create a .NET DataSet and bind the DataSet to a .NET DataGrid:

```
Dim schemaEl As XmlElement
Dim dataEl As XmlElement
Dim node As XmlNode
Dim type As XmlNodeType
...

' Extract the schema and data elements from the output
schemaEl = Nothing
dataEl = Nothing

For i = 0 To dynTTEl.ChildNodes.Count - 1
   node = dynTTEl.ChildNodes( i )
   type = node.NodeType
   If type = System.Xml.XmlNodeType.Element Then
      If schemaEl Is Nothing Then
         schemaEl = node
      ElseIf dataEl Is Nothing Then
         dataEl = node
      Else
         ‘Too many elements, something is wrong
      End If
   End If
Next i

' Load schema and data into a System.Data.DataSet, then bind to a
‘ System.Windows.Forms.DataGrid
mySchemaReader = New System.Xml.XmlNodeReader(schemaEl)
myDataReader = New System.Xml.XmlNodeReader(dataEl)

myDataSet.ReadXmlSchema(mySchemaReader)
myDataSet.ReadXml(myDataReader)

' Load myDataGrid with the output from DynTT
myDataGrid.SetDataBinding(myDataSet, "Item")
```

Extra processing for RPC/Encoded TABLE-HANDLE parameters

For RPC/Encoded Web services, a TABLE-HANDLE parameter is a System.Array containing the <DataSet> System.Xml.XmlElement. Process the array as follows for input and output:

- **Input** — Creates the System.Array with the XmlElement containing schema and data.
- **Output** — Extracts the last element of the System.Array, which is the XmlElement containing schema and data.

The following example shows the outlines of both procedures:

```
'This code goes after the code that creates XML document representing dynTTEl
'and before calling the method taking the TABLE-HANDLE parameter
. . .
‘Create a System.Array containing dynTTEl
dynTTArray = System.Array.CreateInstance(dynTTEl.GetType, 1)
dynTTArray(0) = dynTTEl

‘Run DynTT.p
 wsObj.DynTT(dynTTArray)

' Process the output TABLE-HANDLE from DynTT.p
dynTTEl = dynTTArray(dynTTArray.Length - 1)
'Continue with the rest of the code for processing the output
. . .
```

Handling errors on the client

To handle a SOAP fault in a VB.NET client, catch the `SoapException` and parse it, as shown:

```
Try
   ' Code to access the Web service
   ...
   Catch soapEx As System.Web.Services.Protocols.SoapException
      Dim detail As String, reqId As String
         detail = parseSoapException(soapEx.Detail, reqId)
         MsgBox(detail, MsgBoxStyle.Critical, soapEx.Message)
End Try
```

Caution: In any `catch block` where you exit the program, you must release all Web service objects you created in the program.

The `parseSoapException( )` method in this example is a client function provided in the .NET samples installed with OpenEdge. It parses the detail error information from the SOAP fault message.

You can also use the Microsoft SOAP Toolkit to assist in debugging SOAP fault messages. For more information, see Test and debug OpenEdge SOAP Web Services on page 165.

Creating .NET DataSets from ProDataSet parameters

This section presents an example of how to create an .NET DataSet from a ProDataSet parameter. Because .NET has a proprietary method of recognizing and exposing .NET DataSets in WSDL documents, its toolkit cannot translate the WSDL definition of a ProDataSet directly into an .NET DataSet. To work around this limitation, a .NET client can walk the object arrays and populate a .NET DataSet with the data.

Note: This section does not use RPC/Encoded WSDLs and the VB.NET language. Instead, it uses Doc/Lit and C#.NET.

The following table describes the specifications for the sample Web service and interface used in this section.

Table 44: ProDataSet to .NET sample Web service specifications

Property or component	Value or name	Object type
Web service	`CustOrdersService`	–
URL	`http://servicehost:80/wsa/wsa1`	–
Session model	Session-Free	–
TargetNamespace	`urn:CustOrders`	–
WSDL objects	`CustOrdersObj`	AppObject
	`dsCustOrd`	ProDataSet dsCustOrd

In general, the other information presented in the previous example for creating a client interface and developing a client application applies here as well. Except where the differences in the client language and session model affect things, you would complete the same tasks to build this sample.

This Web service uses the following code to create and populate a static ProDataSet parameter:

```
/* getCustOrders.p */
DEFINE TEMP-TABLE ttCust NO-UNDO
   FIELD CustNum AS INTEGER
   FIELD Name AS CHARACTER
   FIELD Balance AS DECIMAL
   INDEX CustNumIdx IS UNIQUE PRIMARY CustNum.

DEFINE TEMP-TABLE ttOrder NO-UNDO
   FIELD OrderNum AS INTEGER
   FIELD CustNum AS INTEGER
   FIELD OrderDate AS DATE
   INDEX OrderNumIdx IS UNIQUE PRIMARY OrderNum
   INDEX CustOrdIdx IS UNIQUE CustNum OrderNum.

DEFINE DATASET dsCustOrd FOR ttCust, ttOrder
   DATA-RELATION CustOrdRel FOR ttCust, ttOrder
      RELATION-FIELDS (CustNum, CustNum).

DEFINE INPUT PARAMETER iCustNum AS INTEGER EXTENT 2.
DEFINE OUTPUT PARAMETER DATASET FOR dsCustOrd.

DEFINE VARIABLE hq1 AS HANDLE.
DEFINE VARIABLE hq2 AS HANDLE.
DEFINE VARIABLE lret AS LOGICAL.
DEFINE DATA-SOURCE dsCust FOR Customer.
DEFINE DATA-SOURCE dsOrder FOR Order.

/* fill dataset and return to caller */
CREATE QUERY hq1.
hq1:SET-BUFFERS(BUFFER Customer:HANDLE).
lret = hq1:QUERY-PREPARE("for each Customer where CustNum >= " + STRING    (iCustNum[1])
 + " AND CustNum <= " + STRING(iCustNum[2])).

DATA-SOURCE dsCust:QUERY = hq1.

/* attach the data-sources to the dataset buffers */
BUFFER ttCust:HANDLE:ATTACH-DATA-SOURCE(DATA-SOURCE dsCust:HANDLE,?,?,?).
BUFFER ttOrder:HANDLE:ATTACH-DATA-SOURCE(DATA-SOURCE dsOrder:HANDLE,?,?,?).

MESSAGE "FILL() " DATASET dsCustOrd:FILL().
```

The Web service accepts an input array to specify a range of customer numbers. The service then outputs the data in the `dsCustOrd` ProDataSet.

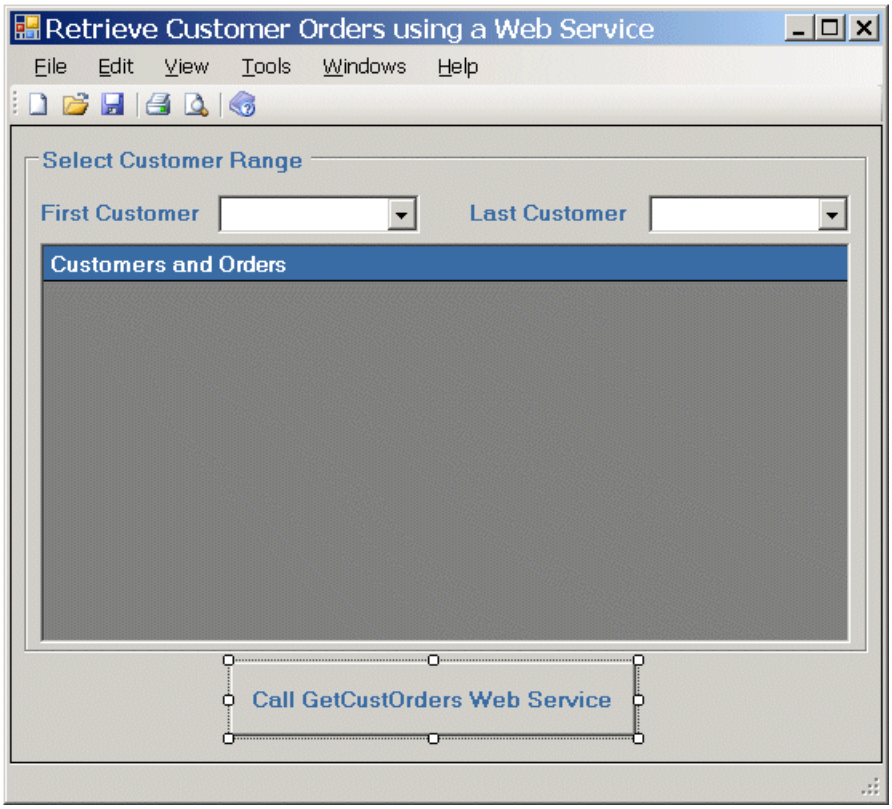
When you add a Web Reference to the `CustOrdersService` Web service in Microsoft Visual Studio, the proxies in the `Reference.cs` file include this method to invoke the `getCustOrders` operation:

```
public string
getCustOrders([System.Xml.Serialization.XmlElementAttribute("iCustNum",
     IsNullable=true)] System.Nullable<int>[] iCustNum,
     out dsCustOrd dsCustOrd) {
        object[] results = this.Invoke("getCustOrders", new object[] {
            iCustNum});
        dsCustOrd = ((dsCustOrd)(results[1]));
        return ((string)(results[0]));
}
```

The `Reference.cs` file also includes the following partial classes to describe the ProDataSet and its constituent temp-tables:

```
public partial class dsCustOrd {

    private dsCustOrdTtCust[] ttCustField;
    private dsCustOrdTtOrder[] ttOrderField;
    . . .

public partial class dsCustOrdTtCust {

    private System.Nullable<int> custNumField;
    private string nameField;
    private System.Nullable<decimal> balanceField;
    . . .

public partial class dsCustOrdTtOrder {

    private System.Nullable<int> orderNumField;
    private System.Nullable<int> custNumField;
    private System.Nullable<System.DateTime> orderDateField;
    . . .
```

To access the Web service, you might build an interface like the following one:



The combo-boxes enable you to set the range of customer numbers for the input parameter. When you click the button, the client calls the Web service, retrieves the data for the specified range, and then displays it in the grid.

As shown in the following code, the button's event logic invokes the Web service passing in the array for the CustNum range and retrieves the requested data:

```
private void button2_Click(object sender, EventArgs e)
   {
      string result = null;
      int cntr;
      int?[] CustNumRange = new int?[2];

     CustOrders.dsCustOrd dsCustOrd;
     CustOrders.CustOrdersService mySvc =
                                  new CustOrders.CustOrdersService();
      try
      {
         CustNumRange[0] = CustNumLow;
         CustNumRange[1] = CustNumHigh;

         if (CustNumHigh < CustNumLow)
             CustNumRange[1] = CustNumRange[0];

             result = mySvc.getCustOrders(CustNumRange, out dsCustOrd);
```

Since you know the schema of the incoming DATASET parameter, the event logic can create a matching .NET DataSet to accept the incoming data, as follows:

```
             // Create a .Net Dataset based on this data
             DataSet x = new DataSet("dsCustOrd");
            DataTable t1 = x.Tables.Add("ttCust");
            DataTable t2 = x.Tables.Add("ttOrder");

             t1.Columns.Add("CustNum", typeof(int));
             t1.Columns.Add("Name", typeof(string));
             t1.Columns.Add("Balance", typeof(System.Decimal));

             t1.Columns[0].Unique = true;

             t2.Columns.Add("OrderNum", typeof(int));
             t2.Columns.Add("CustNum", typeof(int));
             t2.Columns.Add("OrderDate", typeof(DateTime));

             t2.Columns[0].Unique = true;

             DataColumn pCol = t1.Columns[0];
             DataColumn cCol = t2.Columns[1];

             x.Relations.Add(pCol, cCol);
```

Finally, the event logic fills the DataSet with the data from the incoming DATASET parameter and binds the DataSet to a grid, as follows:

```
            //Populate the dataset with data from the SOAP message
            GetCustOrders.dsCustOrdTtCust[] ttCust = dsCustOrd.ttCust;
            for (cntr = 0; cntr < ttCust.Length; ++cntr)             {
               Object[] ooCust = new Object[3];
               ooCust[0] = ttCust[cntr].CustNum;
               ooCust[1] = ttCust[cntr].Name;
               ooCust[2] = ttCust[cntr].Balance;
               t1.Rows.Add(ooCust);
            }

            GetCustOrders.dsCustOrdTtOrder[] ttOrder = dsCustOrd.ttOrder;
            for (cntr = 0; cntr < ttOrder.Length; ++cntr)             {
               Object[] ooOrd = new Object[3];
               ooOrd[0] = ttOrder[cntr].OrderNum;
               ooOrd[1] = ttOrder[cntr].CustNum;
               ooOrd[2] = ttOrder[cntr].OrderDate;
               t2.Rows.Add(ooOrd);
            }

            //bind Dataset to Grid
            myGrid.SetDataBinding(x, "ttCust");      }
        catch (Exception ex)
        {
            MessageBox.Show("getCustOrders Failed: " + ex.Message);
        }
    }
```

Learning more about writing .NET clients

For more information on writing .NET clients, review the .NET samples provided with the OpenEdge, which highlight OpenEdge Web service functionality (see Sample SOAP Web service applications on page 52) and see the following sources for:

- General information on Microsoft .NET at the following URL:

  ```
  http://www.microsoft.com/net/
  ```

- Information on Microsoft Visual Studio .NET at the following URL:

  ```
  http://msdn.microsoft.com/vstudio/
  ```

- Information from other .NET developers at CodePlex, Microsoft's open source project hosting Web site:

  ```
  http://www.codeplex.com
  ```

B

Develop a Java Client to Consume OpenEdge SOAP Web Services

This appendix describes the basic tasks to develop Java client applications that use an OpenEdge SOAP Web service, as detailed in the following sections.

For details, see the following topics:

- Using Java client toolkits
- Java sample Web service specifications
- Creating Java Axis client interface objects
- Developing the Axis client application
- ProDataSet parameters in Java Web service clients

Using Java client toolkits

Most major Java software vendors are developing Java client toolkits to support Web service client development. In general, these toolkits include features that help automate the generation of client interfaces to Web services and offer other development aids, such as SOAP viewers and other debugging aids. Among the more common Java client toolkits are the following:

- Axis from Apache
- JAX-RPC

The client development samples in the remainder of this section are provided using Axis as the client-side Web services toolkit.

If you are developing a secure Web service that relies on the Transport Layer Security (TLS) managed by the Web server, OpenEdge provides a utility (`procertm`) to manage the digital certificates for a Java client. This same utility is also used to manage digital certificates for Java Open Clients. For more information on this utility, see *OpenEdge Development: Java Open Clients.*

Java sample Web service specifications

The following table describes the specifications for a sample Web service and interface used to illustrate client development with Axis.

Table 45: Java sample Web service specifications

Property or component	Value or name	Object type
Web service	`OrderService`	–
URL	`http://servicehost:80/wsa/wsa1`	–
Session model	Managed	–
TargetNamespace	`urn:OrderSvc:OrderInfo`	–
WSDL objects	`OrderInfoObj`	AppObject
	`CustomerOrderObj`	ProcObject
	`OrderInfoID`	AppObject ID
	`CustomerOrderID`	ProcObject ID
	`OrderDetailsRow`	Temp-table `OrderDetails`

Note: This sample is available on the Documentation and Samples (`doc_samples`) directory of the OpenEdge product DVD or Progress Documentation Web site.

Creating Java Axis client interface objects

Axis provides tools that help to automate the creation of the objects for a client interface. The following sections describe these tools and the generated interface objects:

- Generating client interface objects on page 297
- Proxy directory structure on page 297
- Proxy classes on page 298

- Java data type mapping on page 299
- Output parameters on page 300
- ABL unknown values on page 300
- TABLE (static temp-table) parameters on page 300
- TABLE-HANDLE (dynamic temp-table) parameters on page 301
- Sample Java prototypes for common object methods on page 302
- Sample ABL and Java interface method prototypes on page 302

To create client interfaces and client applications to access OpenEdge Web services, you must have Java SDK 1.3 or later and the Axis Toolkit. For more information, see the `README` files in the Java samples described in Sample SOAP Web service applications on page 52.

Generating client interface objects

You can generate client interface objects (classes) for the interface using the following command, where *`wsdlFileRef`* is a pointer to the WSDL file:

```
java org.apache.axis.wsdl.WSDL2Java wsdlFileRef
```

Note: Set the `Classpath` as specified in the *Axis User's Guide*.

The value of *`wsdlFileRef`* can be:

- A local reference; for example:

```
C:\OrderInfo.wsdl
```

- A URL to the WSDL; for example:

```
http://servicehost:80/wsa/wsa1/wsdl?targetURI=OrderInfo
```

Each generated interface object is a class for an Open Client object an/ or some other component of the WSDL that is represented as an object in the Java interface.

Proxy directory structure

The Axis `WSDL2Java` command creates the client interface objects in Java packages that reflect the `TargetNamespace` value specified in the WSDL. Thus, for example, suppose the WSDL specifies a `TargetNamespace` as follows:

```
TargetNamespace="urn:OrderSvc:OrderInfo"
```

The relative directory structure created from this namespace is the following:

```
OrderSvc/OrderInfo
```

Proxy classes

For this sample, the Axis `WSDL2Java` command provides the classes for the Web service components shown in the following table. This represents one class for each specified Web service (WSDL) object or component.

Note: Unlike .NET, there are no Java objects created for object IDs.

Table 46: Proxy classes for sample Java client (RPC/Encoded)

Web service components	Class	Path
Each Open Client object	`OrderInfoObjStub`	`. . .`/OrderInfo/ OrderInfoObjStub.java
	`CustomerOrderObjStub`	`. . .`/OrderInfo/CustomerOrder/CustomerOrderObjStub.java
One service locator object(Provides the URL to the WSA)	`OrderInfoServiceLocator`	`. . .`/OrderInfo/ OrderInfoServiceLocator.java
Each temp-table input parameter	`OrderDetailsRow`	`. . .`/CustomerOrder/ OrderDetailsRow.java
Two holder classes for each output temp-table	`ArrayofOrderDetailsRowHolder`	`. . .`/CustomerOrder/ holders/ ArrayofOrderDetailsRowHolder.java
	`OrderDetailsRowHolder`	`. . .`/CustomerOrder/ holders/OrderDetailsRowHolder.java
SOAP fault detail object	`FaultDetail`	servicehost/FaultDetail.java

Java data type mapping

The following table lists the data type mappings for parameters between ABL and Java.

Table 47: Supported Java data types

ABL data type	Java data type
CHARACTER	String
COM-HANDLE	long
DATASET (static ProDataSet)	Object (for every DATASET)
DATASET-HANDLE (dynamic ProDataSet)	DataSetHandleParam Object
DATE	java.util.Date
DATETIME	java.util.Calendar
DATETIME-TZ	java.util.Calendar
DECIMAL	java.math.BigDecimal
INT64	long
INTEGER (32 bit)	int
LOGICAL	boolean
LONGCHAR	String
MEMPTR	byte[ ]
RAW	byte[ ]
RECID (32 or 64 bit)	long
ROWID	byte[ ]
TABLE (static temp-table)	Object (for every TABLE)
TABLE-HANDLE (dynamic temp-table)	TableHandleParam Object
WIDGET-HANDLE	long

Output parameters

The Java language does not provide a mechanism to pass output parameters. To work around this, client interfaces use the Java standard of representing output parameters as holder classes, which provide the reference space to return output parameter values. Axis provides holder classes for all standard Java data types. The Axis interface generator (WSDL2Java) creates holder classes for output TABLE, TABLE-HANDLE, DATASET, and DATASET-HANDLE parameters. For more information on Axis support for holder classes, see the *Axis User's Guide*.

ABL unknown values

The Unknown value (?) appears as a null value in Java. For any ABL user-defined function that returns the Unknown value (?) as a primitive Java data type, this raises an exception in the interface method that calls this function. The client must compensate for this by catching the exception, as follows:

```
catch (NullPointerException con)
{
    System.err.println("The total Orders are: 0 (unknown)");
}
```

TABLE (static temp-table) parameters

For TABLE parameters, client interfaces:

- Contain a row object for any input parameter; for example:

```
public class OrderDetailsRow
```

- Represent an input TABLE parameter as an array of row objects
- Represent output TABLE parameters using an array holder class and a row holder class for the row objects, as in the following RPC/Encoded example:

```
public class ArrayofOrderDetailsRowHolder
public class OrderDetailsRowHolder
```

The following table lists the data type mappings for TABLE columns between ABL and Java.[15]

Table 48: Data types for TABLE parameter columns

ABL data type	Java data type
BLOB	byte[]

[15] This information also applies to the constituent temp-tables in a static ProDataSet.

ABL data type	Java data type
CHARACTER	String
CLOB	String
COM-HANDLE	long
DATE	java.util.Date
DATETIME	java.util.Calendar
DATETIME-TZ	java.util.Calendar
DECIMAL	java.math.BigDecimal
INT64	long
INTEGER (32 bit)	int
LOGICAL	boolean
RAW	byte[ ]
RECID (32 or 64 bit)	long
ROWID	byte[ ]
WIDGET-HANDLE	long

TABLE-HANDLE (dynamic temp-table) parameters

For TABLE-HANDLE parameters:

- For every Web service object containing a method that passes a TABLE-HANDLE parameter, the WSDL contains a <TableHandleParam> element defined as a <complexType> definition. Therefore, a TableHandleParam class is created for every client object which contains a method that passes a TABLE-HANDLE parameter. For example:

```
public class TableHandleParam {
    private org.apache.axis.message.MessageElement [ ] _any;
    . . .}
```

- For input TABLE-HANDLE parameters, the client must create a TableHandleParam object, consisting of a MessageElement array containing the XML Schema and data for the TABLE-HANDLE. For output TABLE-HANDLE parameters, the client must parse the XML Schema and data in the MessageElement array.

The following table lists the typical data type mappings for TABLE-HANDLE columns between ABL and Java.

Table 49: Data types for TABLE-HANDLE parameter columns

ABL data type	Java data type
CHARACTER	String
DATE	java.util.GregorianCalendar
DECIMAL	java.math.BigDecimal
INT64	long
INTEGER (32 bit)	int
LOGICAL	boolean
RAW	byte[ ]

Sample Java prototypes for common object methods

This is an example of an AppObject connect method for the session-managed OrderInfo AppObject as defined for the OrderInfoObjStub class. It makes the logical connection to the AppServer:

```
public void connect_OrderInfo
         (java.lang.String userID,
          java.lang.String password,
          java.lang.String appServerInfo)
```

This is an example of an AppObject release method for the OrderInfo AppObject as defined for the OrderInfoObjStub class:

```
public void release_OrderInfo( )
```

Note: All interface object release methods have a similar definition.

Sample ABL and Java interface method prototypes

The following examples show ABL prototypes and how they map to equivalent Java interface method prototypes:

Non-persistent procedure

- ABL:

```
/* FindCustomerByNum.p */

DEFINE INPUT PARAMETER CustomerNumber AS INTEGER.
DEFINE OUTPUT PARAMETER CustomerName AS CHARACTER.
```

- Java `OrderInfoObjStub` method:

```
public void findCustomerByNum
        (int customerNumber,
         javax.xml.rpc.holder.StringHolder customerName)
```

Note: The output parameter holder class shown in bold is provided by Axis.

Persistent procedure

- ABL:

```
/* CustomerOrder.p */

DEFINE INPUT PARAMETER CustNum AS INTEGER.
```

Note: This procedure returns a value using the ABL `RETURN` statement.

- Java `OrderInfoObjStub` method:

```
public String createPO_CustomerOrder (int custNum)
```

User-defined function

- ABL:

```
/* CustomerOrder.p */

FUNCTION GetTotalOrdersByNumber RETURN INTEGER
    (Threshold AS DECIMAL):
```

- Java `CustomerOrderObjStub` method:

```
public int getTotalOrdersByNumber
         (java.math.BigDecimal threshold)
```

Internal procedure using a temp-table

- ABL:

```
/* CustomerOrder.p */

PROCEDURE GetOrderDetails :
   DEFINE OUTPUT PARAMETER TABLE FOR OrderDetails.
```

- Java `CustomerOrderObjStub` method:

```
public void getOrderDetails
        (OrderSvc.OrderInfo.CustomerOrder.
         holders.ArrayOfOrderDetailsRowHolder orderDetails)
```

Note: The output parameter holder class shown in bold is generated by the Axis `WSDL2Java` command.

Temp-table definition

- ABL:

```
/* CustomerOrder.p */

DEFINE TEMP-TABLE OrderDetails
    FIELD OrderNum LIKE Order.OrderNum
    FIELD SalesRep LIKE Order.SalesRep
    FIELD OrderDate LIKE Order.OrderDate
    FIELD ShipDate LIKE  Order.ShipDate
    FIELD TotalDollars AS DECIMAL
    FIELD OrderStatus LIKE Order.OrderStatus.
```

- Java `OrderDetailsRow` object:

```
public class OrderDetailsRow {
    private java.lang.Integer orderNum;
    private java.lang.String salesRep;
    private java.util.Date orderDate;
    private java.util.Date shipDate;
    private java.math.BigDecimal totalDollars;
    private java.lang.String orderStatus;
    ...}
```

External procedure passing a TABLE-HANDLE

- ABL:

```
/* DynTT.p */

DEFINE INPUT-OUTPUT PARAMETER TABLE-HANDLE ttHandle.
```

- Java `DynTTObjStub` method:

```
public void DynTT
        (DynTTSrvc.DynTT.holders.TableHandleParamHolder ttHandle)
```

Developing the Axis client application

Once you have generated the client interface classes for the Web service, some typical tasks for developing a Java Axis client include:

- Setting up the Web service objects on page 306
- Using the sample PscObjectIDHandler and HandlerControlBlock classes on page 306
- Setting up the PscObjectIDHandler objects on page 307
- Connecting to a Web service on page 309
- Running a non-persistent (external) procedure on page 309
- Creating server-side context for a ProcObject (running a persistent procedure) on page 309
- Running an internal procedure or user-defined function on page 310
- Running an internal procedure with a TABLE parameter on page 311
- Processing the data from a TABLE parameter on page 311
- Running a procedure with a TABLE-HANDLE parameter on page 312
- Using sample helper classes to manage TABLE-HANDLE parameters on page 312
- Preparing schema and data for input TABLE-HANDLE parameters on page 313
- Processing schema and data for output TABLE-HANDLE parameters on page 314
- Releasing an object on page 314
- Handling errors on the client on page 315

Note: For more information on the concepts and procedures underlying these tasks, see , "Creating OpenEdge REST Web Services."

OpenEdge comes installed with complete sample client applications that access OpenEdge Web services. For more information, see Sample SOAP Web service applications on page 52.

Setting up the Web service objects

To set up the session-managed Web service objects for your client:

1. Create the Web service locator. For the sample, you generate the `OrderInfo` client's service object that manages the connection with the WSA:

```
OrderInfoService service = new OrderInfoServiceLocator( );
```

2. Instantiate the client objects that do the marshalling and unmarshalling of SOAP and HTTP messages for methods on the `OrderInfo` object. For example, you might execute the following method for the sample:

```
OrderInfoObjStub   orderInfo  =
        (OrderInfoObjStub)service.getOrderInfoObj(connectURL);
```

3. Instantiate the client objects that do the marshalling and unmarshalling of SOAP and HTTP messages for methods on the `CustomerOrder` object. For example you might execute the following method for the sample:

```
CustomerOrderObjStub    custOrder =
       (CustomerOrderObjStub)service.getCustomerOrderObj(connectURL);
```

Using the sample PscObjectIDHandler and HandlerControlBlock classes

Axis is a JAX-RPC-based Web service toolkit. JAX-RPC-based Web Service toolkits provide the ability to examine, modify, and insert information into SOAP requests using handler objects that conform to a defined interface (`javax.xml.rpc.handler.GenericHandler`). Axis client interface classes do not give programmatic access to SOAP request and response headers; therefore a client application must create and use one of these handlers to access these SOAP message headers.

A client application defines one or more of these handlers and binds them to a `<portType>` (Open Client object) defined in the Web service's WSDL document. Each time a SOAP request or response message is handled by an object, the appropriate handlers bound to the object are called and allowed access to the request or response message. For more information, see the source code modules for the Java samples described in Sample SOAP Web service applications on page 52.

OpenEdge provides a sample handler class (`PscObjectIDHandler`) to manage object IDs. This `PscObjectIDHandler` class is one possible implementation of a JAX-RPC handler. It provides two essential pieces of functionality:

1. It is invoked for each incoming SOAP response for the <portType> element (Open Client object type) where it is bound. When invoked, it scans the SOAP response header for an object ID that corresponds to an Open Client object name. If it finds one of these Open Client object IDs, it extracts the object ID value and stores it along with the object name. The client application or the handler can then access this stored object ID to insert it into a subsequent SOAP request header. If a handler does not already have an object ID value reserved to insert in a given SOAP request header, it automatically uses the first object ID that it stores.
2. It is invoked for each outgoing SOAP request for the <portType> element (Open Client object type) where it is bound. It then inserts a SOAP header containing the object ID for the Open Client object name that corresponds to the <portType> element where it is bound. If an object ID value does not exist for the Open Client object name, the handler does not insert a SOAP header into the request.

Along with the PscObjectIDHandler class provided with the OpenEdge Web services samples is a companion class, HandlerControlBlock. This class allows the Web service client application to access object ID values stored in a PscObjectIDHandler object. It also gives the application the ability to control the Object ID value the PscObjectIDHandler inserts into SOAP request headers. For each PscObjectIDHandler object instance, there is a companion HandlerControlBlock created and associated with it.

Setting up the PscObjectIDHandler objects

After you have completed the Web service object setup (see Setting up the Web service objects on page 306) that creates the OrderInfoObjStub and CustomerOrderObjStub objects, you can create and register the PscObjectIDHandler and HandlerControlBlock objects for both the OrderInfo and CustomerOrder Open Client objects.

The following steps create and register a unique handler for each Open Client object so it can automatically insert its corresponding object ID into outgoing SOAP requests without intervention by the client application.

To create and register a unique handler for each Open Client object:

1. Set the <portType> element name specified in the WSDL for the OrderInfoObjStub so a PscObjectIDHandler can be bound to it. For example:

```
orderInfo.setPortName("OrderInfoPort");
```

Note: Apache Axis does not automatically obtain the <portType> element name from the WSDL document when it generates the client interface classes.

2. Set the <portType> element name specified in the WSDL for the CustomerOrderObjStub so a PscObjectIDHandler can be bound to it. For example:

```
custOrder.setPortName("CustomerOrderPort");
```

Note: Apache Axis does not automatically obtain the <portType> element name from the WSDL document when it generates the client interface classes.

3. Declare the Open Client object names that the `PscObjectIDHandler` objects will use to scan for object IDs in SOAP response headers returned from the WSA. For example:

```
String[] orderInfoObjectNames =
              new String[] { "OrderInfo", "CustomerOrder" };
```

Note: Both the `"OrderInfo"` and `"CustomerOrder"` object names are included because the object IDs for both are returned from factory methods contained in the OrderInfo AppObject.

4. Call the `PscObjectIDHandler` built-in factory method to create and register a `PscObjectIDHandler` object for the `"OrderInfoPort"` <portType> element. The handler is set to scan for and record the object ID values for the `OrderInfo` and `CustomerOrder` Open Client objects. This automatically creates and binds a `HandlerControlBlock` object to the `PscObjectIDHandler` object, returning a reference for it to the client application, as shown:

```
HandlerControlBlock orderInfoControlBlock = null;

orderInfoControlBlock =
    PscObjectIDHandler.registerObjectIDHandler(
        service,
        orderInfoObjectNames,
        "",
        "OrderInfoPort",
        debugHandler );
```

5. Call the `PscObjectIDHandler` built-in factory method to create and register a `PscObjectIDHandler` object for the `"CustomerOrderPort"` <portType> element. The handler is set to scan for and record the object ID values for the `OrderInfo` and `CustomerOrder` Open Client objects. This automatically creates and binds a `HandlerControlBlock` object to the `PscObjectIDHandler` object, returning a reference for it to the client application, as shown:

```
HandlerControlBlock custOrderControlBlock = null;

custOrderControlBlock =
    PscObjectIDHandler.registerObjectIDHandler(
        service,
        orderInfoObjectNames,
        "",
        "CustomerOrderPort",
        debugHandler );
```

Connecting to a Web service

For session-managed Web services, make a logical connection to the AppObject and save its object ID for later use. For example:

```
orderInfo.connect_OrderInfo("", "", "");
if (null == orderInfoControlBlock.getObjectNameID("OrderInfo"))
{
   throw new Exception("No header returned from a connect operation to
   OrderInfo.");
}
```

Note: The `PscObjectIDHandler` registered for the `OrderInfoPort` type object (`OrderInfoObjStub`) automatically looks for and stores the object ID value returned for the `OrderInfoObjStub` object if the `connect_OrderInfo( )` method is successful. Because this is the first object ID that the handler stores, it is automatically set to be inserted as the object ID value in the SOAP header for each SOAP request sent to the WSA for the `OrderInfoObjStub` object.

Caution: Now that the Web service is connected, remember to release the AppObject when it is no longer needed.

Running a non-persistent (external) procedure

The following example shows how you might invoke the sample `FindCustomerByNum( )` method:

```
// Send a request to the AppServer to get the Customer Name

StringHolder    custNameHolder = new StringHolder( );
orderInfo.findCustomerByNum(3, custNameHolder);
System.out.println("Customer #3's name is " + custNameHolder.value);
```

The object ID handler automatically inserts the `orderInfo` object ID into the SOAP request header.

`StringHolder` is one of several holder classes defined by Axis.

Creating server-side context for a ProcObject (running a persistent procedure)

You create the server-side context for the ProcObject as shown below.

To create the context for a ProcObject on the AppServer:

1. Run the persistent procedure, creating the ProcObject:

```
orderInfo.createPO_CustomerOrder(3);
```

Caution: Now that the ProcObject is created, remember to release the object later when it is no longer needed.

2. Check to see if an object ID was returned:

```
if (null == orderInfoControlBlock.getObjectNameID("CustomerOrder"))
{
   throw new Exception("No header returned from a create operation
   for CustomerOrder.");
}
```

3. The `CustomerOrderObjStub` object is created from a factory method included in the `OrderInfoObjStub` object. Therefore, the `PscObjectIDHandler` bound to the `OrderInfoObjStub` locates and stores the object ID value for the `CustomerOrderObjStub` object in the `OrderInfoObjStub` object. Thus the client application must obtain (export) the object ID value for the `CustomerOrderObjStub` from the `OrderInfoObjStub` handler and insert (import) it into the `CustomerOrderObjStub` handler. For example:

```
custOrderControlBlock.importObjectID("CustomerOrder",
orderInfoControlBlock.exportObjectID("CustomerOrder"));
```

   This enables the `CustomerOrderObjStub` handler to automatically insert the `CustomerOrder` object ID into the headers for all SOAP requests made on the `CustomerOrderObjStub` object.

4. The client application must then remove (release) the object ID value for the `CustomerOrderObjStub` object from the `OrderInfoObjStub` handler because it is no longer needed by that handler. For example:

```
orderInfoControlBlock.releaseObjectNameID("CustomerOrder");
```

Running an internal procedure or user-defined function

The following sample shows how you might invoke the `GetTotalOrdersByNumber( )` method:

```
try
{
  int orderCount = custOrder.getTotalOrdersByNumber(new BigDecimal(5.0));
  System.out.println("The total Customer Orders are: " + orderCount);
}
catch (NullPointer Exception e)
{
  ...
}
```

Note: The object ID handler automatically inserts the `custOrder` object ID into the SOAP request header.

Running an internal procedure with a TABLE parameter

This example shows how you might invoke a method that takes a TABLE parameter, by calling the sample method, `GetOrderDetails( )`:

```
// Create the holder for the TEMP-TABLE OrderDetails

ArrayOfOrderDetailsRowHolder orderDetailsHolder =
                             new ArrayOfOrderDetailsRowHolder(null);

// Let's now ask the WebService for the order details of the
// current customer

custOrder.getOrderDetails(orderDetailsHolder);
```

Note: The object ID handler automatically inserts the `custOrder` object ID into the SOAP request header.

Processing the data from a TABLE parameter

This example shows how you might process data from a TABLE parameter:

```
// Loop through the rows and print some of the column values

OrderDetailsRow[] rows = (OrderDetailsRow[]) orderDetailsHolder.value;

// Print out some labels
System.out.println("Customer's Order Details listed below:"); System.out.println("Order#
 " + "Order Status " + "Total Dollars");

// Now print out all the rows
for (int j = 0; j < rows.length; j++)
{
   OrderDetailsRow thisRow = rows[j];
   System.out.println(thisRow.getOrderNum( ) +
                      thisRow.getOrderStatus( ) +
                      thisRow.getTotalDollars( ));
}
```

Running a procedure with a TABLE-HANDLE parameter

This example shows how you might invoke a method that takes a TABLE-HANDLE parameter, by calling the sample method, dynTT( ):

```
import DynTTSrvc.*;
import DynTTSrvc.DynTT.*;
import DynTTSrvc.DynTT.holders.*;
import org.apache.axis.message.MessageElement;
import org.w3c.dom.Element;
...

// Prepare the Schema and Data for the Input TABLE-HANDLE Parameter
// Create the XML Schema and data for the dynamic TEMP-TABLE.
// Then create the TableHandleParam object, ttHandle
...
// Create the holder for the INPUT-OUTPUT TableHandleParam parameter, ttHandle
TableHandleParamHolder ttHolder = new TableHandleParamHolder( );
ttHolder.value = ttHandle;

// Call DynTT.p, passing the Input-Output TABLE-HANDLE
dynTTObj.dynTT(ttHolder);

// Process the schema and data for the Output TABLE-HANDLE
...
```

Using sample helper classes to manage TABLE-HANDLE parameters

OpenEdge Web services sample applications come installed with a set of helper classes that you can use to manipulate TABLE-HANDLE parameters. For example:

- **ColumnMetaData.java** — Represents the schema of a column, as shown:

```
public class ColumnMetaData {
   protected String name;
   protected int type;
   protected int extent;
...}
```

- **RowSet.java** — Represents the XML Schema and data for a TABLE-HANDLE parameter, as shown:

```
public class RowSet {
   private Vector m_rows;
   private ColumnMetaData[ ] m_schema;
...}
```

In the RowSet class, m_rows is a Vector of rows, each of which is a Vector of column data. Each column datum is a Java object appropriate for the column data type. The m_schema variable is the ColumnMetaData array representing the schema for the temp-table.

- **SchemaParser.java** — Parses the <schema> element from a SOAP response message and creates a ColumnMetaData array for the RowSet class, as shown:

```
public class SchemaParser
{    protected ColumnMetaData[ ] m_schema;
...}
```

Preparing schema and data for input TABLE-HANDLE parameters

This example shows how you might prepare the schema and data for an input TABLE-HANDLE parameter using the helper classes described in the previous section:

```
// Build up a simple RowSet object representing the input dynamic TEMP-TABLE.
RowSet rsIn = new RowSet( );

// Create the MetaData, consisting of String and Integer columns
ColumnMetaData[] schema = new ColumnMetaData[2];
ColumnMetaData firstCol = new ColumnMetaData("Name",
                                             ColumnMetaData.CHAR_TYPE, 0);
ColumnMetaData secondCol = new ColumnMetaData("Number",
                                              ColumnMetaData.INT_TYPE, 0);
schema[0] = firstCol;
schema[1] = secondCol;

rsIn.setSchema(schema);

// Create a data row and add to the RowSet
Vector row;
row = new Vector( );
row.addElement(new String("Sally Jones"));
row.addElement(new Integer(1));
rsIn.addRow(row);

// Convert the RowSet into a TableHandleParam Object,
// the input parameter for DynTT.p

// Get the RowSet as a DOM Element.  This element has two
// children, a <schema> element and a <Data> element
Element dataSetIn = rsIn.getDataSetAsDom( );

// Create a MessageElement containing the DataSet
MessageElement dataSetMsgEl = new MessageElement(dataSetIn);

// Place the DataSet MessageElement into the message element array
// and create the TableHandleParam object
MessageElement msgArrayIn[] = new MessageElement[1];
msgArrayIn[0] = dataSetMsgEl;

// Create the TableHandleParam object, ttHandle, representing the
// dynamic TABLE-HANDLE parameter
TableHandleParam ttHandle = new TableHandleParam( );
ttHandle .set_any(msgArrayIn);

...
```

Processing schema and data for output TABLE-HANDLE parameters

This example shows how you might process the data from an output TABLE-HANDLE parameter by using the sample TABLE-HANDLE helper classes:

```
// Process the Output TABLE-HANDLE parameter
ttHandle = ttHolder.value;

MessageElement [] msgArrayOut = ttHandle.get_any( );

// msgArrayOut has one entry, the DataSet
// Get the DOM representation of the MessageElement
Element dataSetOut = msgArrayOut[0].getAsDOM( );

// Create a new RowSet Object based on the DataSet
RowSet rsOut = new RowSet( );

/*
Call the buildRowSet method on the RowSet object.
buildRowSet creates a SchemaParser object to parse the <schema> element of the
dataSetOut and creates the m_schema ColumnMetaData[ ] array representing the
schema.  buildRowSet then parses the <Data> element and creates the m_rows Vector
representing the data.
*/
rsOut.buildRowSet(dataSetOut);

// print out the data for the dynamic temp-table to the console
rsOut.printData( );
```

Releasing an object

You can manage the object IDs of the two objects about to be released by using the object ID handler (PscObjectIDHandler), as shown here.

To release the **CustomerOrder** ProcObject and the **OrderInfo** AppObject:

1. Release the logical connection. For example, to release the CustomerOrder ProcObject, call this method:

```
custOrder.release_CustomerOrder( );
```

2. Remove (release) the ProcObject ID from the object ID handler, so this ProcObject ID cannot be used again, as shown:

```
custOrderControlBlock.releaseObjectNameID("CustomerOrder");
```

3. Release the logical connection for the `OrderInfo` AppObject, as shown:

```
orderInfo.release_OrderInfo( );
```

4. Remove (release) the AppObject ID from the object ID handler, so this AppObject ID cannot be used again. For example:

```
orderInfoControlBlock.releaseObjectNameID("OrderInfo");
```

Handling errors on the client

To understand how to handle SOAP fault messages returned by the WSA, first note that the `<FaultDetail>` element is described in the interface Java class, `servicehost/FaultDetail.java`. For example:

```
public class FaultDetail {
   java.lang.String errorMessage;
   java.lang.String requestID;
   ...
}
```

Place a `try...catch` block around any code that accesses the Web server and catch the `AxisFault` exception.

This is an example of Axis client code to catch a SOAP fault (an `AxisFault` exception):

```
try
{
    // code to Access the Web Service
}
catch (AxisFault e)
{
    // Get the (single) child element of the SOAP Fault <detail> element,
    // the <FaultDetail> element.

    Element[] faultDetails = e.getFaultDetails( );
    if (faultDetails.length > 0)
    {
        // Now get the contents of the <FaultDetail> element,
        //    <errorMessage> and <requestID>.

        Node     faultDetailElem = faultDetails[0].getFirstChild( );
        String   detailErrorMsg =
           faultDetailElem.getFirstChild( ).getNodeValue( );
        System.err.println("Exception errorMessage: " + detailErrorMsg);
        Node     requestIDElem = faultDetailElem.getNextSibling( );
        String   requestID = requestIDElem.getFirstChild( ).getNodeValue( );
        System.err.println("Exception requestID   : " + requestID);
    }
}
```

Caution: In any catch block where you exit the program, you must release all Web service objects you created in the program.

Compiling and running the client application

To compile and run the application:

1. Set up your `Classpath` as specified in the *Axis User's Guide*. Make sure you put the path to your client interface on the `Classpath`.
2. Compile both the interface and your client application classes using the Java compiler.
3. Run the application, as usual, in the JVM.

ProDataSet parameters in Java Web service clients

This section provides basic information for handling ProDataSet parameters in Java.

Note: This section does not continue the sample application in the rest of this appendix.

The following table describes the specifications for a sample Web service and interface used in this section.

Table 50: Java sample Web service specifications

Property or component	Value or name	Object type
Web service	`CustOrdersService`	–
URL	`http://servicehost:80/wsa/wsa1`	–
Session model	Session-Free	–
TargetNamespace	`urn:CustOrders`	–
WSDL objects	`CustOrdersObj`	AppObject
	`dsCustOrd`	ProDataSet dsCustOrd

In general, the other information presented in the previous example for creating a client interface and developing a client application applies here as well. Except where the differences in the session model affect things, you would complete the same tasks to build this sample.

The code samples in this section rely on classes generated by Apache Axis from a Doc/Lit WSDL for the following ABL code snippet:

```
/* getCustOrders.p */
DEFINE TEMP-TABLE ttCust NO-UNDO
    FIELD CustNum AS INTEGER
    FIELD Name AS CHARACTER
    INDEX CustNumIdx IS UNIQUE PRIMARY CustNum.

DEFINE TEMP-TABLE ttOrder NO-UNDO
    FIELD OrderNum AS INTEGER
    FIELD CustNum AS INTEGER
    INDEX OrderNumIdx IS UNIQUE PRIMARY OrderNum
    INDEX CustOrdIdx IS UNIQUE CustNum OrderNum.

DEFINE TEMP-TABLE ttOrderLine NO-UNDO
    FIELD OrderNum AS INTEGER
    FIELD LineNum AS INTEGER
    INDEX OrderLineIdx IS UNIQUE PRIMARY OrderNum LineNum.

DEFINE DATASET dsCustOrd FOR ttCust, ttOrder, ttOrderLine
    DATA-RELATION CustOrdRel FOR ttCust, ttOrder
        RELATION-FIELDS (CustNum, CustNum)
    DATA-RELATION OrdLinesRel FOR ttOrder, ttOrderLine
        RELATION-FIELDS (OrderNum, OrderNum) NESTED.

DEFINE INPUT PARAMETER iCustNum AS INTEGER.
DEFINE OUTPUT PARAMETER DATASET FOR dsCustOrd.

/* fill dataset and return to caller */
...
```

Proxy classes

The following table shows the classes created for the `dsCustOrd` ProDataSet by Apache Axis. Axis also creates classes similar to those described for the previous example in Table 6.

Table 51: Proxy Java classes for ProDataSet parameter

Web service components	Class	Path
ProDataSet output parameter	`DsCustOrd`	`. . ./CustOrders/ DsCustOrd.java`

Web service components	Class	Path
Constituent temp-tables	DsCustOrdTtCust	. . ./CustOrders/DsCustOrdTtCust.java
	DsCustOrdTtOrder	. . ./CustOrders/DsCustOrdTtOrder.java
	DsCustOrdTtOrderTtOrderLine	. . ./CustOrders/DsCustOrdTtOrderLine.java
Holder class for output ProDataSet	DsCustOrdHolder	. . ./CustOrders/holders/DsCustOrdHolder.java

DATASET (static ProDataSet) parameters

In Java, the client interface for a DATASET parameter:

- Represents a DATASET object as arrays of the constituent temp-tables' row objects. For example:

```
public class DsCustOrd implements java.io.Serializable {
    private CustOrders.CustOrders.DsCustOrdTtCust[] ttCust;
    private CustOrders.CustOrders.DsCustOrdTtOrder[] ttOrder;
...
}
```

- Represents an output DATASET parameter using an array holder class. For example:

```
public final class DsCustOrdHolder implements
                                    javax.xml.rpc.holders.Holder {
    public CustOrders.CustOrders.DsCustOrd value;
    public DsCustOrdHolder() {
    }
    public DsCustOrdHolder(CustOrders.CustOrders.DsCustOrd value) {
        this.value = value;
    }
}
```

- Represents a `NESTED DATA-RELATION` by embedding an array of the child temp-table's row objects in the parent temp-table definition. For example:

```
public class DsCustOrdTtOrder  implements java.io.Serializable {
    private java.lang.Integer orderNum;
    private java.lang.Integer custNum;
    private CustOrders.CustOrders.DsCustOrdTtOrderTtOrderLine[]
         ttOrderLine;
...
}
```

The following Java application is an example of handling the `DsCustOrd` parameter in a Java client:

Table 52: Sample Java application for getCustOrders

```
import java.net.URL;
import javax.xml.rpc.holders.*;

import CustOrders.*;
import CustOrders.CustOrders.*;
import CustOrders.CustOrders.holders.*;
public class CustOrders {

  public static void main(String[] args) {

    int iCustNum;
    CustOrdersObjStub appobj = null;

    try
    {
      CustOrdersService ws = new CustOrdersServiceLocator();

      URL connectURL = new java.net.URL("http://localhost:8080/wsa/wsa1");

      appobj = (CustOrdersObjStub)ws.getCustOrdersObj(connectURL);

      iCustNum = 1;
      StringHolder result = new StringHolder();
      DsCustOrdHolder dsCustOrdH = new DsCustOrdHolder();

      //call getCustOrders on Web service
      appobj.getCustOrders(iCustNum, result, dsCustOrdH);

      DsCustOrd dsCustOrd = dsCustOrdH.value;
      //print out ttCust records
      DsCustOrdTtCust[] ttCust = dsCustOrd.getTtCust();
      for (int i = 0; i< ttCust.length; i++)
      {
        System.out.println("CustNum: " + ttCust[i].getCustNum());
        System.out.println("Name: " + ttCust[i].getName());
      }

      //print out ttOrder records
      DsCustOrdTtOrder ttOrder[] = dsCustOrd.getTtOrder();
      for (int i = 0; i < ttOrder.length; i++)
      {
        System.out.println("OrderNum: " + ttOrder[i].getOrderNum());
        System.out.println("CustNum: " + ttOrder[i].getCustNum());
      // get nested ttOrderLine records
      DsCustOrdTtOrderTtOrderLine[] ttOrderLine =
                                              ttOrder[i].getTtOrderLine();
      for (int j = 0; j < ttOrderLine.length; j++)
      {
        System.out.println("OrderNum: " + ttOrderLine[j].getOrderNum());
        System.out.println("LineNum: " + ttOrderLine[j].getLineNum());
      }
    }
  } catch (Exception e){
    System.out.println("CAUGHT EXCEPTION - printing stack trace");
    System.out.println(e.toString());
    e.printStackTrace();
    }
  }
}
```

Before-image data

The WSDL represents static ProDataSet parameters with before-image data as arbitrary complex data in an XML Schema any element. Apache Axis represents the any element as a Java class with a MessageElement[] member that contains the DOM tree for the ProDataSet. The client developer has to parse the XML to build a data set.

DATASET-HANDLE (dynamic ProDataSet) parameters

In Java, the client interface for a DATASET-HANDLE parameter is based on the following:

- For every Web service object containing a method that passes a DATASET-HANDLE parameter, the WSDL contains a <DatasetHandleParam> element defined as a <complexType> definition. Therefore, a DatasetHandleParam class is created for every client object which contains a method that passes a DATSET-HANDLE parameter.
- For input DATASET-HANDLE parameters, the client must create a DatasetHandleParam object, consisting of a MessageElement array containing the XML Schema and data for the DATASET-HANDLE. For output DATASET-HANDLE parameters, the client must parse the XML Schema and data in the MessageElement array.

The following code snippet reads an OUTPUT DATASET-HANDLE from a Web service, outDynDS:

Table 53: Reading OUTPUT DATASET-HANDLE in Java

```
StringHolder retval = new StringHolder();
DataSetHandleParamHolder dsParamH = new DataSetHandleParamHolder();

// call outDyn.p on appserver
appobj.outDyn(retval, dsParamH);

DataSetHandleParam dsParam = dsParamH.value;
MessageElement domElem[] = new MessageElement[2];
domElem = dsParam.get_any();

// Extract the schema, followed by the data.

MessageElement schemaElem = domElem[0];
// parse the XML Schema for the Dataset

MessageElement dataElem = domElem[1];
// parse the XML Data for the Dataset
```

Before-image data

The WSDL represents dynamic ProDataSet parameters with before-image data as arbitrary complex data in an XML Schema any element. Apache Axis represents the any element as a Java class with a MessageElement[] member that contains the DOM tree for the ProDataSet. The client developer has to parse the XML to build a data set.

C

ABL Elements to Consume SOAP Web Services

Many elements of ABL support consumption of OpenEdge SOAP Web services, including some that are extensions to other functionality and some that are unique for interacting with Web services. The following sections describe all of these elements, including.

- Handles to consume a web service
- Statements to consume SOAP web services
- Attributes methods and events for consuming Web services

For details, see the following topics:

- Handles to consume a web service
- Statements to consume SOAP web services
- Attributes, methods, and events to consume web services

Handles to consume a web service

The following table lists the ABL handles that are either valid only for consuming a Web service or have special application in Web service client programming.

Table 54: Handles to consume Web services

ABL handle	Description
Asynchronous request object handle	A type of handle that maintains the status of an asynchronous request in an ABL client application. This handle provides methods and attributes that allow you to check the status of an asynchronous Web service operation.
`ERROR-STATUS` system handle	Provides access to the error information returned from processing a Web service request. If the error resulted from a SOAP fault, the SOAP fault is returned as a SOAP-fault object.
Procedure object handle	A handle to a type of procedure object (*Web service procedure object*) that provides the interface to a port type of a Web service. port type operations are represented as ABL internal procedures and user-defined functions within the procedure object that represents the specified port type. A single Web service binding supports one associated port type.
`SELF` system handle	In the context of an asynchronous event procedure or method, returns the asynchronous request object handle of the completed request for which the event procedure or method is executing.
Server object handle	A handle to a server object that can provide a logical connection (or binding) to a Web service from an ABL client application. The handle provides methods and attributes that allow you to logically connect (or bind) the server object to a Web service and manage the Web service binding.
`SESSION` system handle	Maintains ABL session status, including a list of all server objects created by the session to bind Web services.
SOAP-fault object handle	A handle to an object that contains SOAP fault information for a Web service request. This system handle provides the SOAP-fault object handle as the value of its `ERROR-OBJECT-DETAIL` attribute.
SOAP fault-detail object handle	A handle to an object that references any `<detail>` element returned in a SOAP fault message generated for a Web service request. The SOAP-fault object handle provides any SOAP fault-detail object handle as the value of its `SOAP-FAULT-DETAIL` attribute.
SOAP header object handle	A handle to an object that contains the SOAP header for a SOAP request or response message generated for a Web service operation. This can be either an existing header from a SOAP response message, or a newly-created header for a pending SOAP request message.

ABL handle	Description
SOAP header-entryref object handle	A handle to an object that references an entry of a SOAP header, either an existing entry from the header of a SOAP response message, or a newly-created entry for a pending SOAP request message.
X-document object handle	A handle to an XML document object created for any SOAP message content that you must access as XML.
X-noderef object handle	A handle to any XML element (node object) within an XML document object that contains SOAP message content. This allows you to access the actual text of elements in the XML document retrieved as X-noderef objects.

Statements to consume SOAP web services

The following table lists the ABL statements that are either valid only for consuming a web service or have special application in web service client programming.

Table 55: Statements to consume web services

ABL statement	Description
`CREATE SERVER` *`server-handle`*	Creates a server object and stores a reference to it in the specified `HANDLE` variable. You can then bind (logically connect) the server object to a web service using the server handle `CONNECT( )` method.
`CREATE SOAP-HEADER` *`header-obj-handle`*	Creates a SOAP header object used to add a SOAP header to a pending SOAP request message generated by an OpenEdge web service invocation.
`CREATE SOAP-HEADER-ENTRYREF` *`soap-obj-handle`*	Creates a SOAP header-entryref object used to add SOAP header entries to an existing SOAP header.

ABL statement	Description
`DELETE OBJECT` *handle*	Deletes certain objects, including server objects, procedure objects, SOAP header objects, SOAP header-entryref objects, and asynchronous request objects.
`DELETE PROCEDURE` *procedure-handle*	Deletes the procedure object associated with a web service.
`FUNCTION` *operationName* [`RETURNS`] *dataType* [`(` *parameter* [`,` *parameter*]...] `IN` *hPortType*.	Defines a user-defined function prototype to map a web service operation as specified by the WSDL Analyzer, which determines the need for a function to return a value.
return `=` *operationName* [`(` *parameter* [`,` *parameter*]... `)`].	Invokes a web service operation defined as a user-defined function, where *return* is a variable to receive the value of the operation `<return>` parameter element, *operationName* is the name of the operation as specified in the WSDL file and whose ABL prototype is defined using the `FUNCTION` statement, and *parameter* is an ABL function parameter as required by the WSDL file for the operation. The operation can also be invoked as part of any other ABL statement that can invoke a user-defined function.

ABL statement	Description
PROCESS EVENTS	Handles any pending PROCEDURE-COMPLETE events for asynchronous requests by triggering execution of the event procedures for all completed asynchronous requests. You can also use any blocking I/O statement, such as the WAIT-FOR statement, to handle these events.
RUN *portTypeName* [SET *hPortType*] ON SERVER *server-handle* [NO-ERROR] .	Creates and associates a procedure object with a web service, where *portTypeName* is the name of a web service port type as specified in the WSDL file and whose operations this procedure object encapsulates, *hPortType* is a HANDLE variable that is set to the handle of the created procedure object, and *server-handle* is a handle to the server object that binds the web service.
RUN *operationName* IN *hPortType* [ASYNCHRONOUS [SET *asyncRequestHandle*] [EVENT-PROCEDURE *eventInternalProcedure* [IN *procedureContext*]] [EVENT-HANDLER *event-handler-name* [EVENT-HANDLER-CONTEXT *event-handler-context*]] [(*parameter* [, *parameter*] . . .)] [NO-ERROR] .	Invokes a web service operation that does not contain a <return> parameter element, where *operationName* is the name of a web service operation specified in the WSDL file, *hPortType* is a handle to the procedure object that encapsulates the operation, and *parameter* is an ABL procedure parameter as required by the WSDL for the operation. If the operation is invoked asynchronously, *asyncRequestHandle* is a handle that is set to the asynchronous request object created for the asynchronous request, *eventInternalProcedure* is the name of an ABL internal procedure defined to handle the results of the asynchronous request, and *procedureContext* is a handle to an active ABL procedure object that encapsulates the event internal procedure. *event-handler-name* is the name of an internal procedure or a method that is specified as a callback handler. The *event-handler-context* resolves to either a handle to an active procedure or the object-oriented ABL object's instance reference containing the method specified by *event-handler-name*.
WAIT-FOR ...	Handles any pending PROCEDURE-COMPLETE events for asynchronous requests by forcing the event procedures or methods for all completed asynchronous requests to execute. You can also use PROCESS EVENTS or any other blocking I/O statement, such as the PROMPT-FOR statement, to handle these events.

Attributes, methods, and events to consume web services

The following table lists the ABL handle attributes and methods that are either valid only for consuming a Web service or have special application in Web service client programming.

Table 56: Attributes, methods, and events to consume Web services

ABL attribute, method, or event	Description
ACTOR	(SOAP Version 1.1 only) A CHARACTER attribute on a SOAP header-entryref object handle that returns the value of the actor attribute specified in the associated SOAP header entry. Replaced in SOAP Version 1.2 by the ROLE attribute, and assumes the value of that attribute if used in the context of a SOAP 1.2 connection.
ADD-HEADER-ENTRY( )	A LOGICAL method on the SOAP header object handle that creates a new SOAP header entry and attaches it to the SOAP header. A specified SOAP header-entryref object handle references the new header entry.
ASYNC-REQUEST-COUNT	An INTEGER attribute that: • On a server object handle, returns the number of active asynchronous requests submitted to this Web service. • On a procedure handle, returns the number of currently outstanding asynchronous requests for this procedure object. Can be nonzero only if the PROXY and PERSISTENT attributes are both set to TRUE.
CANCELLED	A LOGICAL attribute on the asynchronous request object handle that indicates if the asynchronous request was cancelled using either the CANCEL-REQUESTS( ) method or the DISCONNECT( ) method on the associated server handle.
CANCEL-REQUESTS( )	A LOGICAL method on the server object handle that: • Terminates the socket connection to all currently running asynchronous requests for this Web service and raises the STOP condition in the event procedure context for each such request. • Purges the send queue of any asynchronous requests that have not yet been executed for this Web service.
CLIENT-CONNECTION-ID	A CHARACTER attribute on the server object handle that returns the connection ID for the connection associated with this server handle. For Web services, this is the empty string.
COMPLETE	A LOGICAL attribute on the asynchronous request object handle that indicates if the asynchronous request is completed and its result is processed on the client.
CONNECT ([connection-parms])	A LOGICAL method on the server object handle that logically connects (binds) and associates a Web service to the server handle.For complete list of parameters, see Connect() method (Web service)

ABL attribute, method, or event	Description
CONNECTED( )	A LOGICAL method on the server object handle that returns TRUE if the handle is currently bound to a Web service.
DELETE-HEADER-ENTRY( )	A LOGICAL method on the SOAP header-entryref object handle that deletes the underlying SOAP header entry and all of its content, but does not delete the SOAP header-entryref object used to reference the deleted header entry.
DISCONNECT( )	A LOGICAL method on the server object handle that disconnects from and removes all reference to the Web service currently associated with the server handle. Any running or pending asynchronous requests to the Web service submitted by this client are also cancelled.
ERROR	A LOGICAL attribute on the asynchronous request object handle that indicates that an ERROR condition was returned as a result of processing a Web service request.
ERROR-OBJECT	An attribute on the asynchronous request object handle that returns an object reference to an instance of a class that implements Progress.Lang.Error.
ERROR-OBJECT-DETAIL	A HANDLE attribute an the ERROR-STATUS system handle that references the SOAP-fault object for any Web service request that returns a SOAP fault that is trapped using the ABL NO-ERROR option.
EVENT-HANDLER	A character expression that results in the name of an internal procedure or a method to be run as the event procedure for this asynchronous event.
EVENT-HANDLER-CONTEXT	The event-handler-context value resolves to either a handle to an active procedure or the object-oriented ABL object's instance reference, where the event method for this asynchronous request is defined.
EVENT-PROCEDURE	A CHARACTER attribute on the asynchronous request object handle that contains the name of the internal procedure to be run as the event procedure for this asynchronous request.
EVENT-PROCEDURE-CONTEXT	A HANDLE attribute on the asynchronous request object handle that contains the procedure handle of the active procedure context where the event procedure for this asynchronous request is defined.
FIRST-ASYNC-REQUEST( )	A HANDLE method on the server object handle that returns the first entry in the list of all current asynchronous request handles for the specified Web service.

ABL attribute, method, or event	Description
FIRST-PROCEDURE	A HANDLE attribute on the server object handle that references the first procedure object associated with the Web service port type bound to this server object.
FIRST-SERVER	A HANDLE attribute on the SESSION system handle that returns the handle to the first entry in the chain of server handles for the session, including server handles for Web services.
GET-HEADER-ENTRY( )	A LOGICAL method on the SOAP header object handle that associates a specified SOAP header-entryref object handle with a specified entry in the associated SOAP header.
GET-NODE( )	A LOGICAL method that: • On the SOAP header-entryref object handle, returns a handle to an X-noderef object that is the root node of a DOM tree containing the parsed XML for the underlying SOAP header entry. • On the SOAP fault-detail object handle, returns a handle to an X-noderef object that is the root node of a DOM tree containing the parsed XML for the underlying SOAP detail information.
GET-SERIALIZED( )	A LONGCHAR method that: • On the SOAP header-entryref object handle, returns the XML for the underlying SOAP header entry in serialized form. • On the SOAP fault-detail object handle, returns the XML for the underlying SOAP fault detail information in serialized form.
LAST-ASYNC-REQUEST( )	A HANDLE method on the server object handle that returns the last entry in the list of all current asynchronous request handles for the specified Web service.
LAST-PROCEDURE	A HANDLE attribute on the server object handle that references the last procedure object associated with the Web service port type bound to this server object.
LAST-SERVER	A HANDLE attribute on the SESSION system handle that returns the handle to the last entry in the chain of server handles for the session, including server handles for Web services.
LOCAL-NAME	A CHARACTER attribute on the SOAP header-entryref object handle that returns the unqualified part of name specified for the associated SOAP header entry element.

ABL attribute, method, or event	Description
MUST-UNDERSTAND	A LOGICAL attribute on the SOAP header-entryref object handle that returns the value of the mustUnderstand attribute specified in the associated SOAP header.
NAME	A CHARACTER attribute that: • On a Web service server object handle, returns the name of the Web service for use in the OpenEdge Application Debugger. By default, this name is set to the URL of the Web service. • On a Web service procedure object handle, returns the name of the port type in the WSDL file that specifies the Web service operations encapsulated by this procedure object. This is also the value of *portTypeName* in the RUN portTypeName statement used to instantiate this procedure object. • On a SOAP header object handle, returns the qualified name of the SOAP header ("*namespacePrefix*:HEADER", where *namespacePrefix* is usually "SOAP" or "SOAP-ENV"). • On a SOAP header-entryref object handle, returns the qualified name of the SOAP header entry ("*namespacePrefix*:*localName*").
NAMESPACE-URI	A CHARACTER attribute on the SOAP header-entryref object handle that returns the namespace URI prefixed to the associated SOAP header entry element's name.
NEXT-SIBLING	A HANDLE attribute that: • On an asynchronous request object handle, returns the next entry in the list of asynchronous request handles for asynchronous operation requests submitted for the same Web service. • On a Web service procedure handle, returns the next entry in the list of all procedure objects bound to the same Web service port type. • On a server object handle, returns the next entry in the list of all server handles created for the current ABL session, regardless of subtype (see the SUBTYPE attribute).
NUM-HEADER-ENTRIES	An INTEGER attribute on the SOAP header object handle that returns the number of entries attached to the SOAP header.
PERSISTENT	A LOGICAL attribute on procedure handles that returns TRUE for a procedure object associated with a Web service.

ABL attribute, method, or event	Description
PERSISTENT-PROCEDURE	A HANDLE attribute on the asynchronous request object handle that returns the handle to the procedure object for the specified asynchronous Web service request.
PREV-SIBLING	A HANDLE attribute that: • On an asynchronous request object handle, returns the previous entry in the list of asynchronous request handles for asynchronous operation requests submitted for the same Web service. • On a Web service procedure handle, returns the previous entry in the list of all procedure objects bound to the same Web service port type. • On a server object handle, returns the previous entry in the list of all server handles created for the current ABL session, regardless of subtype (see the SUBTYPE attribute).
PROCEDURE-COMPLETE	The event returned for an asynchronous request object handle that indicates the associated Web service request has completed execution and, as a result causes execution of the: • event procedure, as specified by the EVENT-PROCEDURE and EVENT-PROCEDURE-CONTEXT attributes or • event method, as specified by the EVENT-HANDLER and EVENT-HANDLER-CONTEXT attributes.
PROCEDURE-NAME	A CHARACTER attribute on the asynchronous request object handle that provides the name of the Web service operation executed to instantiate this asynchronous request handle.
PROXY	A LOGICAL attribute on procedure object handles that is TRUE if the procedure handle references a procedure object associated with a Web service.
ROLE	(SOAP 1.2 only) A CHARACTER attribute on a SOAP header-entryref object handle that returns the value of the role attribute specified in the associated SOAP header entry. Replaces the ACTOR attribute used in SOAP 1.1.

ABL attribute, method, or event	Description
SERVER	A HANDLE attribute that: • On a procedure object handle, returns the handle to the Web service server object with which the procedure object is associated. Valid only if the PROXY and PERSISTENT attributes are both TRUE. • On an asynchronous request object handle, returns the server handle of the Web service where this asynchronous request was invoked.
SET-ACTOR( )	(SOAP 1.1 only) A LOGICAL method on the SOAP header-entryref object handle that sets the value of the actor attribute in the underlying SOAP header entry. This method completes and returns TRUE only if there is an underlying SOAP header entry (XML) associated with the object handle. Replaced by the SET-ROLE method in SOAP 1.2.
SET-CALLBACK( )	A LOGICAL method on the procedure object handle that associates a specified internal procedure or method with an ABL callback. For Web services, the two supported types of ABL callbacks, include: • **"REQUEST-HEADER"** — SOAP request header callback • **"RESPONSE-HEADER"** — SOAP Response header callback The internal procedures or methods associated with these callbacks provide access to the SOAP headers of the request and response messages sent for all the Web service operations encapsulated by the procedure object.
SET-CALLBACK-PROCEDURE( )	A LOGICAL method on the procedure object handle that associates a specified internal procedure with an ABL callback. For Web services, the two supported types of ABL callbacks, include: • **"REQUEST-HEADER"** — SOAP request header callback • **"RESPONSE-HEADER"** — SOAP Response header callback The internal procedures associated with these callbacks provide access to the SOAP headers of the request and response messages sent for all the Web service operations encapsulated by the procedure object.
SET-MUST-UNDERSTAND( )	A LOGICAL method on the SOAP header-entryref object handle that sets the value of the mustUnderstand attribute in the underlying SOAP header entry. This method completes and returns TRUE only if there is an underlying SOAP header entry (XML) associated with the object handle.

ABL attribute, method, or event	Description
SET-NODE( )	A LOGICAL method on the SOAP header-entryref object handle that replaces the header entry referenced by this SOAP header-entryref object with a specified DOM sub-tree (parsed XML) that is assumed to represent a SOAP header entry element.
SET-ROLE( )	(SOAP 1.2 only) A LOGICAL method on the SOAP header-entryref object handle that sets the value of the role attribute in the underlying SOAP header entry. This method completes and returns TRUE only if there is an underlying SOAP header entry (XML) associated with the object handle. Replaces the SET_ACTOR method used in SOAP 1.1.
SET-SERIALIZED( )	A LOGICAL method on the SOAP header-entryref object handle that replaces the header entry referenced by this SOAP header-entryref object with serialized XML that is assumed to parse into a DOM sub-tree that represents a SOAP header entry element.
SOAP-FAULT-CODE	A CHARACTER attribute on the SOAP-fault object handle that contains the value of the faultcode attribute for the SOAP fault, which identifies the fault.
SOAP-FAULT-STRING	A CHARACTER attribute on the SOAP-fault object handle that contains the value of the faultstring attribute for the SOAP fault, which provides a human-readable description of the fault.
SOAP-FAULT-ACTOR	(SOAP 1.1 only) A CHARACTER attribute on the SOAP-fault object handle that contains the value of the faultactor attribute for the SOAP fault, which is a URI that identifies the Web service returning the fault. Replaced in SOAP Version 1.2 by a combination of SOAP-FAULT-ROLE and SOAP-FAULT-NODE.
SOAP-FAULT-DETAIL	A HANDLE attribute on the SOAP-fault object handle that references the SOAP fault-detail object, which contains application-specific error information.
SOAP-FAULT-MISUNDERSTOOD-HEADER	(SOAP 1.2 only) A CHARACTER attribute on the SOAP-fault object handle that returns the list of fully qualified names of SOAP headers, if any, for which mandatory processing (as designated by the SOAP-ENV:mustUnderstand attribute) failed.
SOAP-FAULT-NODE	(SOAP 1.2 only) A CHARACTER attribute on the SOAP-fault object handle that returns the URI of the SOAP node that generated the SOAP-fault object, if available. In combination with SOAP-FAULT-ROLE, replaces the SOAP-FAULT-ACTOR attribute used in SOAP 1.1.

ABL attribute, method, or event	Description
SOAP-FAULT-ROLE	(SOAP 1.2 only) A CHARACTER attribute on the SOAP-fault object handle that contains the value of the faultrole attribute for the SOAP fault, which is a URI that identifies the Web service returning the fault. In combination with SOAP-FAULT-NODE, replaces the SOAP-FAULT-ACTOR attribute used in SOAP 1.1.
SOAP-FAULT-SUBCODE	(SOAP 1.2 only) A CHARACTER attribute on the SOAP-fault object handle that returns the list of fully qualified sub-code names for the SOAP-fault object.
SOAP-VERSION	A CHARACTER attribute on the server object handle that returns the version number of the SOAP connection current.
STOP	A LOGICAL attribute on the asynchronous request object handle that is set to TRUE, if the asynchronous request was executing when the client invoked a CANCEL-REQUESTS( ) method.
SUBTYPE	A CHARACTER attribute that returns the subtype of a handle. For a server object handle, this is: • **"WEBSERVICE"** — For a server object bound to a Web service The default value for an unbound server object handle is the Unknown value (?).
TYPE	A CHARACTER attribute that returns the handle type, which: • On a server object handle is "SERVER" • On a procedure object handle is "PROCEDURE" • On a SOAP header object handle is "SOAP-HEADER" • On a SOAP header-entryref object handle is "SOAP-HEADER-ENTRYREF" • On a SOAP-fault object handle is "SOAP-FAULT" • On a SOAP fault-detail object handle is "SOAP-FAULT-DETAIL" • On an X-document object handle is "X-DOCUMENT" • On an X-noderef object handle is "X-NODEREF" • On an asynchronous request object handle is "ASYNC-REQUEST"

D

Data Type Conversion Rules for ABL Calls to SOAP Web Services

This appendix describes how OpenEdge converts between the following ABL data types and XML Schema data types in parameters passed to SOAP Web services called from ABL. Any casting between an ABL type and an unsupported XML Schema type or an invalid match between an ABL type and a supported XML Schema type raises an ABL run-time error, as detailed in the following sections.

Note: The tables in this chapter describe data transformations for the ABL `INPUT` and `OUTPUT` parameter modes. The `INPUT-OUTPUT` parameter mode behaves in the same manner.

For details, see the following topics:

- Data type casting
- CHARACTER or LONGCHAR
- DATE
- DATETIME
- DATETIME-TZ
- DECIMAL
- INT64
- INTEGER
- LOGICAL

- MEMPTR or RAW

Data type casting

OpenEdge supports a set of alternative ABL data types (in addition to a suggested data type) to represent the value for an XML Schema data type in ABL. These alternative data types essentially force the Web service invocation to cast the value between the specified native ABL representation and the corresponding XML Schema data type. The result of this casting might not preserve as much accuracy as the suggested mapping.

The following table shows all the supported castings (alternative mappings) between the XML Schema and ABL data types. The suggested ABL data type mapping for each XML Schema type appears in bold font.

Note: OpenEdge supports no castings for the `RECID`, `ROWID`, or `HANDLE` ABL data types.

Table 57: Supported casts between data types

XML Schema data type	ABL data type
anyURI	**CHARACTER** LONGCHAR
base64Binary	CHARACTER LONGCHAR MEMPTR**RAW**
boolean	CHARACTER DECIMAL INT64 INTEGER **LOGICAL** LONGCHAR
byte	CHARACTER DECIMAL INT64 **INTEGER** LOGICAL LONGCHAR
date	CHARACTER **DATE** DATETIME DATETIME-TZ
dateTime	CHARACTER DATE DATETIME **DATETIME-TZ**
decimal	CHARACTER **DECIMAL** INT64 INTEGER LOGICAL LONGCHAR
double	**CHARACTER** DECIMAL INT64 INTEGER LOGICAL LONGCHAR
duration	

XML Schema data type	ABL data type
	CHARACTER LONGCHAR
ENTITIES	**CHARACTER** LONGCHAR
ENTITY	**CHARACTER** LONGCHAR
float	**CHARACTER** DECIMAL INT64 INTEGER LOGICAL LONGCHAR
gDay	**CHARACTER** LONGCHAR
gMonth	**CHARACTER** LONGCHAR
gMonthDay	**CHARACTER** LONGCHAR
gYear	**CHARACTER** LONGCHAR
gYearMonth	**CHARACTER** LONGCHAR
hexBinary	CHARACTER LONGCHAR MEMPTR**RAW**
ID	**CHARACTER** LONGCHAR
IDREF	

XML Schema data type	ABL data type
	CHARACTER LONGCHAR
IDREFS	**CHARACTER** LONGCHAR
int	CHARACTER DECIMAL INT64 **INTEGER** LOGICAL LONGCHAR
integer	CHARACTER **DECIMAL** INT64 INTEGER LOGICAL LONGCHAR
Language	**CHARACTER** LONGCHAR
long	CHARACTER DECIMAL **INT64** INTEGER LOGICAL LONGCHAR
Name	**CHARACTER** LONGCHAR
NCName	**CHARACTER** LONGCHAR
negativeInteger	CHARACTER **DECIMAL** INT64 INTEGER LONGCHAR
NMTOKEN	**CHARACTER** LONGCHAR

XML Schema data type	ABL data type
NMTOKENS	**CHARACTER** LONGCHAR
nonNegativeInteger	CHARACTER **DECIMAL** INT64 INTEGER LOGICAL LONGCHAR
nonPositiveInteger	CHARACTER **DECIMAL** INT64 INTEGER LOGICAL LONGCHAR
normalizedString	**CHARACTER** DATE DATETIME DATETIME-TZ DECIMAL INT64 INTEGER LOGICAL LONGCHAR
NOTATION	**CHARACTER** LONGCHAR
positiveInteger	CHARACTER **DECIMAL** INT64 INTEGER LONGCHAR
qName	**CHARACTER** LONGCHAR
short	CHARACTER DECIMAL INT64 **INTEGER** LOGICAL LONGCHAR
string	

XML Schema data type	ABL data type
	CHARACTER DATE DATETIME DATETIME-TZ DECIMAL INT64 INTEGER LOGICAL LONGCHAR
time	CHARACTER INT64 **INTEGER** LONGCHAR
token	**CHARACTER** LONGCHAR
unsignedByte	CHARACTER DECIMAL INT64 **INTEGER** LOGICAL LONGCHAR
unsignedInt	CHARACTER **DECIMAL** INT64 INTEGER LOGICAL LONGCHAR
unsignedLong	CHARACTER **DECIMAL** INT64 INTEGER LOGICAL LONGCHAR
unsignedShort	CHARACTER DECIMAL INT64 **INTEGER** LOGICAL LONGCHAR

CHARACTER or LONGCHAR

The following table describes the supported castings in each ABL parameter mode (INPUT and OUTPUT) between the ABL CHARACTER or LONGCHAR type and XML Schema.

Table 58: ABL data type conversion—CHARACTER or LONGCHAR

For this XML Schema type . . .	In this ABL parameter mode . . .	OpenEdge . . .
All XML Schema types where CHARACTER is the suggested ABL mapping (seeMapping XML Schema data types to ABL data types).	INPUT[16]	Attempts to format the ABL string value to match the specified XML Schema type for inclusion in the SOAP request message.[17]
	OUTPUT[16]	Converts the value from the formatting of the specified XML Schema type before copying it into the ABL parameter as a string value.[17]
All XML Schema types where CHARACTER or LONGCHAR is **not** the suggested ABL mapping (see Mapping XML Schema data types to ABL data types).	INPUT[16]	Copies the string value directly, with no attempt to format it, for inclusion in the SOAP request message. OpenEdge performs minimal validation to ensure that the string contains data formatted according to the rules of the XML Schema type.
	OUTPUT[16]	Copies the XML Schema value directly from the SOAP response message to the ABL parameter unchanged from its XML Schema format.

DATE

The following table describes the supported castings in each ABL parameter mode (INPUT and OUTPUT) between the ABL DATE type and XML Schema.

[17] The process of serializing and de-serializing CHARACTER data inserts and removes XML character references, for example, replacing "<" with "<".

[16] On both INPUT and OUTPUT parameters, OpenEdge translates the value between the cpinternal code page and Unicode.

Table 59: ABL data type cast—DATE

For this XML Schema type . . .	In this ABL parameter mode . . .	OpenEdge . . .
`string` `normalizedString`	`INPUT`	Serializes the ABL parameter into the SOAP request message according to the XML Schema serialization rules.
	`OUTPUT`	De-serializes the string value from the SOAP response message into the ABL parameter as if the ABL `DATE( )` function was called on the string in an OpenEdge session started with the `–d ymd` startup parameter.
`dateTime`	`INPUT`	Serializes the ABL parameter according to the XML Schema serialization rules, with the time assumed to be 12:00 midnight local time.
	`OUTPUT`	De-serializes the XML Schema value into the ABL parameter according to the XML Schema serialization rules with the value set to the local time adjusted from any time and time zone information (which is stripped away). If there is no time and time zone information the value is stored as is. If you need to maintain the time information, use the ABL `DATETIME` data type. If you need to maintain the time zone information, use the ABL `DATETIME-TZ` data type.
`date`	`INPUT`	Serializes the ABL parameter into the SOAP request message according to the XML Schema serialization rules with no time zone.
	`OUTPUT`	De-serializes the XML Schema value into the ABL parameter with the date adjusted for any time zone information and the time zone information stripped away. If you need to maintain the time zone information, use the ABL `DATETIME-TZ` data type.

DATETIME

The following table describes the supported castings in each ABL parameter mode (`INPUT` and `OUTPUT`) between the ABL `DATETIME` type and XML Schema.

Table 60: ABL data type cast—DATETIME

For this XML Schema type . . .	In this ABL parameter mode . . .	OpenEdge . . .
`string` `normalizedString`	`INPUT`	Serializes the ABL parameter into the SOAP request message according to the XML Schema serialization rules.
	`OUTPUT`	De-serializes the string value from the SOAP response message into the ABL parameter as if the ABL `DATETIME( )` function was called on the string.
`dateTime`	`INPUT`	Serializes the ABL parameter into the SOAP request message according to the XML Schema serialization rules without a time zone.
	`OUTPUT`	De-serializes the XML Schema value from the SOAP response message into the ABL parameter according to the XML Schema serialization rules with the value set to the local time adjusted from any time zone information (which is stripped away). If there is no time zone information the value is stored as is.
`date`	`INPUT`	Serializes the ABL parameter into the SOAP request message according to the XML Schema serialization rules. The time part of the `DATETIME` value is lost.
	`OUTPUT`	De-serializes the XML Schema value from the SOAP response message into the ABL parameter according to the XML Schema serialization rules with the date adjusted for any time zone information (which is stripped away). The ABL `DATETIME` value has the time set to 12:00 midnight.

DATETIME-TZ

The following table describes the supported castings in each ABL parameter mode (`INPUT` and `OUTPUT`) between the ABL `DATETIME-TZ` type and XML Schema.

Table 61: ABL data type cast—DATETIME-TZ

For this XML Schema type . . .	In this ABL parameter mode . . .	OpenEdge . . .
`string` `normalizedString`	`INPUT`	Serializes the ABL parameter into the SOAP request message according to the XML Schema serialization rules.
	`OUTPUT`	De-serializes the string value from the SOAP response message into the ABL parameter according to the XML Schema serialization rules as if the ABL `DATETIME-TZ( )` function was called on the string.

For this XML Schema type . . .	In this ABL parameter mode . . .	OpenEdge . . .
dateTime	INPUT	Serializes the ABL parameter into the SOAP request message according to the XML Schema serialization rules including the time zone.
	OUTPUT	De-serializes the XML Schema value from the SOAP response message into the ABL parameter according to the XML Schema serialization rules.
date	INPUT	Serializes the ABL parameter into the SOAP request message according to the XML Schema serialization rules. The time part of the DATETIME-TZ value is lost, but the time zone part of the DATETIME-TZ value is retained.
	OUTPUT	De-serializes the XML Schema value from the SOAP response message into the ABL parameter according to the XML Schema serialization rules. The ABL DATETIME-TZ value has the time set to 12:00 midnight.

DECIMAL

The following table describes the supported castings in each ABL parameter mode (INPUT and OUTPUT) between the ABL DECIMAL type and XML Schema.

Table 62: ABL data type cast—DECIMAL

For this XML Schema type . . .	In this ABL parameter mode . . .	OpenEdge . . .
string normalizedString	INPUT	Serializes the ABL parameter into the SOAP request message according to the XML Schema serialization rules.
	OUTPUT	De-serializes the string value from the SOAP response message into the ABL parameter as if the ABL DECIMAL( ) function was called on the string.
boolean	INPUT	Serializes an ABL DECIMAL value of 0 to false and all other values for the ABL parameter to true.
	OUTPUT	De-serializes a value of false to an ABL DECIMAL value of 0, and de-serializes a value of true to a DECIMAL value of 1.

For this XML Schema type . . .	In this ABL parameter mode . . .	OpenEdge . . .
decimal	INPUT	Serializes the ABL parameter into the SOAP request message according to the XML Schema serialization rules.
	OUTPUT	De-serializes the XML Schema value into the ABL parameter according to the XML Schema serialization rules. If the XML Schema decimal value overflows the ABL DECIMAL, the AVM raises a run-time error.
float double	INPUT	Serializes the ABL DECIMAL value according to XML Schema serialization rules. Some of the least significant digits might be lost.
	OUTPUT	De-serializes the XML Schema value to the equivalent ABL DECIMAL value. If the value is outside the range of the ABL DECIMAL, the AVM raises a run-time error.
integer nonPositiveInteger negativeInteger long int short byte nonNegativeInteger unsignedLong unsignedInt unsignedShort unsignedByte positiveInteger	INPUT	Rounds the ABL DECIMAL value to an integer and serializes the result based on the serialization rules for the XML Schema type. Data might be lost. If the DECIMAL value is outside the valid range of the XML Schema type, the AVM raises a run-time error.
	OUTPUT	De-serializes the XML Schema value into the ABL parameter as if the ABL DECIMAL( ) function was called on the value. If the value in the SOAP response message is outside the range of the DECIMAL type, the AVM raises a run-time error.

INT64

The following table describes the supported castings in each ABL parameter mode (INPUT and OUTPUT) between the ABL INT64 type and XML Schema.

Table 63: ABL data type cast—INT64

For this XML Schema type . . .	In this ABL parameter mode . . .	OpenEdge . . .
string normalizedString	INPUT	Serializes the ABL parameter into the XML Schema value as if the ABL STRING( ) function was called on the INT64 value.
	OUTPUT	De-serializes the XML Schema value as if the INT64( ) function was called on string value.

For this XML Schema type . . .	In this ABL parameter mode . . .	OpenEdge . . .
boolean	INPUT	Serializes an INT64 value of 0 to false and all other values to true.
	OUTPUT	De-serializes a value of false to an ABL INT64 value of 0, and de-serializes a value of true to an INT64 value of 1.
decimal	INPUT	Serializes the ABL parameter into the SOAP request message according to the XML Schema serialization rules.
	OUTPUT	De-serializes the XML Schema value as if the INT64( ) function was called on the serialized ABL DECIMAL value. This rounds any positions after the decimal point. If the XML Schema decimal value is outside the range of an ABL INT64, the AVM raises a run-time error.
float	INPUT	Translate the INT64 to a C value, cast to a C float value, and then serialize the ABL INT64 value to a float according to the XML Schema rules. Some of the least significant digits of the INT64 value are lost if the number of digits in the value is large.
	OUTPUT	De-serializes the XML Schema value into a C float value and then cast the C value to ABL INT64. If the XML Schema value overflows or underflows an ABL INT64, the AVM raises a run-time error.
double	INPUT	Translate the INT64 to a C value, cast to a C double value, and then serialize the value to a double according to the XML Schema rules.
	OUTPUT	De-serializes the XML Schema value into a C double value and cast it to an ABL INT64. If the XML Schema value overflows or underflows an ABL INT64, the AVM raises a run-time error.
integer nonPositiveInteger negativeInteger long nonNegativeInteger unsignedLong unsignedInt positiveInteger	INPUT	Serializes the ABL parameter into the SOAP request message according to the serialization rules for the XML Schema data type.
	OUTPUT	De-serializes the XML Schema value as if the ABL INT64( ) function was called on the value. If the XML Schema value is outside the valid range of an ABL INT64, the AVM raises a run-time error.

For this XML Schema type ...	In this ABL parameter mode ...	OpenEdge ...
long	INPUT	Serializes the ABL parameter into the SOAP request message according to the XML Schema serialization rules.
	OUTPUT	De-serializes the XML Schema value as if the ABL INT64( ) function was called on the value.
int short byte unsignedShort unsignedByte	INPUT	Serializes the ABL parameter into the SOAP request message according to the serialization rules for the XML Schema data type. If the ABL INT64 value is outside the valid range of the XML Schema type, the AVM raises a run-time error.
	OUTPUT	De-serializes the XML Schema value as if the ABL INT64( ) function was called on the value.

INTEGER

The following table describes the supported castings in each ABL parameter mode (INPUT and OUTPUT) between the ABL INTEGER type and XML Schema.

Table 64: ABL data type cast—INTEGER

For this XML Schema type ...	In this ABL parameter mode ...	OpenEdge ...
string normalizedString	INPUT	Serializes the ABL parameter into the XML Schema value as if the ABL STRING( ) function was called on the INTEGER value.
	OUTPUT	De-serializes the XML Schema value as if the INTEGER( ) function was called on string value.
boolean	INPUT	Serializes an INTEGER value of 0 to false and all other values to true.
	OUTPUT	De-serializes a value of false to an ABL INTEGER value of 0, and de-serializes a value of true to an INTEGER value of 1.
decimal	INPUT	Serializes the ABL parameter into the SOAP request message according to the XML Schema serialization rules.
	OUTPUT	De-serializes the XML Schema value as if the INTEGER( ) function was called on the serialized ABL DECIMAL value. This rounds any positions after the decimal point. If the XML Schema decimal value is outside the range of an ABL INTEGER, the AVM raises a run-time error.

For this XML Schema type . . .	In this ABL parameter mode . . .	OpenEdge . . .
float	INPUT	Serializes the ABL INTEGER value to a float according to the XML Schema rules. Some of the least significant digits of the INTEGER value are lost if the number of digits in the value is large.
	OUTPUT	De-serializes the XML Schema value into an ABL INTEGER. If the XML Schema value overflows or underflows an ABL INTEGER, the AVM raises a run-time error.
double	INPUT	Serializes the ABL INTEGER value to a double according to the XML Schema rules.
	OUTPUT	De-serializes the XML Schema value into an ABL INTEGER. If the XML Schema value overflows or underflows an ABL INTEGER, the AVM raises a run-time error.
integer nonPositiveInteger negativeInteger long nonNegativeInteger unsignedLong unsignedInt positiveInteger	INPUT	Serializes the ABL parameter into the SOAP request message according to the serialization rules for the XML Schema data type.
	OUTPUT	De-serializes the XML Schema value as if the ABL INTEGER( ) function was called on the value. If the XML Schema value is outside the valid range of an ABL INTEGER, the AVM raises a run-time error.
int	INPUT	Serializes the ABL parameter into the SOAP request message according to the XML Schema serialization rules.
	OUTPUT	De-serializes the XML Schema value as if the ABL INTEGER( ) function was called on the value.
short byte unsignedShort unsignedByte	INPUT	Serializes the ABL parameter into the SOAP request message according to the serialization rules for the XML Schema data type. If the ABL INTEGER value is outside the valid range of the XML Schema type, the AVM raises a run-time error.
	OUTPUT	De-serializes the XML Schema value as if the ABL INTEGER( ) function was called on the value.
time	INPUT	Serializes the ABL parameter into the SOAP request message according to the XML Schema serialization rules without a time zone. The ABL INTEGER value is treated as the number of seconds since midnight.
	OUTPUT	De-serializes the XML Schema value to the number of seconds since midnight. The conversion loses fractions of seconds. If a time zone is specified in the value, the time is adjusted to the same instant in the local time zone.

LOGICAL

The following table describes the supported castings in each ABL parameter mode (INPUT and OUTPUT) between the ABL LOGICAL type and XML Schema.

Table 65: ABL data type cast—LOGICAL

For this XML Schema type . . .	In this ABL parameter mode . . .	OpenEdge . . .
string normalizedString	INPUT	Serializes the ABL parameter into the SOAP request message according to the XML Schema serialization rules.
	OUTPUT	De-serializes the XML Schema string type as if it was a serialized boolean value.
boolean	INPUT	Serializes the ABL parameter into the SOAP request message according to the XML Schema serialization rules.
	OUTPUT	De-serializes the XML Schema value into the ABL parameter according to the XML Schema serialization rules.
decimal float double	INPUT	Serializes an ABL LOGICAL value of true to an XML Schema type value of 1, and serializes a LOGICAL value of false to an XML Schema type value of 0.
	OUTPUT	De-serializes an XML Schema value of 0 to an ABL LOGICAL value of false, and all other XML Schema values to a LOGICAL value of true.
integer nonPositiveInteger long int short byte nonNegativeInteger unsignedLong unsignedIn unsignedShort unsignedByte	INPUT	Serializes an ABL LOGICAL value of true to an XML Schema type value of 1 (or -1 for a nonPositiveInteger), and serializes a LOGICAL value of false to an XML Schema type value of 0.
	OUTPUT	De-serializes an XML Schema value of 0 to an ABL LOGICAL value of false, and all other XML Schema values to a LOGICAL value of true.

MEMPTR or RAW

The following table describes the supported castings in each ABL parameter mode (INPUT and OUTPUT) between the ABL MEMPTR or RAW type and XML Schema.

Table 66: ABL data type cast—RAW or MEMPTR

For this XML Schema type . . .	In this ABL parameter mode . . .	OpenEdge . . .
`base64Binary` `hexBinary`	`INPUT`	Serializes the value of each byte in the ABL value according to the XML Schema serialization rules for the data type. If the mapping is to a base64Binary value with the encoding attribute set, the value is base-64 encoded and copied directly from the ABL parameter without serialization.
	`OUTPUT`	De-serializes the value of each byte in the ABL value according to the XML Schema serialization rules for the data type. If the mapping is from a base64Binary value, it is always de-serialized into the ABL parameter.

E

WSDL Details

This appendix includes expanded information on WSDL files. Only certain users need this level of detail. The topics include:

- ABL procedure prototype to WSDL operation on page 356
- Array mapping in WSDL documents on page 358
- Define TABLE (static temp-table) parameters on page 361
- Define TABLE-HANDLE (dynamic temp-table) parameters on page 363
- Define DATASET (static ProDataSet) parameters on page 364
- Define DATASET-HANDLE (dynamic ProDataSet) parameters on page 371

For details, see the following topics:

- ABL procedure prototype to WSDL operation
- Array mapping in WSDL documents
- Define TABLE (static temp-table) parameters
- Define TABLE-HANDLE (dynamic temp-table) parameters
- Define DATASET (static ProDataSet) parameters
- Define DATASET-HANDLE (dynamic ProDataSet) parameters

ABL procedure prototype to WSDL operation

This is the ABL procedure prototype for the `FindCustomerByNum.p` external procedure:

ABL procedure prototype

```
/* FindCustomerByNum.p */

DEFINE INPUT PARAMETER CustomerNumber AS INTEGER.
DEFINE OUTPUT PARAMETER CustomerName AS CHARACTER.
```

The boldface elements in this prototype are the main information that ProxyGen maps into the corresponding Web service operation definition. These include the procedure name (filename for an external procedure) and for any parameters, the parameter mode (input or output), names, and data types.

Note: Some information can only be specified in ProxyGen, such as whether the ABL `RETURN-VALUE` is used and (for external procedures) what Open Client object this operation belongs to.

These are the `message` section definitions in the RPC/Encoded and RPC/Literal WSDL file for the `FindCustomerByNum` operation request and response messages:

WSDL message section defining request and response messages

```
<message name="OrderInfo_FindCustomerByNum">
  <part name="CustomerNumber" type="xsd:int"/>
</message>
<message name="OrderInfo_FindCustomerByNumResponse">
  <part name="CustomerName" type="xsd:string"/>
</message>
```

Note that the request message contains the input parameter, `CustomerNumber`, and the response message contains the output parameter, `CustomerName`, both defined by appropriate XML data types.

This is the definition for the `FindCustomerByNum` operation in the `portType` section of the WSDL:

WSDL portType section defining an operation signature on an object

```
<portType name="OrderInfoObj">
  <operation name="FindCustomerByNum"
             parameterOrder="CustomerNumber CustomerName">
    <input message="tns:OrderInfo_FindCustomerByNum"/>
    <output message="tns:OrderInfo_FindCustomerByNumResponse"/>
    <fault name="OrderInfoFault" message="tns:FaultDetailMessage"/>
  </operation>
  ...
</portType>
```

The `portType` section defines the object in which the operation is defined, in this case, the AppObject, `OrderInfo` (as specified in ProxyGen). Note that this definition groups together the request (input) and response (output) messages, along with a generic fault message as part of the operation definition.

This is the definition for the `FindCustomerByNum` operation in the Bindings section for the `OrderInfo` AppObject:

WSDL Bindings section defining an operation and object binding

```
<binding name="OrderInfoObj" type="tns:OrderInfoObj">
  <soap:binding style="rpc"
      transport="http://schemas.xmlsoap.org/soap/http"/>

  <operation name="FindCustomerByNum">
    <soap:operation soapAction="" style="rpc"/>
    <input>
      <soap:header message="tns:OrderInfoID" part="OrderInfoID"
                use="encoded"
                encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
                namespace="urn:OrderSvc:OrderInfo" wsdl:required="true">
      </soap:header>
      <soap:body use="encoded"
                encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
                namespace="urn:OrderSvc:OrderInfo"/>
    </input>
    <output>
      <soap:body use="encoded"
                encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
                namespace="urn:OrderSvc:OrderInfo"/>
    </output>
    <fault name="OrderInfoFault">
      <soap:fault name="OrderInfoFault" use="encoded"
                encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
                namespace="http://servicehost:80/wsa/wsa1"/>
    </fault>
  </operation>
  ...
</binding>
```

Note that this definition specifies that the transport protocol as SOAP over HTTP, and goes on to define the content for SOAP messages request (input) and response (output) messages for the operation. This is where the object ID definitions are referenced for operations that require them.

This is the port definition in the `service` section for the object (`OrderInfo` AppObject) containing the `FindCustomerByNum` operation:

WSDL service section defining the Web service location

```
<service name="OrderInfoService">
  <port name="OrderInfoObj" binding="tns:OrderInfoObj">
    <documentation/>
    <soap:address location="http://servicehost:80/wsa/wsa1"/>
  </port>
  ...
</service>
```

Note that the URL for the web service is specified in `soap:address`.

Array mapping in WSDL documents

This section provides detailed information about how array parameters are represented in each of the WSDL formats. The description of each format includes an example based on an ABL procedure contained in the `CustomerA0` AppObject with the following signature:

arraySample procedure signature

```
/* arraySample*/

DEFINE INPUT  PARAMETER names     AS CHARACTER EXTENT.
DEFINE INPUT  PARAMETER hireDates AS DATETIME  EXTENT.
DEFINE OUTPUT PARAMETER quotas    AS INTEGER   EXTENT 12.
```

Doc/Lit

For the Doc/Lit format, an array parameter is represented as a sequence of its data type in an XML Schema type definition:

Array parameter definition for Doc/Lit WSDL

```
<complexType
  <sequence>
    <element name="paramName" type="XMLType"
             minOccurs="zero_or_extentval"
             maxOccurs="extentval_or_unbounded"/>
  </sequence>
</complexType>
```

The bolded elements refer to:

- ***paramName*** — The name of the parameter
- ***XMLType*** — The XML Schema type of the parameter
- ***zero_or_extentval*** — `0` or an integer for the minimum array size
- ***extentval_or_unbounded*** — An integer for the maximum array size or `unbounded`

The Doc/Lit WSDL for `arraySample` has the following `types` and `message` sections:

Doc/Lit WSDL schema example

```
<wsdl:types>
  <schema targetNamespace="urn:tempuri-org:CustomerAO"
          xmlns="http://www.w3.org/2001/XMLSchema"
          elementFormDefault="qualified">
    <element name="arraySample">
      <complexType>
        <sequence>
          <element name="names" type="xsd:string" minOccurs="0"
                   maxOccurs="unbounded" nillable="true">
          <element name="hireDates" type="xsd:dateTime" minOccurs="0"
                   maxOccurs="unbounded" nillable="true">
        </sequence>
      </complexType>
    </element>
    <element name="arraySampleResponse">
      <complexType>
        <sequence>
          <element name="quotas" type="xsd:int" minOccurs="12"
                   maxOccurs="12" nillable="true">
        </sequence>
      </complexType>
    </element>
  </schema>
</wsdl:types>
<wsdl:message name="CustomerAO_procName">
  <part name="parameters" element="S1:procName"/>
</wsdl:message>
<wsdl:message name="CustomerAO_procNameResponse">
  <part name="parameters" element="S1:procNameResponse"/>
</wsdl:message>
```

RPC/Literal

For the RPC/Literal format, an array parameter is represented as an unbounded sequence of its data type in an XML Schema type definition, where ***XMLType*** is the XML Schema type:

Array parameter definition for RPC/Literal WSDL

```
<complexType name="ArrayOf***XMLType***">
  <sequence>
    <element name="item" type="XMLType" minOccurs="0"
             maxOccurs="unbounded"/>
  </sequence>
</complexType>
```

The WSDL file contains a separate schema for each object defined in ProxyGen. Each such schema includes one `complexType` definition for each data type used as an array parameter for any procedure or function in that object. For example, if the ABL defines one or more parameters in the object with the data type `CHARACTER EXTENT`, the schema includes a `complexType` named "`ArrayOfString`".

The RPC/Literal WSDL document for the `arraySample` procedure shown at the beginning of this section includes the following `types` and `message` sections:

RPC/Literal WSDL schema example

```
<wsdl:types>
  <schema targetNamespace="urn:tempuri-org:CustomerAO"
          xmlns="http://www.w3.org/2001/XMLSchema"
          elementFormDefault="unqualified"
    <complexType name="ArrayOfInt">
      <sequence>
        <element name="item" type="xsd:int" minOccurs="0"
                 maxOccurs="unbounded"/>
      </sequence>
    </complexType>
    <complexType name="ArrayOfDateTime">
      <sequence>
        <element name="item" type="xsd:dateTime" minOccurs="0"
                 maxOccurs="unbounded"/>
      </sequence>
    </complexType>
    <complexType name="ArrayOfString">
      <sequence>
        <element name="item" type="xsd:string" minOccurs="0"
                 maxOccurs="unbounded"/>
      </sequence>
    </complexType>
  </schema>
</wsdl:types>

<wsdl:message name="CustomerAO_arraySample">
  <part name="names"     type="S1:ArrayOfString"/>
  <part name="hireDates" type="S1:ArrayOfDateTime"/>
</wsdl:message>
<wsdl:message name="CustomerAO_arraySampleResponse">
  <part name="quotas"    type="S1:ArrayOfInt"/>
</wsdl:message>
```

RPC/Encoded

For the RPC/Encoded format, an array parameter is represented as a SOAP array `complexType` in an XML Schema type definition, as shown:

Array parameter definition for RPC/Encoded WSDL

```
<complexType name="ArrayOfXMLType">
  <complexContent>
    <restriction base="soapenc:Array">
      <attribute ref=soapenc:arrayType" wsdl:arrayType="XMLType[]"/>
    </restriction>
  <complexContent>
</complexType>
```

The WSDL file contains a separate schema for each object defined in ProxyGen. Each such schema includes one SOAP array `complexType` definition for each data type used as an array parameter for any procedure or function in that object. For example, if the ABL defines one or more parameters in the object with the data type `CHARACTER EXTENT`, the schema includes a `complexType` named "`ArrayOfString`".

The RPC/Encoded WSDL document for the `arraySample` procedure shown at the beginning of this section includes the following `types` and `message` sections:

RPC/Encoded WSDL schema example

```
<wsdl:types>
  <schema targetNamespace="urn:tempuri-org:CustomerAO"
          xmlns="http://www.w3.org/2001/XMLSchema"
          elementFormDefault="unqualified">
    <import namespace="http://schemas.xmlsoap.org/soap/encoding/"/>
    <complexType name="ArrayOfInt">
      <complexContent>
        <restriction base="soapenc:Array">
          <attribute ref="soapenc:arrayType" wsdl:arrayType="xsd:int[]"/>
        </restriction>
      </complexContent>
    </complexType>
    <complexType name="ArrayOfDateTime">
      <complexContent>
        <restriction base="soapenc:Array">
          <attribute ref="soapenc:arrayType"
                     wsdl:arrayType="xsd:dateTime[]"/>
        </restriction>
      </complexContent>
    </complexType>
    <complexType name="ArrayOfString">
      <complexContent>
        <restriction base="soapenc:Array">
          <attribute ref="soapenc:arrayType" wsdl:arrayType="xsd:string[]"/>
        </restriction>
      </complexContent>
    </complexType>
  </schema>
</wsdl:types>

. . .

<wsdl:message name="CustomerAO_arraySample">
  <part name="names"     type="S1:ArrayOfString"/>
  <part name="hireDates" type="S1:ArrayOfDateTime"/>
</wsdl:message>
<wsdl:message name="CustomerAO_arraySampleResponse">
  <part name="quotas"    type="S1:ArrayOfInt"/>
</wsdl:message>
```

Define TABLE (static temp-table) parameters

TABLE parameters pass data only, because the static temp-table's schema is known at WSDL generation. OpenEdge Web services map a TABLE definition to a <complexType> consisting of a <sequence> of elements that represent a row (temp-table record). Each <element> in this sequence represents a column (temp-table field) of the row. For all SOAP formats, a TABLE parameter is defined as a <complexType> that references the corresponding row element <complexType>.

The following WSDL sample defines a TABLE row named, staticTT_ttEmpRow, with two columns, Name and Number:

TABLE parameter row schema for all SOAP formats

```
<complexType name="staticTT_ttEmpRow">
  <sequence>
    <element name="Name" nillable="true" type="xsd:string"/>
    <element name="Number" nillable="true" type="xsd:int"/>
  </sequence>
</complexType>
```

The following WSDL sample defines a temp-table parameter for the `ttEmp` row using the RPC/Encoded SOAP format. Note that the parameter is a SOAP array of rows:

TABLE parameter for RPC/Encoded

```
<complexType name="ArrayOfstaticTT_ttEmpRow">
   <complexContent>
      <restriction base="soapenc:Array">
         <attribute ref="soapenc:arrayType"
            wsdl:arrayType="S2:staticTT_ttEmpRow[]"/>
      </restriction>
   </complexContent>
</complexType>
```

The following WSDL sample defines a TABLE parameter using the Doc/Lit or RPC/Literal SOAP formats. Note that the parameter is a sequence of multiple rows:

TABLE parameter for RPC/Literal and Doc/Lit

```
<complexType name="staticTT_ttEmpParam">
  <sequence>
    <element maxOccurs="unbounded" minOccurs="0" name="ttEmpRow"
             type="S2:staticTT_ttEmpRow" />
  </sequence>
</complexType>
```

For these SOAP formats, the row element name (`ttEmpRow`) is used to identify each element that holds a data row sent in SOAP messages that pass a TABLE parameter.

Each column of a TABLE row can hold any data type shown in the following table.

Table 67: XML data types for TABLE parameter columns

ABL data type	XML Schema data type
BLOB[18]	xsd:base64Binary
CHARACTER	xsd:string
CLOB[18]	xsd:string
COM-HANDLE	xsd:long

[18] BLOB and CLOB data types are designed to support very large objects. Use of these data types for table fields in Web services can result in a serious performance impact.

ABL data type	XML Schema data type
DATE	xsd:date
DATETIME	xsd:dateTime
DATETIME-TZ	xsd:dateTime
DECIMAL	xsd:decimal
INT64	xsd:long
INTEGER (32 bit)	xsd:int
LOGICAL	xsd:boolean
RAW	xsd:base64Binary
RECID (32 or 64 bit)	xsd:long
ROWID	xsd:base64Binary
WIDGET-HANDLE	xsd:long

Define TABLE-HANDLE (dynamic temp-table) parameters

TABLE-HANDLE parameters pass both the schema and data, because the dynamic temp-table schema is not known at compile time. Thus, for TABLE-HANDLE parameters, OpenEdge Web services map an ABL TABLE-HANDLE to a <complexType> containing a sequence of xsd:any. There is a single definition used for all TABLE-HANDLE parameters in all supported SOAP formats. The following WSDL sample shows this common TABLE-HANDLE parameter definition:

TABLE-HANDLE definition for all dynamic temp-table parameters

```
<complexType name="TableHandleParam">
  <sequence>
    <any namespace="##local"/>
  </sequence>
</complexType>
```

The client application must create (for input) and parse (for output) the XML Schema along with the data for the parameter. How the client inserts the input schema and data in request messages and how it parses the output schema and data from response messages is entirely dependent on the client toolkit.

Each column of a TABLE-HANDLE row can hold any data type shown in the following table.

XML data types for TABLE-HANDLE parameter columns

ABL data type	XML Schema data type
CHARACTER	xsd:string
DATE	xsd:date
DATETIME-TZ	xsd:dateTime
DECIMAL	xsd:decimal
INT64	xsd:long
INTEGER (32 bit)	xsd:int
LOGICAL	xsd:boolean
RAW	xsd:base64Binary

Define DATASET (static ProDataSet) parameters

DATASET parameters pass data only because the static ProDataSet's schema is known at WSDL generation. OpenEdge Web services map a DATASET definition to a <complexType> consisting of a <sequence> of elements that represent the ProDataSet's temp-tables. Each temp-table element includes a <complexType> describing the temp-table's fields. The definition also includes elements describing the data relations and indexes.

By default, a ProDataSet parameter includes only the current data. You must specify in ProxyGen the ProDataSet parameters for which you want to include before-image data. A ProDataSet parameter with before-image data is serialized as a proprietary OpenEdge datasetChanges document.

Nested and non-nested data relations produce different WSDL structures. For non-nested data relations, each temp-table description is separate. For nested data relations, the description of the child temp-table is embedded in the description of the parent temp-table.

Client-development toolkits typically define an object for every <complexType> in the WSDL. For an ABL client, the WSDL Analyzer produces definitions for a corresponding ProDataSet, its temp-tables, indexes, and data relations. A non-ABL client toolkit produces object definitions for the ProDataSet and for each of its temp-tables. Non-ABL clients toolkits do not produce code from the indexes and data relations.

The following code snippet defines a ProDataSet with nested and non-nested data relations:

```
/* getCustOrders.p */
DEFINE TEMP-TABLE ttCust     NO-UNDO
       FIELD      CustNum    AS INTEGER
       FIELD      Name       AS CHARACTER
       INDEX      CustNumIdx IS UNIQUE PRIMARY CustNum.

DEFINE TEMP-TABLE ttOrder     NO-UNDO
       FIELD      OrderNum    AS INTEGER
       FIELD      CustNum     AS INTEGER
       INDEX      OrderNumIdx IS UNIQUE PRIMARY OrderNum
       INDEX      CustOrdIdx  IS UNIQUE CustNum OrderNum.

DEFINE TEMP-TABLE ttOrderLine  NO-UNDO
       FIELD      OrderNum     AS INTEGER
       FIELD      LineNum      AS INTEGER
       INDEX      OrderLineIdx IS UNIQUE PRIMARY OrderNum LineNum.

DEFINE DATASET dsCustOrd FOR ttCust, ttOrder, ttOrderLine
       DATA-RELATION CustOrdRel FOR ttCust, ttOrder
         RELATION-FIELDS (CustNum, CustNum)
       DATA-RELATION OrdLinesRel FOR ttOrder, ttOrderLine
         RELATION-FIELDS (OrderNum, OrderNum) NESTED.

DEFINE INPUT  PARAMETER iCustNum AS INTEGER.
DEFINE OUTPUT PARAMETER DATASET FOR dsCustOrd.

/* fill dataset and return to caller */
...
```

The following WSDL sample defines the ProDataSet parameter for `getCustOrders.p` using the Doc/Lit SOAP format. Note the differences between the nested and non-nested data relations in this sample:

DATASET parameter for Doc/Lit

```
<!-- dataset definition -->
<element name="dsCustOrd" prodata:proDataSet="true">
  <complexType>
    <sequence>
      <element maxOccurs="unbounded" minOccurs="0" name="ttCust">
        <complexType>
          <sequence>
            <element name="CustNum" nillable="true" type="xsd:int"/>
            <element name="Name" nillable="true" type="xsd:string"/>
          </sequence>
        </complexType>
      </element>
      <element maxOccurs="unbounded" minOccurs="0" name="ttOrder">
        <complexType>
          <sequence>
            <element name="OrderNum" nillable="true" type="xsd:int"/>
            <element name="CustNum" nillable="true" type="xsd:int"/>
            <!-- nested data relation between ttOrder and ttOrderLine -->
            <element maxOccurs="unbounded" minOccurs="0"
                     name="ttOrderLine">
              <complexType>
                <sequence>
                 <element name="OrderNum" nillable="true" type="xsd:int"/>
                 <element name="LineNum" nillable="true" type="xsd:int"/>
                </sequence>
              </complexType>
            </element>
          </sequence>
        </complexType>
      </element>
    </sequence>
  </complexType>
  <unique name="CustNumIdx" prodata:primaryIndex="true">
    <selector xpath="Sn:.//ttCust"/>
    <field xpath="Sn:CustNum"/>
  </unique>
  <unique name="OrderNumIdx" prodata:primaryIndex="true">
    <selector xpath=".//Sn:ttOrder"/>
    <field xpath="Sn:OrderNum"/>
  </unique>
  <unique name="CustOrdIdx">
    <selector xpath="Sn:.//ttOrder"/>
    <field xpath="Sn:CustNum"/>
    <field xpath="Sn:OrderNum"/>
  </unique>
  <unique name="OrderLineIdx" prodata:primaryIndex="true">
    <selector xpath=".//Sn:ttOrderLine"/>
    <field xpath="Sn:OrderNum"/>
    <field xpath="Sn:LineNum"/>
  </unique>
  <!-- non-nested data relation between ttCust and ttOrder -->
  <keyref name="CustOrdRel" refer="Sn:CustNumIdx">
    <selector xpath="Sn:.//ttOrder"/>
    <field xpath="Sn:CustNum"/>
  </keyref>
  <!-- nested data relation between ttOrder and ttOrderLine -->
  <keyref name="OrdLinesRel" prodata:nested="true" refer="Sn:OrderLineIdx">
    <selector xpath="Sn:.//ttOrderLine"/>
    <field xpath="Sn:OrderNum"/>
  </keyref>
</element>
```

Note: *Sn* refers to the namespace prefix for the XML Schema containing the dataset's definition.

For RPC styles, the name of the ProDataSet parameter follows the format, *PDSname*`Param`, where *PDSname* is the name of your ProDataSet. Both RPC styles use the same structure to define a ProDataSet parameter. The following WSDL sample defines the ProDataSet parameter using the RPC/Literal SOAP format. Note the differences between the nested and non-nested data relations in this sample:

DATASET parameter for RPC/Literal and RPC/Encoded

```
<!-- dataset definition -->
<complexType name="dsCustOrdParam" prodata:proDataSet="true">
  <sequence>
    <element maxOccurs="unbounded" minOccurs="0" name="ttCust">
      <complexType>
        <sequence>
          <element name="CustNum" nillable="true" type="xsd:int"/>
          <element name="Name" nillable="true" type="xsd:string"/>
        </sequence>
      </complexType>
    </element>
    <element maxOccurs="unbounded" minOccurs="0" name="ttOrder">
      <complexType>
        <sequence>
          <element name="OrderNum" nillable="true" type="xsd:int"/>
          <element name="CustNum" nillable="true" type="xsd:int"/>
          <!-- nested data relation between ttOrder and ttOrderLine -->
          <element maxOccurs="unbounded" minOccurs="0" name="ttOrderLine">
            <complexType>
              <sequence>
                <element name="OrderNum" nillable="true" type="xsd:int"/>
                <element name="LineNum" nillable="true" type="xsd:int"/>
              </sequence>
            </complexType>
          </element>
        </sequence>
      </complexType>
    </element>
  </sequence>
  <annotation>
    <appinfo>
      <unique name="CustNumIdx" prodata:primaryIndex="true">
        <selector xpath=".//Sn:ttCust"/>
        <field xpath="Sn:CustNum"/>
      </unique>
      <unique name="OrderNumIdx" prodata:primaryIndex="true">
        <selector xpath=".//Sn:ttOrder"/>
        <field xpath="Sn:OrderNum"/>
      </unique>
      <unique name="CustOrdIdx">
        <selector xpath=".//Sn:ttOrder"/>
        <field xpath="Sn:CustNum"/>
        <field xpath="Sn:OrderNum"/>
      </unique>
      <unique name="OrderLineIdx" prodata:primaryIndex="true">
        <selector xpath=".//Sn:ttOrderLine"/>
        <field xpath="Sn:OrderNum"/>
        <field xpath="Sn:LineNum"/>
      </unique>
      <!-- non-nested data relation between ttCust and ttOrder -->
      <keyref name="CustOrdRel" refer="Sn:CustNumIdx">
        <selector xpath=".//Sn:ttOrder"/>
        <field xpath="Sn:CustNum"/>
      </keyref>
      <!-- nested data relation between ttOrder and ttOrderLine -->
      <keyref name="OrdLinesRel" prodata:nested="true"
              refer="Sn:OrderLineIdx">
        <selector xpath=".//Sn:ttOrderLine"/>
        <field xpath="Sn:OrderNum"/>
        <field xpath="Sn:LineNum"/>
      </keyref>
    </appinfo>
  </annotation>
</complexType>
```

Include before-image data

Before-image data is serialized in a proprietary OpenEdge `datasetChanges` document. The WSDL represents the parameter as arbitrary complex data with an <any> element. XML Schema attributes from the ABL-specific namespace identify the element as a `datasetChanges` document.

An ABL-based client can map the <any> element to a ProDataSet parameter and parse the OpenEdge `datasetChanges` document into a ProDataSet and its before-image data through the `READ-XML( )` method. For more information on how ABL handles before-image data in XML, see the chapter on reading and writing XML data from ProDataSets in *OpenEdge Development: Working with XML*. Non-ABL clients map the <any> element to an XML document that the client developer needs to parse with an XML API.

The following code snippet defines a ProDataSet with before-image data:

```
/* getCustOrdersBI.p */
DEFINE TEMP-TABLE    ttCust     NO-UNDO
       BEFORE-TABLE  ttCustBef
       FIELD         CustNum    AS INTEGER
       FIELD         Name       AS CHARACTER
       INDEX         CustNumIdx IS UNIQUE PRIMARY CustNum.

DEFINE TEMP-TABLE   ttOrder     NO-UNDO
       BEFORE-TABLE ttOrderBef
       FIELD        OrderNum    AS INTEGER
       FIELD        CustNum     AS INTEGER
       INDEX        OrderNumIdx IS UNIQUE PRIMARY OrderNum
       INDEX        CustOrdIdx  IS UNIQUE CustNum OrderNum.

DEFINE DATASET dsCustOrd FOR ttCust, ttOrder
       DATA-RELATION CustOrdRel FOR ttCust, ttOrder
         RELATION-FIELDS (CustNum, CustNum).

DEFINE INPUT  PARAMETER iCustNum AS INTEGER.
DEFINE OUTPUT PARAMETER DATASET  FOR dsCustOrd.

/* fill dataset and return to caller */
...
```

The following WSDL sample defines the ProDataSet parameter for `getCustOrdersBI.p` using the Doc/Lit SOAP format:

Doc/Lit WSDL for getCustOrdersBI.p

```
<!-- datasetChanges document -->
<complexType name="dsCustOrdChanges"
  prodata:datasetName="dsCustOrd"
  prodata:isDsChanges="true"
  prodata:namespace="WebServiceNameSpace:ObjectName">
  <sequence>
    <any />
  </sequence>
</complexType>
<!-- dataset definition -->
<element name="dsCustOrd" prodata:proDataSet="true">
  <complexType>
    <sequence>
      <element maxOccurs="unbounded" minOccurs="0" name="ttCust"
               prodata:beforeTable="BIttCust">
        <complexType>
          <sequence>
            <element name="CustNum" nillable="true" type="xsd:int"/>
            <element name="Name" nillable="true" type="xsd:string"/>
          </sequence>
        </complexType>
      </element>
      <element maxOccurs="unbounded" minOccurs="0" name="ttOrder"
               prodata:beforeTable="BIttOrder">
        <complexType>
          <sequence>
            <element name="OrderNum" nillable="true" type="xsd:int"/>
            <element name="CustNum" nillable="true" type="xsd:int"/>
          </sequence>
        </complexType>
      </element>
    </sequence>
  </complexType>
</element>
```

Note: *ObjectName* refers to the object's name as defined in ProxyGen. Each object gets its own XML Schema.

Note that the ProDataSet parameter is described in two parts:

- An arbitrary complex type (`<any />`) for the OpenEdge `datasetChanges` document
- The ProDataSet definition specifying the before-image tables with the `prodata:beforeTable` attribute

The RPC styles use the same structure for the dataset definition.

Use NAMESPACE-URI attributes

If you use ProDataSets with `NAMESPACE-URI` attributes, the WSDL contains a separate `<schema>` element in the `<types>` section for each namespace. The `<schema>` element for each namespace contains the definitions for all ProDataSets that share that namespace. In the Doc/Lit SOAP format, the primary `<schema>` element imports all the other namespaces.

Define DATASET-HANDLE (dynamic ProDataSet) parameters

DATASET-HANDLE parameters pass both the schema and data, because the dynamic ProDataSet schema is not known at compile time. Thus, for ProDataSet parameters, OpenEdge Web services map an ABL DATASET-HANDLE to an arbitrary complex type (<any>). There is a single definition used for all ProDataSet parameters in all supported SOAP formats. The following WSDL sample shows this common ProDataSet parameter definition:

Common DATASET-HANDLE definition for all SOAP formats

```
<complexType name="DataSetHandleParam">
  <annotation>
    <documentation>This is the schema definition for an OpenEdge dynamic
     ProDataSet parameter. The first element in this sequence must be a
     w3c XML Schema document describing the definition of the ProDataSet.
     The second element contains the serialized data.
    </documentation>
  </annotation>
  <sequence>
    <any maxOccurs="2" minOccurs="2"/>
  </sequence>
</complexType>
```

All dynamic ProDataSet parameters share the <complexType> definitions in the WSDL. Parameters without before-image data use one <complexType>, and parameters with before-image data use another <complexType>. The before-image version uses the following <complexType>:

```
<complexType name="DataSetHandleChangesParam" prodata:isDsChanges="true">
  <annotation>
    <documentation>This is the schema definition for an OpenEdge dynamic
     ProDataSet parameter. The first element in this sequence must be a
     w3c XML Schema document describing the definition of the ProDataSet.
     The second element contains the serialized data, including before-image
     data.
    </documentation>
  </annotation>
  <sequence>
    <any maxOccurs="2" minOccurs="2"/>
  </sequence>
</complexType>
```

The client application must create (for input) and parse (for output) the XML Schema along with the data for the parameter. How the client inserts the input schema and data in request messages and how it parses the output schema and data from response messages depends entirely on the client application.

F

The WSDL Analyzer

This appendix describes the command syntax for running the WSDL Analyzer (`bprowsdldoc`).

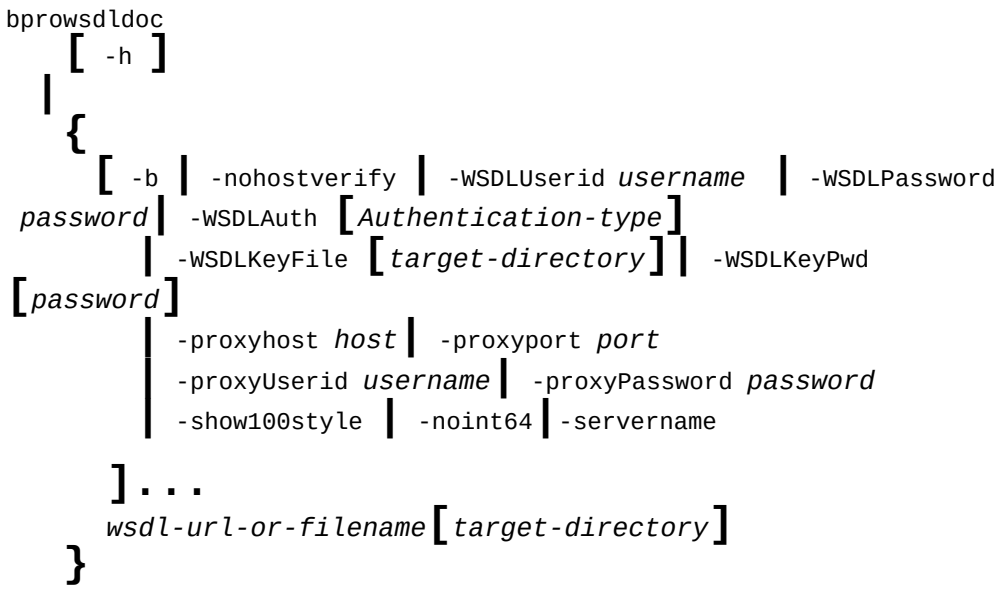
For details, see the following topics:

- bprowsdldoc

bprowsdldoc

Runs the WSDL Analyzer, which provides HTML documentation on the interface that a Web Service Description Language (WSDL) describes. This HTML documentation describes how an ABL developer can access the Web service and its operations in ABL.

Syntax

Operating system	Syntax
UNIX Windows	

`-h`

Displays a help message on the usage of this command.

`-b`

Forces documentation of binding names. A Web service can offer two options for a Web service client to connect (or bind) to it:

- Using services with ports (most common)
- Using binding names (the names of the WSDL <`binding`> elements) with SOAP endpoints that you must obtain separately (sometimes used to bind a SOAP viewer)

Normally, if a WSDL defines services, the Analyzer includes only the service and port names in the generated documentation. If the WSDL does not define any services, the Analyzer documents the binding names. This option tells the Analyzer to document the binding names even when services are defined in the WSDL. For more information on connecting to Web services, see Connecting to OpenEdge SOAP Web Services from ABL on page 205.

`-nohostverify`

Turns off host verification for a Transport Layer Security (TLS) connection using HTTPS.

`-WSDLUserid` *`username`*

Specifies a username for accessing the WSDL file.

`-WSDLPassword` *`password`*

Specifies a password for accessing the WSDL file.

`-WSDLAuth` *`password`*

Specifies if the access to a WSDL file requires TLS client authentication. Set this to `ssl` to enable TLS client authentication for WSDL access. If you set this to `Basic`, the connect method ignores client authentication for WSDL access.

`-WSDLKeyFile` *`password`*

Specifies the location of the client certificate. If you do not specify an absolute path of the client certificate file, the connection operation searches the `$DLC/keys` folder for the *`client-certificate-file-name.pem`* file. This option must be updated only if `-WSDLAuth` parameter is set to `ssl`.

`-WSDLKeyPwd` *`password`*

Specifies, in clear text or encoded format, the password of the client certificate. This option must be updated only if `-WSDLAuth` parameter is set to `ssl`.

`-proxyhost` *`host`*

Specifies the name or IP address of the host where an HTTP-based proxy server required to access the WSDL file is located.

`-proxyport` *`port`*

Specifies the port on which the HTTP-based proxy server is listening for requests to download WSDL files.

`-proxyUserid` *`username`*

Specifies a username for accessing an HTTP-based proxy server.

`-proxyPassword` *`password`*

Specifies a password for accessing an HTTP-based proxy server.

`-show100style`

Shows procedure and function signatures as documented in the 10.0x releases of OpenEdge. With the release of 10.1A, some procedure signatures are changed for ease of use. For more information, see Analyzing wrapped document literal on page 194.

`-noint64`

Prior to OpenEdge Version 10.1B, the ABL `INT64` data type did not exist and the WDSL Analyzer mapped XML Schema types of `xsd:long` to the ABL `DECIMAL` data type. Use this option if you want to use the `xsd:long` to ABL `DECIMAL` mapping. Otherwise, `xsd:long` maps to `INT64`. The current version of OpenEdge continues to recognize existing mappings of `xsd:long` to `DECIMAL` as valid whether or not this option is specified.

`wsdl-url-or-filename`

Specifies a URL, Microsoft Uniform Naming Convention (UNC), or local pathname to the WSDL file. If the string does not specify a URL protocol ("`file://`", "`http://`", or "`https://`") or start with a UNC prefix ("`\\`"), it is assumed to be a a local file pathname.

target-directory

Specifies the target directory (to be created if necessary) where the Analyzer will write the generated documents. If not specified, the Analyzer assumes the current working directory. Choose a directory dedicated for the specified WSDL file, as some generated document filenames are the same for multiple WSDL files.

–servername

Specifies the server name in TLS connection initialization for client that it sends to the server as part of the TLS negotiation.

For more information on the documentation output from the WSDL Analyzer, see Use the WSDL Analyzer on page 182.