Web Services Integration Toolkit for OpenVMS

Developer's Guide

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This document contains information that will help you use the development tools in this release of WSIT for OpenVMS.

Software Version
Web Services Integration Toolkit
Version 3.0

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CONTENTS

About Web Services Integration Toolkit for OpenVMS Documentation

This *Developer's Guide* contains information about how to use the tools in the Web Services Integration Toolkit for OpenVMS, and things to consider as you prepare your legacy application.

The *Installation Guide and Release Notes* includes system requirements and installation instructions for OpenVMS, as well as release notes for the current release of the Web Services Integration Toolkit for OpenVMS.

For the latest release information, refer to the Web Services Toolkit for OpenVMS web site at http://www.hp.com/products/openvms/webservices/.

1 USING WEB SERVICES INTEGRATION TOOLKIT

1.1 Overview

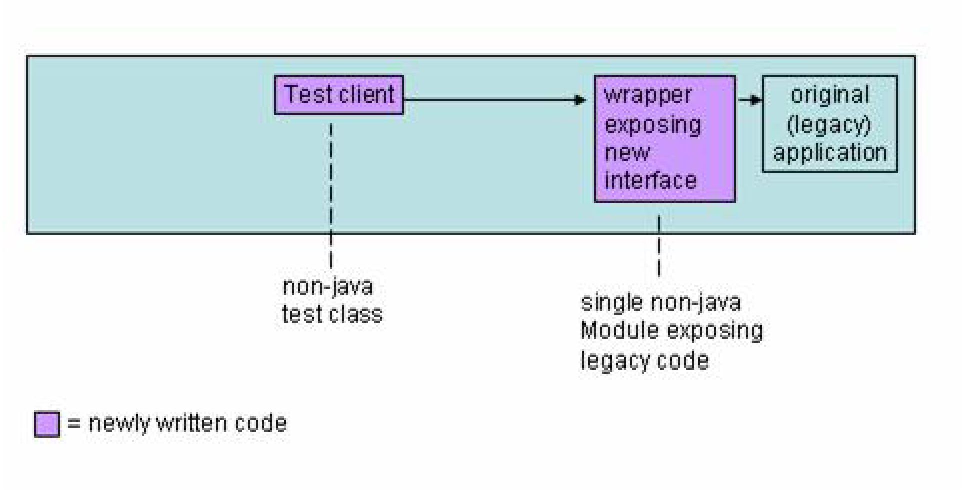
The Web Service Integration Toolkit for OpenVMS (WSIT) contains a collection of integration tools. These tools are easy to use, highly extensible, based on standards and built on open source technology. The toolkit can be used to call OpenVMS applications written in 3GL languages, such as C, BASIC, COBOL, FORTRAN, and ACMS from newer technologies and languages such as Java, Microsoft .NET, Java -RMI, JMS, and web services.

The Web Service Integration Toolkit is focused on integrating at the API level. It generates a JavaBean wrapper for a supplied OpenVMS application interface (API). At runtime, you can specify if the application will be run in the process of the caller (in-process) or in separate processes (out-of-process) managed by the WSIT runtime.

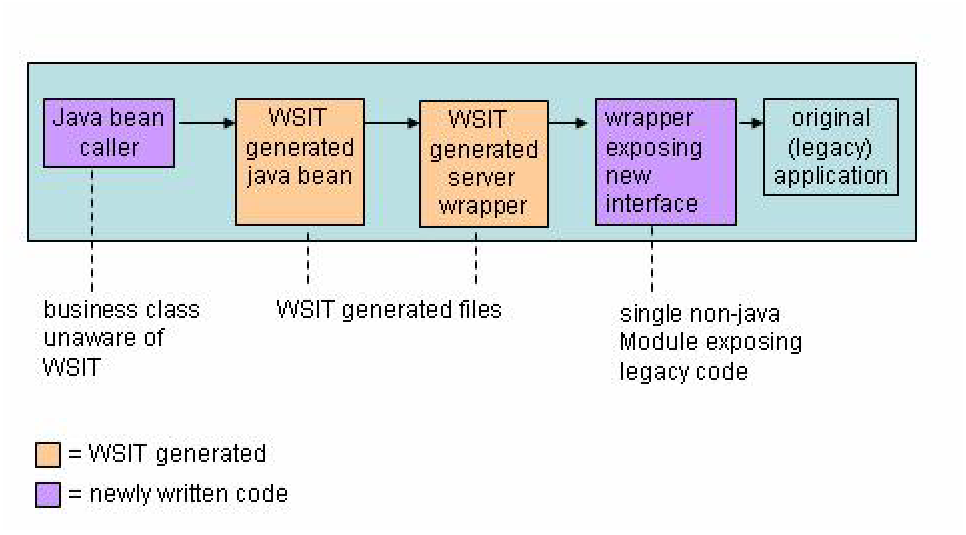
1.2 Preparing the Original (Legacy) Application

Using the Web Services Integration Toolkit for OpenVMS, as with all programmatic integration, requires some upfront development work before you can begin performing the integration. Your existing application is likely to have been written long ago and will benefit from having a wrapper expose a new and clean interface. The new interface will expose the legacy implementation. Separating the interface from the implementation provides encapsulation and the ability to easily extend and reuse the implementation.

Before you use the Web Services Integration Toolkit or any other integration technology, you must evaluate the original application and design one or more interface classes to expose different features of the business logic. These new interfaces should be tested with a simple client before you use the Web Services Integration Toolkit. When you know that the interface classes are working properly, you can use WSIT to extend the use of the new interface to the Java environment.


Test client
wrapper exposing new interface
original (legacy) application
non-java test class
single non-java Module exposing legacy code
= newly written code

After you have prepared the application, WSIT can extend the features of the new interface to Java as shown in the following diagram.


Java bean caller
WSIT generated java bean
WSIT generated server wrapper
wrapper exposing new interface
original (legacy) application
business class unaware of WSIT
WSIT generated files
single non-java Module exposing legacy code
= WSIT generated
= newly written code

1.3 Exposing an OpenVMS 3GL Application: Typical Development Steps

Following are the development steps required to use the Web Services Integration Toolkit to expose an OpenVMS 3GL or ACMS application. Note that these steps are only required for the development phase. It is expected that the application has been prepared as discussed in the previous section.

Note: These tools were renamed in a pre-V1.0 field test kit. See Chapter 3 in the Installation Guide and Release Notes for a table containing the old and new file names.

1. **Create XML IDL file (on I64)**

Create an XML interface definition file (IDL) that describes the interface to be exposed. You create an XML IDL file using the tool named OBJ2IDL.EXE (for 3GL languages) or STDL2IDL.JAR (for ACMS). Note: OBJ2IDL.EXE runs on OpenVMS I64 only. If you are using WSIT on OpenVMS Alpha, see Section 2.5.5 for information about the HP TestDrive program.

2. **Validate XML IDL file**

Verify that the XML IDL file correctly describes the interface being exposed. If it does not, manually update the XML IDL file until the interface definition is correct. VALIDATE.JAR allows you to verify that an XML IDL file conforms to the openvms-integration.xsd schema.

3. **Generate components**

For the interface being exposed, generate one WSIT server interface wrapper and one WSIT Java Bean using IDL2CODE.JAR. The generated source code must be built on the OpenVMS system that hosts the application.

4. **Use the generated code**

Call the generated WSIT JavaBean from the technology of your choice, including BEA WLS, Apache Axis, JMS, Java RMI, J2EE or another JavaBean.

1.4 Wrapping a 3GL Application: C Sample

The following steps demonstrate how to wrap a 3GL application using the math sample program found in WSI$ROOT:[SAMPLES.C]. Other 3GL sample programs can be found in WSI$ROOT:[SAMPLES.COBOL] and WSI$ROOT:[SAMPLES.BASIC]. (See Section 1.5 for information about a sample program that wraps an ACMS application.)

The information in this section is also included in WSI$ROOT:[SAMPLES.C]MATH-SAMPLE.README.

Note: For demonstration purposes only, the steps below use the wsi$root:[samples.c] directory as the default directory. HP recommends that you copy the contents of this directory into your own local directory before performing these steps.

Step 1: Generate an Interface Definition with OBJ2IDL

The tool OBJ2IDL.EXE is used to generate an XML interface definition file (IDL). (For information about manually reading or modifying an IDL, see Chapter 5.)

Establish a foreign command:

```
$ obj2idl = "$WSI$ROOT:[tools]obj2idl.exe"
```

Compile the wrapper that exposes the new interface:

```
$ set def WSI$ROOT:[samples.c]
$ cc/debug/noopt math.c
```

Note: Your code must be compiled with the /DEBUG option for the OBJ2IDL parser to work properly.

Use OBJ2IDL to generate an XML file with the interface definition:

```
$ obj2idl -f WSI$ROOT:[samples.c]math.obj
```

The tool OBJ2IDL creates the file math.xml. See the Appendix for a full listing of math.xml.

You should become familiar with the XML description of OpenVMS applications. Review the math.xml file and notice the overall structure of the file. Following are the level 1 tags used to define an interface. These tags contain lower level tags and more information.

`<OpenVMSInterface>`	
`<Primitives></Primitives>`	Define the fundamental types referenced in the interface.
`<Routines></Routines>`	Define the callable routines of the interface.
`<Structures></Structures>`	Define the structures of the interface.
`<Typedefs></Typedefs>`	Define the type definitions of the interface.
`</OpenVMSInterface>`	

Note: To view the XML file with coloring and a collapsible outline, use Internet Explorer.

Step 2: Validate the Generated XML File

The OBJ2IDL tool is sometimes unable to extract a complete interface definition from the supplied object file. When the tool is missing data or has made assumptions, a comment is placed in the XML file below the line of concern.

The file math.log is also generated from OBJ2IDL. Use this file to conveniently see an overview of the comments within the XML file. (ACMS does not create a .log file.)

```
$ ty math.log
Generated IDL file: WSI$ROOT:[samples.c]math.xml
Tue Apr 5 11:22:37 2005
```

In this case the tool did not report any issues. However, even in cases where the log file has not generated any error or warning, you should always review the XML file to ensure that the interface definition is exactly correct. It is very important that the XML IDL describe the interface accurately to generate correct code in Step 3.

The validate.jar tool is provided to allow you to verify that an XML IDL file conforms to the openvms-integration.xsd schema. Use this tool to validate all XML IDL files before they are passed to the IDL2CODE tool. The IDL2CODE tool does not validate the XML IDL file.

The validate tool is an executable JAR file. To run the tool, you must supply two parameters: an XML IDL file and the openvms-integration schema. For example:

```
$ java -jar wsi$root:[tools]validate.jar -x wsi$root:[samples.c]math.xml
  –s wsi$root:[tools]openvms-integration.xsd
```

<u>Step 3: Generate WSIT Components with IDL2CODE</u>

Use the tool IDL2CODE.JAR (also called the Generator) to create a server wrapper for the application and a JavaBean client. This tool requires certain JAR files to be in the Java classpath. A command procedure is supplied to add these files to the java$classpath logical. (The java$classpath logical lets you define a class path using OpenVMS file specification syntax. Defining this logical overrides the classpath logical, if set.)

```
$ @WSI$ROOT:[tools]wsi-setenv - wsi$dev
The New JAVA$CLASSPATH is:
"JAVA$CLASSPATH" = "WSI$ROOT:[LIB]WSIRTL.JAR" (LNM$JOB_86F82E00)
= "[]"
= "WSI$ROOT:[LIB]VELOCITY-DEP-1_4.JAR"
= "WSI$ROOT:[TOOLS]IDL2CODE.JAR"
$
```

To generate files for the math demo, use the following command. In this case, the tool is passed the math.xml file and the application is named math. All generated files for the application are placed in a subdirectory named generated.

```
$ create/dir [.generated]
$ java "com.hp.wsi.Generator" -i math.xml -a math -o [.generated]
File: ./generated/mathServer/build-math-server.com generated.
File: ./generated/mathServer/methIds.h generated.
File: ./generated/mathServer/structkeys.h generated.
File: ./generated/mathServer/math.wsi generated.
File: ./generated/mathServer/math.opt generated.
File: ./generated/mathServer/math-server.h generated.
File: ./generated/mathServer/math-server.c generated.
File: ./generated/math/build-math-jb.com generated.
File: ./generated/math/Imath.java generated.
File: ./generated/math/mathImpl.java generated.
*** Application math generated! ***
$
```

<u>Step 4: Build the generated WSIT Components</u>

Build the server:

This command procedure installs the server image after it has been built. This requires writing to the WSI$ROOT:[DEPLOY] directory, which may be write protected on your system. (This is a security measure. Have your system manager assist you if your account does not have the required privileges.)

```
$ set def WSI$ROOT:[samples.c.generated.mathserver]
$ @BUILD-MATH-SERVER
Begin server build procedure.
..configuring switches and compiler options
..compiling native server code
..linking shareable image
..installing server image
End server build procedure.
$
```

Build the client:

The JavaBean build procedure creates a JAR file that contains the WSI Java classes used to call the server created earlier.

```
$ SET DEF WSI$ROOT:[samples.c.generated.math]
$ @BUILD-MATH-JB
Begin java bean build procedure.
The New JAVA$CLASSPATH is:
"JAVA$CLASSPATH" = "WSI$ROOT:[LIB]WSIRTL.JAR" (LNM$JOB_86D5AE00)
= "[]"
= "WSI$ROOT:[LIB]VELOCITY-DEP-1_4.JAR"
= "WSI$ROOT:[TOOLS]IDL2CODE.JAR"
..Compiling structure classes
..Compiling math Interface classes
..Creating math.JAR file from classes
End of JavaBean build procedure.
```

Step 5a: Run the Math Sample “In-Process”

You can run the math sample program in-process or out-of-process. In-process means that the application will be run in the process of the caller. (Follow the instructions in step 5b instead of 5a if you want to run the sample out-of-process.)

Add the math.jar file to the java$classpath.

```
$ @WSI$ROOT:[tools]wsi-setenv – WSI$ROOT:[samples.c.GENERATED.math]math.jar
The New JAVA$CLASSPATH is:
"JAVA$CLASSPATH" = "WSI$ROOT:[LIB]WSIRTL.JAR" (LNM$JOB_86F82E00)
= "[]"
= "WSI$ROOT:[LIB]VELOCITY-DEP-1_4.JAR"
= "WSI$ROOT:[TOOLS]IDL2CODE.JAR"
= "WSI$ROOT:[SAMPLES.C.GENERATED]MATH.JAR"
$
```

In the normal course of development, you would now need to write a JavaBean to call the math JavaBean that was generated above. However, for the purpose of this demonstration, a JavaBean file named mathcaller.java is provided in the directory WSI$ROOT:[samples.c]. See the Appendix for a source listing of this file.

Compile the supplied JavaBean:

```
$ set def WSI$ROOT:[samples.c]
$ javac mathcaller.java
```

Run the supplied JavaBean:

```
$ java mathcaller
Sum of 10 and 15 is 25
Product of 10 and 15 is 150
$
```

Step 5b: Run the Math Sample "Out-of-Process"

You can run the math sample program either in-process or out-of-process. Out-of-process means that the sample will be run in a separate process managed by the WSIT runtime. (Follow the instructions in step 5a instead of 5b if you want to run the sample in-process.)

Add the math.jar file to the java$classpath.

```
$ @WSI$ROOT:[tools]wsi-setenv - WSI$ROOT:[samples.c.GENERATED.math]math.jar
The New JAVA$CLASSPATH is:
"JAVA$CLASSPATH" = "WSI$ROOT:[LIB]WSIRTL.JAR" (LNM$JOB_86F82E00)
= "[]"
= "WSI$ROOT:[LIB]VELOCITY-DEP-1_4.JAR"
= "WSI$ROOT:[TOOLS]IDL2CODE.JAR"
= "WSI$ROOT:[SAMPLES.C.GENERATED.MATH]MATH.JAR"
$
```

In the normal course of development, you would now need to write a JavaBean to call the math JavaBean that was generated above. However, for the purpose of this demonstration, a JavaBean file named mathcaller.java is provided in the directory WSI$ROOT:[samples.c]. See the Appendix for a source listing of this file.

Modify the provided Java file:

To run the math sample out-of-process, make the following changes to mathcaller.java:

- Call a different constructor
- Call remove when done with server

These changed lines are underlined in the following listing of mathcaller.java.

```
$ type mathcaller.java
import math.*;
import java.io.*;
import com.hp.wsi.WsiIpcContext;

public class mathcaller {

/** Creates a new instance of Main */
public mathcaller() {
}

public static void main(String[] args) {

   try {
```

```
  mathImpl math = new mathImpl(new WsiIpcContext());

          int num1 = 10;
  int num2 = 15;

  int result;

          result = math.sum(num1, num2);
         System.out.println("Sum of " + num1 + " and " + num2 + "is " +
result);

          result = math.product(num1, num2);
System.out.println("Product of " + num1 + " and " + num2 + "is " +    result);

math.remove();

} catch (Exception e) {
System.out.println("Exception thrown");
}
  }
}
```

Important: Review WSI$ROOT:[DEPLOY]MATH.WSI. By default, the deployment configuration file is the most restrictive. It assumes the application is not reusable, therefore it needs a new server process for every client. After evaluating your application, you can modify math.wsi to scale the deployment configuration for the application. See Chapter 2, Deployment Considerations, for more information.

Compile the supplied JavaBean:

```
$ set def WSI$ROOT:[samples.c]
$ javac mathcaller.java
```

Run the supplied JavaBean:

```
$ java mathcaller
Sum of 10 and 15 is 25
Product of 10 and 15 is 150
$
```

1.4.1 Server/Application Build Procedure

The Web Services Integration Toolkit generates a command procedure to build a server. The generated command procedure, named build-<appname>-server.com, creates a shareable image named <appnam>.exe and copies it to the deployment directory WSI$ROOT:[DEPLOY]. The WSIT runtime loads this shareable image to process requests from the WSIT generated JavaBean.

The shareable image <appnam>.exe is composed of three parts:

- The object file provided by the user (in the XML IDL file) to expose the application interface. For example, wsi$root:[samples.c]math.obj located in wsi$root:[samples.c]math.xml.

- A WSIT object file named <appname>-server.obj which exposes the application interface with a set of fixed WSIT entry points. The source file for this object file is <appname>-server.c.

- A WSIT shareable image containing common reusable procedures. This shareable image is named SYS$LIBRARY:WSI$COMMON.EXE.

This shareable image must provide entry points for the WSIT runtime to call. The entry points for all WSIT applications are always the same. The entry points are as follows:

Symbol Name	**Symbol Type**
WSI$INIT	PROCEDURE
WSI$EXIT	PROCEDURE
WSI$START_SESSION	PROCEDURE
WSI$END_SESSION	PROCEDURE
WSI$ACMS_SIGN_IN	PROCEDURE
WSI$ACMS_SIGN_OUT	PROCEDURE
WSI$VMS_LOGIN	PROCEDURE
WSI$VMS_LOGOUT	PROCEDURE
WSI$INVOKE	PROCEDURE
WSI$INVOKE_DCL	PROCEDURE
WSI$GET_FILE	PROCEDURE
WSI$INFO_BLOCK	DATA
WSI$DCL_PROC_MAPS	DATA
WSI$FILENAME_MAPS	DATA

1.4.2 Customizing the Build Environment

In the default behavior described in the preceding section, the application's interface object module is expected to process the requests without calling others modules. While this approach allows WSIT applications to be quickly prototyped, it is obviously not sufficient for "real" applications.

The application being wrapped will almost always be composed of many object modules, object libraries, and/or shareable images. These object modules need to be packaged into a shareable image that includes the WSIT files described above.

You can package the object modules in two ways, as follows:

- Add the few WSIT build elements to the existing application's build environment. (This is the recommended method.)

- Add the application files to the WSIT server build command procedure.

If you choose the recommended option above, the file <appname>.opt provides an overview of the files and entry points that must be added to the new application's shareable image.

If you decide to integrate the WSIT files into your application, remember that the application must be built as a shareable image named <appnam>.exe and must be copied to the WSIT deployment directory WSI$ROOT:[DEPLOY].

1.5 Wrapping an ACMS Application: ACMS Sample

The following steps demonstrate how to wrap an ACMS application using the sample program found in WSI$ROOT:[SAMPLES.ACMS]. Sample programs written in 3GL languages can be found in WSI$ROOT:[SAMPLES.C], WSI$ROOT:[SAMPLES.COBOL], and WSI$ROOT:[SAMPLES.BASIC]. (See Section 1.4 for information about a sample program that wraps a C application.)

The information in this section is also included in WSI$ROOT:[SAMPLES.ACMS]ACMS-SAMPLE.README.

Important: Before you run this sample program, make sure ACMS is properly configured and running on your system.

This ACMS application exists in a nondistributed environment and illustrates some common functions of an administrative system using an Rdb database. For example, in this system, a user adds a new employee record to a master file or updates an existing employee record.

The following files (a modified version of the Getting Started tutorial included with ACMS for OpenVMS) are installed by the Web Services Integration Toolkit for OpenVMS installation in the WSI$ROOT:[SAMPLES.ACMS] directory:

```
acms-sample.readme;1            acmscaller.java;1    ACMSEXAMPLE_SETUP.COM;1
EMPLOYEE_INFO_APPL_WSI.ADF;1    WSI_ADD_EMPL_INFO.TDF;1
WSI_EMP_INFO_TASK_GROUP.GDF;1   WSI_GET_EMPL_INFO.TDF;1
WSI_PUT_EMPL_INFO.TDF;1
```

To run the Web Services Integration Toolkit ACMS sample program, perform the following steps.

Step 1: Execute the WSIT-supplied command file to set up the ACMS application

On the OpenVMS system on which you installed WSIT, log in using an account with SYSTEM privileges.

Create a directory to set up the application. For example:

```
$ create /dir [.acmsgenerated]
```

Set default to the newly created directory:

```
$ set def [.acmsgenerated]
```

Execute the following command:

```
$ @WSI$ROOT:[samples.acms]acmsexample_setup.com
```

This assumes that the ACMS$EXAMPLES logical is present and correct on your system.

This DCL script does the following:

- Creates a local data dictionary for this application
- Defines a CDD (common dictionary data) record (using the supplied .CDO files)
- Defines a CDD entry task
- Builds the application, generating a STDL file (used to import ACMS task and structure definitions)
- Starts the ACMS application

When prompted for a CDD directory, you can press Enter to accept the default (which will be under the directory you just created and set default to), or you may choose another name or location.

For example:

CDD Directory? DKA100:[USER.ACMSGENERATED.DICTIONARY] :

The sample application is set up and started when you see the following:

```
%ACMSINS-S-ADBINS, Application
DISK:[USER.ACMSGENERATED]EMPLOYEE_INFO_APPL_BWX.ADB;
```

```
has been installed to ACMS$DIRECTORY
```

Step 2: Generate an interface definition with STDL2IDL.JAR

Use the STDL2IDL.JAR tool to generate an XML interface definition (IDL file) from the STDL file generated in Step 1.

Run the STDL2IDL importer:

```
$ java -classpath WSI$ROOT:[TOOLS]stdl2idl.jar "com.hp.wsi.Import" -f
EMPLOYEE_INFO_APPL_WSI.STDL
Import File was successfully processed.
File: ./employee_info_appl_wsi.xml generated.
*** Files for Application employee_info_appl_wsi successfully generated! ***
```

Step 3: Review and validate the generated XML file

Because STDL files completely describe the ACMS application, the STDL2IDL tool is able to use the STDL file to create a complete WSIT interface definition representation of that ACMS application. However, even if the STDL2IDL tool specifies that the IDL generation was successful, you should review and validate the generated XML file to ensure complete accuracy. The XML IDL must accurately describe the interface to generate correct code in Step 4.

For this reason, WSIT includes the validate.jar tool to allow you to verify that an XML IDL file conforms to the openvms-integration.xsd schema before it is passed to the IDL2CODE.JAR tool. (The IDL2CODE.JAR tool does not validate the XML IDL file.) To run the validate.jar tool, supply two parameters: an XML IDL file and the openvms-integration schema. For example:

```
$ java -jar wsi$root:[tools]validate.jar
 -x wsi$root:[samples.acms]employee_info_appl_wsi.xml
 -s wsi$root:[tools]openvms-integration.xsd
```

Step 4: Generate WSIT components with IDL2CODE.JAR

Use the IDL2CODE.JAR tool to create a server wrapper for the application and a JavaBean client. This tool requires certain Jar files to be in the Java classpath. A command procedure is supplied to add these files to the java$classpath logical.

```
$ @WSI$ROOT:[tools]wsi-setenv - wsi$dev
The New JAVA$CLASSPATH is:
"JAVA$CLASSPATH" = "WSI$ROOT:[LIB]WSIRTL.JAR" (LNM$JOB_86F82E00)
= "[]"
= "WSI$ROOT:[LIB]VELOCITY-DEP-1_4.JAR"
= "WSI$ROOT:[TOOLS]IDL2CODE.JAR"
$
```

To generate files for the ACMS sample, use the following command. In this case we pass the tool the employee_info_appl_wsi.xml file (generated above) and we call the application AcmsApp. We also place all generated files for the application in a subdirectory named generated.

```
$ create/dir [.generated]
$ java "com.hp.wsi.Generator" -i employee_info_appl_wsi.xml  -a AcmsApp  -o
[.generated]
File: ./generated/AcmsAppServer/build-AcmsApp-server.com generated.
File: ./generated/AcmsAppServer/methIds.h generated.
File: ./generated/AcmsAppServer/structkeys.h generated.
```

```
File: ./generated/AcmsAppServer/AcmsApp.wsi generated.
File: ./generated/AcmsAppServer/AcmsApp.opt generated.
File: ./generated/AcmsAppServer/AcmsApp-server.h generated.
File: ./generated/AcmsAppServer/AcmsApp-server.c generated.
File: ./generated/AcmsApp/build-AcmsApp-jb.com generated.
File: ./generated/AcmsApp/IAcmsApp.java generated.
File: ./generated/AcmsApp/AcmsAppImpl.java generated.
File: ./generated/AcmsApp/CONTROL_WORKSPACE.java generated.
File: ./generated/AcmsApp/EMPLOYEE_INFO_WKSP.java generated.
*** Application AcmsApp generated! ***
$
```

Build the server:

The server build procedure links the generated server files with the user's application, which creates a dynamically loadable shareable image.

```
$ set def [.generated]
$ @BUILD-ACMSAPP-SERVER
Begin server build procedure.
  ..configuring switches and compiler options
  ..compiling native server code
  ..linking shareable image
  ..installing server image
End server build procedure.
$
```

Build the client:

The JavaBean build procedure creates a JAR file that contains the WSIT Java classes used to call the server created earlier.

```
$ @BUILD-ACMSAPP-JB

Begin Java bean build procedure.
The New JAVA$CLASSPATH is:
   "JAVA$CLASSPATH" = "WSI$ROOT:[LIB]WSIRTL.JAR" (LNM$JOB_86F82E00)
        = "[]"
        = "WSI$ROOT:[LIB]VELOCITY-DEP-1_4.JAR"
        = "WSI$ROOT:[TOOLS]IDL2CODE.JAR"
  ..Compiling structure classes
  ..Compiling acmsapp Interface classes
  ..Creating acmsapp.JAR file from classes
End of JavaBean build procedure.
```

<u>Step 5: Run the ACMS Sample</u>

Add the AcmsApp.jar file to the java$classpath.

```
$ @WSI$ROOT:[tools]wsi-setenv - disk:[directory]acmsapp.jar
The new JAVA$CLASSPATH is:
   "JAVA$CLASSPATH" = "WSI$ROOT:[LIB]WSIRTL.JAR" (LNM$JOB_86F82E00)
        = "[]"
        = "WSI$ROOT:[LIB]VELOCITY-DEP-1_4.JAR"
        = "WSI$ROOT:[TOOLS]IDL2CODE.JAR"
        = "disk:[directory]ACMSAPP.JAR"
$
```

In the normal course of development, you would now need to write a client to call the AcmsApp JavaBean that was generated above. However, for the purpose of this sample, a client file named acmscaller.java is provided in the directory WSI$ROOT:[samples.acms].

Compile the supplied client:

```
$ set def WSI$ROOT:[samples.acms]
$ javac acmscaller.java
```

Run the supplied client:

```
$ java acmscaller
******* Creating JavaBean & Server **********
************ Calling AcmsSignIn ***************
***** Calling add and get empl_info tasks ******
************ Calling AcmsSignOut ***************
123456
John Adams
1 Beacon Hill
Boston
MA
01776
******** Removing the JavaBean & Server *********
*********** End ACMS Client *************
$
```

The output from the Java program shows the code that the client is executing, as well as the calls that it is making into ACMS. The data displayed was first entered into an Rdb database via ACMS, then retrieved using ACMS for display purposes.

1.6 Generating Sample Clients

The Web Services Integration Toolkit allows you to quickly and easily generate sample clients that call the WSIT generated JavaBean. These clients are especially useful when prototyping, testing, or creating a demo for an integration project. However, these samples are not intended to be used in a production environment.

You can specify the type of client you want the WSIT generator (IDL2CODE) to generate by using the –C parameter.

There are three different sample clients that IDL2CODE can generate:

- POJO – a simple java command line tool
- JSP – a Java Server Page that can be deployed in Tomcat or other containers.
- AXIS2 Web Service – a web services that can be deployed in Apache AXIS2 (available in WSIT V3.0 and higher)

Specifying –c S generates only the POJO command line client. Specifying –c J generates only the JSP client. Specifying –c W generates only the AXIS2 web service, and specifying –c SJW generates all.

For example, to generate sample clients for the C math application from Section 1.4, follow the same sequence of steps from 1 to 4. At step 3, however, pass in the additional switch shown below.

Note: WSIT generated JSP samples require a server environment that supports the JSP V2.0. Examples include Tomcat 5.5.9 and WebLogic Server V9.0.

```
$ java "com.hp.wsi.Generator" -i math.xml  -a math -c SJ -o [.generated]
File: ./generated/mathServer/build-math-server.com generated.
File: ./generated/mathServer/methIds.h generated.
File: ./generated/mathServer/structkeys.h generated.
File: ./generated/mathServer/math.wsi generated.
File: ./generated/mathServer/math.opt generated.
File: ./generated/mathServer/math-server.h generated.
File: ./generated/mathServer/math-server.c generated.
File: ./generated/math/build-math-jb.com generated.
File: ./generated/math/Imath.java generated.
File: ./generated/math/mathImpl.java generated.
File: ./generated/mathSamples/POJO/mathMain.java generated.
File: ./generated/mathSamples/POJO/build-math-PoJoClient.com generated.
File: ./generated/mathSamples/JSP/index.html generated.
File: ./generated/mathSamples/JSP/mathMethodList.html generated.
File: ./generated/mathSamples/JSP/mathPopulate.jsp generated.
File: ./generated/mathSamples/JSP/mathDoCall.jsp generated.
File: ./generated/mathSamples/JSP/build-math-JspClient.com generated.***
Application math generated! ***
$
```

Using the generated POJO client sample:

Normally this class will be written to integrate the WSIT generated JavaBean with the Java technology of your choice.

The sample must first be built as shown below.

```
$ @wsi$root:[tools]wsi-setenv - WSI$ROOT:[samples.c.generated.math]math.jar
$ set default WSI$ROOT:[samples.c.generated.mathSamples.POJO]
$ @build-math-PoJoClient
Begin client build procedure.
  ..Compiling mathMain client class
End of client build procedure.
```

To run this client, type the following at the command line:

```
$ java "math.mathMain"
```

The sample client is able to make calls to the methods of the generated JavaBean. There is a limitation that only methods with primitive arguments can be called. To see which methods the sample client can call, use the switch –m as shown below.

```
$ set default WSI$ROOT:[samples.c.generated.mathSamples.POJO]
$ java math.mathMain -m
```

The list of available methods within math are:

```
sum(int P1, int P2)
product(int P1, int P2)
```

(Methods that take structures or arrays as parameters are not callable from this command line interface. These methods are denoted by the * next to them.)

To call the sum and product methods with arguments of 5 and 2, use the commands as shown below.

```
$ set default WSI$ROOT:[samples.c.generated.mathSamples.POJO]
$ java math.mathMain -m sum -p1 5 -p2 2
Calling mathImpl.sum:
 P1 = 5
 P2 = 2
 Return value = 7
 ++ The client was successful ++
$ java math.mathMain -m product -p1 5 -p2 2
Calling mathImpl.product:
 P1 = 5
 P2 = 2
 Return value = 10
 ++ The client was successful ++
$
```

Using the generated JSP client sample:

Similar to the POJO sample, the JSP sample client must first be built as shown below.

```
$ @wsi$root:[tools]wsi-setenv – WSI$ROOT:[samples.c.generated.math]math.jar
$ set default WSI$ROOT:[samples.c.generated.mathSamples.JSP]
$ @build-math-JSPClient
Begin JSP client build procedure.
Unpacking static files into current location.
Copying math.jar into local [.WEB-INF.lib] directory
Creating mathJsp.war file
End of JSP client build procedure.
```

To deploy this client:

Copy mathJsp.War into the deployment directory for your JSP server.

To deploy the JSP, copy the mathJsp.war file to a web server servlet deployment directory. For example, if you have installed Tomcat (CSWS_JAVA) on OpenVMS, the command is similar to the following:

```
$ copy mathJSP.war sys$common:[apache.jakarta.tomcat.webapps]
```

After the war file has been copied, you can view the JSP pages by using a URL similar to the one shown below. (Replace yourwebserver.hp.com with the actual name of your web server.) By default, Tomcat listens on port 8080. If the system manger changed the port number, replace 8080 with the new number.

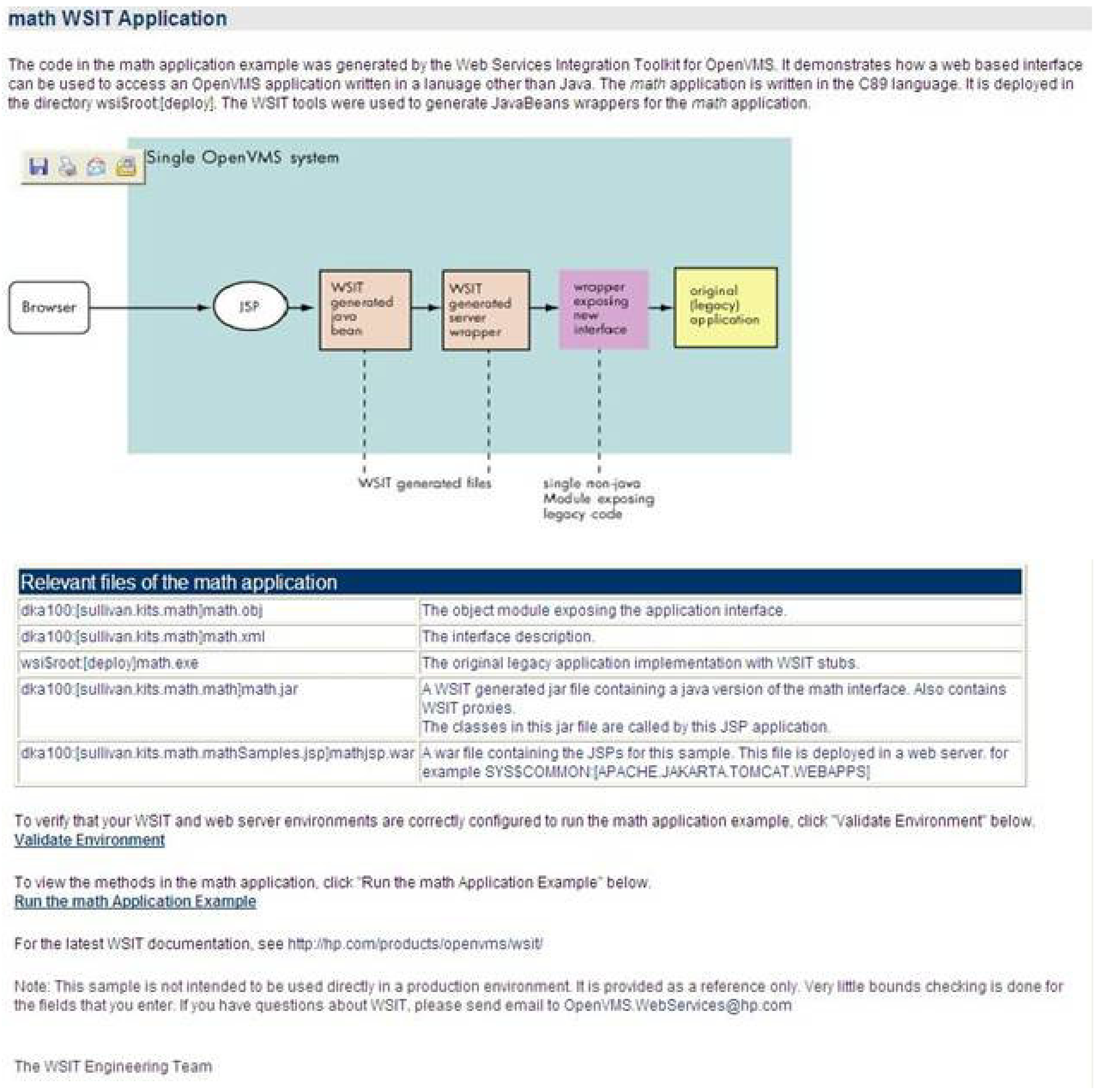
```
$ copy mathJSP.war sys$common:[apache.jakarta.tomcat.webapps]
```

The POJO client is not supported when the –l switch is used on IDL2CODE.
Note: Web applications deployed as Java classes are seen and used immediately, but web applications deployed as JAR files may require a Tomcat restart in order for them to be seen and used. For information about restarting Tomcat, see the CSWS_JAVA (Tomcat) for OpenVMS documentation at

http://h71000.www7.hp.com/openvms/products/ips/apache/csws_java_relnotes.html

The following screen captures illustrate the JSP sample client calling the C Math application.

Example Web Page 1: The mathJSP Application


Single OpenVMS system
Browser
JSP
WSIT generated java bean
WSIT generated server wrapper
wrapper exposing new interface
original (legacy) application
WSIT generated files
single non-java Module exposing legacy code

math WSIT Application

The code in the math application example was generated by the Web Services Integration Toolkit for OpenVMS. It demonstrates how a web based interface can be used to access an OpenVMS application written in a lanuage other than Java. The *math* application is written in the C89 language. It is deployed in the directory wsi$root:[deploy]. The WSIT tools were used to generate JavaBeans wrappers for the *math* application.

Relevant files of the math application	
dka100:[sullivan.kits.math]math.obj	The object module exposing the application interface.
dka100:[sullivan.kits.math]math.xml	The interface description.
wsi$root:[deploy]math.exe	The original legacy application implementation with WSIT stubs.
dka100:[sullivan.kits.math.math]math.jar	A WSIT generated jar file containing a java version of the math interface. Also contains WSIT proxies. The classes in this jar file are called by this JSP application.
dka100:[sullivan.kits.math.mathSamples.jsp]mathjsp.war	A war file containing the JSPs for this sample. This file is deployed in a web server. for example SYS$COMMON:[APACHE.JAKARTA.TOMCAT.WEBAPPS]

To verify that your WSIT and web server environments are correctly configured to run the math application example, click "Validate Environment" below.
Validate Environment

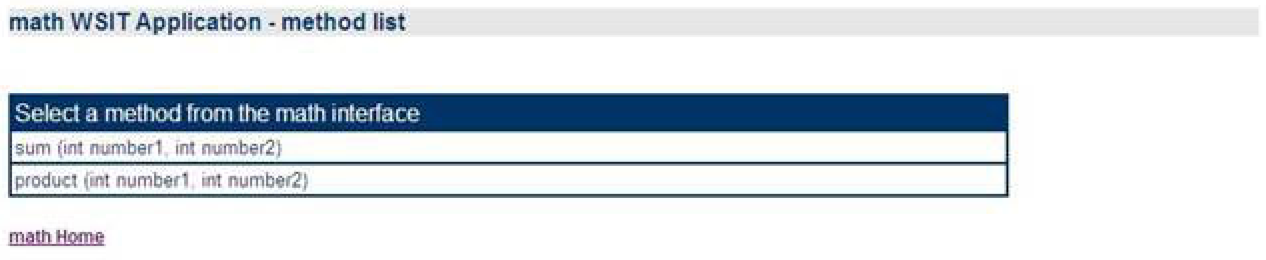
To view the methods in the math application, click "Run the math Application Example" below.
Run the math Application Example

For the latest WSIT documentation, see http://hp.com/products/openvms/wsit/

Note: This sample is not intended to be used directly in a production environment. It is provided as a reference only. Very little bounds checking is done for the fields that you enter. If you have questions about WSIT, please send email to OpenVMS.WebServices@hp.com

The WSIT Engineering Team

Example Web Page 2: The MathJSP Application Methods

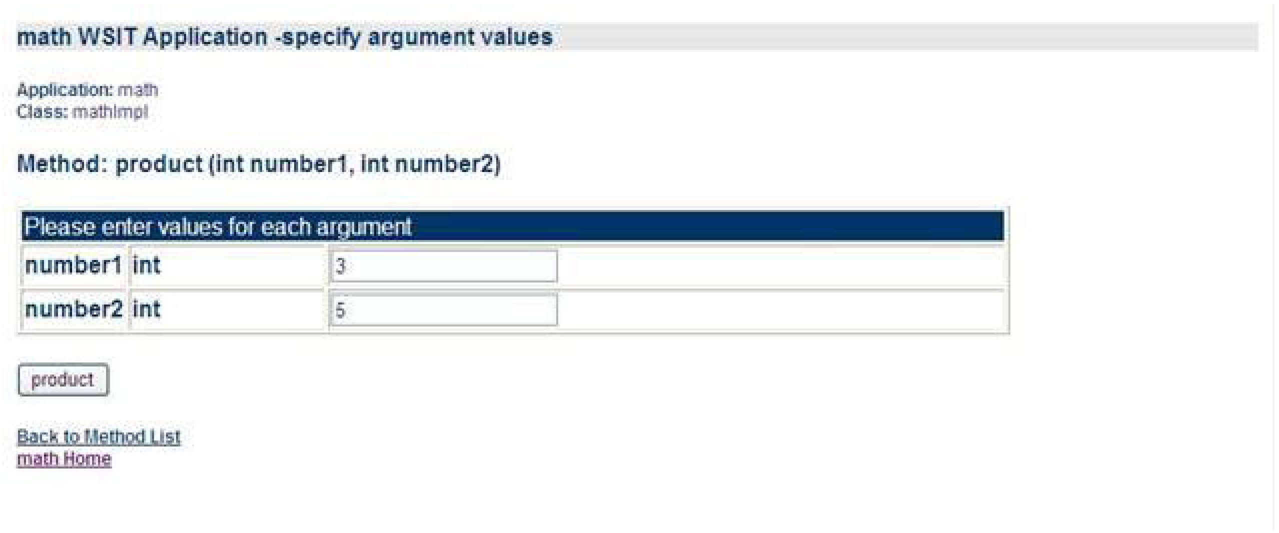


math WSIT Application - method list

Select a method from the math interface
sum (int number1, int number2)
product (int number1, int number2)

math Home

Example Web Page 3: The MathJSP Application Method Product



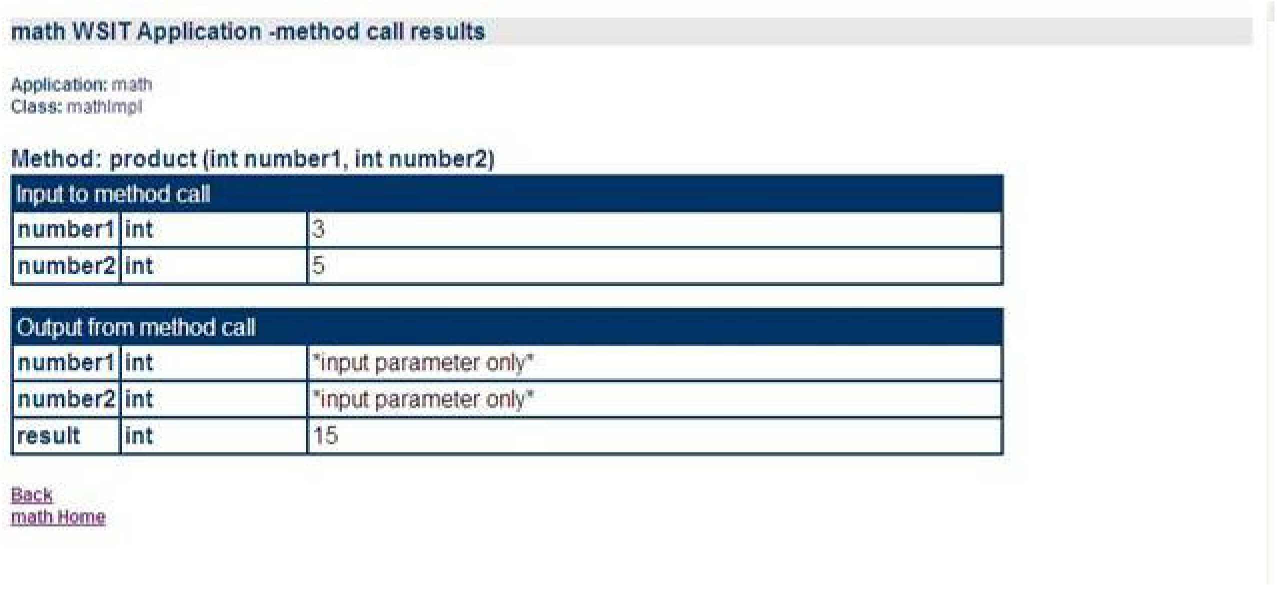
math WSIT Application -specify argument values

Application: math
Class: mathImpl

Method: product (int number1, int number2)

Please enter values for each argument		
number1	int	3
number2	int	5

Example Web Page 4: The MathJSP Application Method Product Results



math WSIT Application -method call results

Application: math
Class: mathImpl

Method: product (int number1, int number2)

Input to method call		
number1	int	3
number2	int	5

Output from method call		
number1	int	*input parameter only*
number2	int	*input parameter only*
result	int	15

Using the generated AXIS2 client sample:

The AXIS2 web service sample must first be built as shown below. (This is similar to the POJO sample.) The generated DCL command procedure that builds the web service uses the Ant tool. This tool can be downloaded from the OpenVMS web site.

```
$ @[.generated.mathSamples.Service]build-service
Begin web service build procedure.
Buildfile: build.xml
     [echo] Building against WSIT application jar file =
/wsi$root/samples/c/generated/math/math.jar
     [echo] Building against Axis2 libraries in directory = /AXIS2$ROOT/lib
     [echo] Web Service name = mathService
     [echo] Build directory = build
```

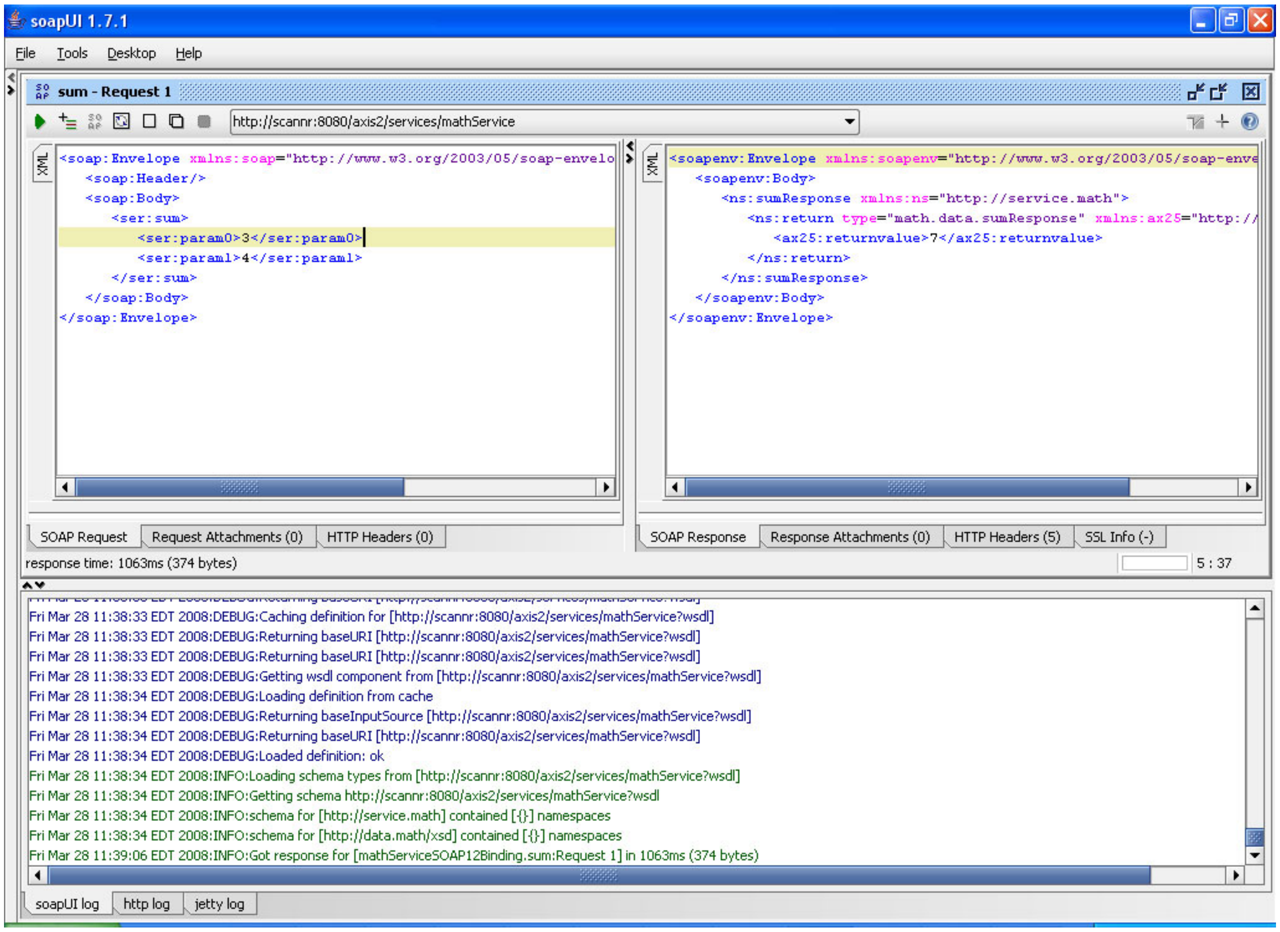
```
cleanService:

prepare:
    [mkdir] Created dir:
/wsi$root/samples/c/generated/mathSamples/Service/build
    [mkdir] Created dir:
/wsi$root/samples/c/generated/mathSamples/Service/build/lib
    [mkdir] Created dir:
/wsi$root/samples/c/generated/mathSamples/Service/build/mathService
    [mkdir] Created dir:
/wsi$root/samples/c/generated/mathSamples/Service/build/mathService/META-INF
    [mkdir] Created dir:
/wsi$root/samples/c/generated/mathSamples/Service/build/mathService/lib

generate.service:
     [copy] Copying 1 file to
/wsi$root/samples/c/generated/mathSamples/Service/build/mathService/META-INF
     [copy] Copying 1 file to
/wsi$root/samples/c/generated/mathSamples/Service/build/mathService/lib
    [javac] Compiling 2 source files to
/wsi$root/samples/c/generated/mathSamples/Service/build/mathService
    [javac] Compiling 1 source file to
/wsi$root/samples/c/generated/mathSamples/Service/build/mathService
      [jar] Building jar:
/wsi$root/samples/c/generated/mathSamples/Service/build/mathService.aar
     [echo]
     [echo] To deploy this web service, verify the build was successful and
copy
     [echo] the archive file to the Axis2 deployment directory
     [echo]      For Example:
     [echo]      $ copy [.build]mathService.aar  TOMCAT$ROOT:[webapps.axis2.WEB-
                   INF.services]
     [echo]

BUILD SUCCESSFUL
Total time: 26 seconds
End of web service build procedure.
```

To test the web service and associated WSIT application, you can use any web service client and any platform. SOAPUI is a free and very useful tool. It is the available from http://soapui.com/. The figure below shows the tool being used to execute the generated web service.



```
<soap:Envelope xmlns:soap="http://www.w3.org/2003/05/soap-envelo
   <soap:Header/>
   <soap:Body>
      <ser:sum>
         <ser:param0>3</ser:param0>
         <ser:param1>4</ser:param1>
      </ser:sum>
   </soap:Body>
</soap:Envelope>
```

```
<soapenv:Envelope xmlns:soapenv="http://www.w3.org/2003/05/soap-enve
   <soapenv:Body>
      <ns:sumResponse xmlns:ns="http://service.math">
         <ns:return type="math.data.sumResponse" xmlns:ax25="http://
            <ax25:returnvalue>7</ax25:returnvalue>
         </ns:return>
      </ns:sumResponse>
   </soapenv:Body>
</soapenv:Envelope>
```

response time: 1063ms (374 bytes)

```
Fri Mar 28 11:38:33 EDT 2008:DEBUG:Caching definition for [http://scannr:8080/axis2/services/mathService?wsdl]
Fri Mar 28 11:38:33 EDT 2008:DEBUG:Returning baseURI [http://scannr:8080/axis2/services/mathService?wsdl]
Fri Mar 28 11:38:33 EDT 2008:DEBUG:Returning baseURI [http://scannr:8080/axis2/services/mathService?wsdl]
Fri Mar 28 11:38:33 EDT 2008:DEBUG:Getting wsdl component from [http://scannr:8080/axis2/services/mathService?wsdl]
Fri Mar 28 11:38:34 EDT 2008:DEBUG:Loading definition from cache
Fri Mar 28 11:38:34 EDT 2008:DEBUG:Returning baseInputSource [http://scannr:8080/axis2/services/mathService?wsdl]
Fri Mar 28 11:38:34 EDT 2008:DEBUG:Returning baseURI [http://scannr:8080/axis2/services/mathService?wsdl]
Fri Mar 28 11:38:34 EDT 2008:DEBUG:Loaded definition: ok
Fri Mar 28 11:38:34 EDT 2008:INFO:Loading schema types from [http://scannr:8080/axis2/services/mathService?wsdl]
Fri Mar 28 11:38:34 EDT 2008:INFO:Getting schema http://scannr:8080/axis2/services/mathService?wsdl
Fri Mar 28 11:38:34 EDT 2008:INFO:schema for [http://service.math] contained [{}] namespaces
Fri Mar 28 11:38:34 EDT 2008:INFO:schema for [http://data.math/xsd] contained [{}] namespaces
Fri Mar 28 11:39:06 EDT 2008:INFO:Got response for [mathServiceSOAP12Binding.sum:Request 1] in 1063ms (374 bytes)
```

1.7 Using Ant with the Web Services Integration Toolkit

The Web Services Integration Toolkit provides the capability to use Ant to automate the tasks for exposing your application (described in Section 1.4). Ant is a powerful Java-based build tool that is an open source Apache project. Ant is platform independent and highly extendable.

The build scripts are XML files containing targets and specifying tasks and properties.

To download Ant, see the Ant for HP OpenVMS web site at http://h71000.www7.hp.com/openvms/products/ips/ant/.

For more information about Ant, see the web site for the Apache Ant Project at http://ant.apache.org and the *Ant Manual* at http://ant.apache.org/manual/index.html.

1.7.1 Ant Setup

For WSIT V2.0 and earlier:

The Web Services Integration Toolkit includes its own binary distribution of Ant 1.6.5. To set up Ant, establish the foreign command by entering the following command:

```
$ ant == "@WSI$ROOT:[tools.ant]ant.com"
```

1.7.2 Configuring the wsit-ant-user.properties File

Before you run Ant to build your application, you must configure the wsit-ant-user.properties file by specifying a set of property values. Perform the following steps to complete the configuration:

1. Copy the wsit-ant-user.properties file from WSI$ROOT:[tools.ant] to your local directory where you will be running the Ant build procedure.

2. Set the application type property to be one of the following, based on the kind of application you are building:

3GL.with.OBJ
3GL.with.IDL
ACMS.with.STDL

For detailed Ant property descriptions, see Section 1.7.4.

3. Specify values for all required properties for the kind of application you are building, in the section marked “BEGIN properties for …”.

4. Specify values for properties in the section “BEGIN COMMON properties to customize.”

1.7.3 Using the wsit-ant-userbuild.xml Build File

After you have configured the properties, you can build the full WSIT application and any generated sample clients by copying the wsit-ant-userbuild.xml file from wsi$root:[tools.ant] to your local directory and executing the following command:

```
$ ant "-f wsit-ant-userbuild.xml"
Buildfile: wsit-ant-userbuild.xml

checkinput:
     [echo] Verifying properties ...

getidl:
     [echo] Calling obj2idl ...

obj2idl:
     [echo] Creating XML IDL file ...
  [obj2idl] WSIT IDL Generator version is: V1.0

validate:
     [echo] Validating XML IDL file ...
     [java] XML file validated successfully

idl2code:
 [idl2code] %WSI-I-GENCREOUT, The specified Output directory does not exist,
creating /WSI$ROOT/samples/c/generated
 [idl2code] %WSI-I-GENCREOUT, The specified Package directory does not exist,
creating /WSI$ROOT/samples/c/generated/math
 [idl2code] %WSI-I-GENCREOUT, The specified Server directory does not exist,
creating /WSI$ROOT/samples/c/generated/mathServer
 [idl2code] %WSI-I-GENCREOUT, The specified Samples directory does not exist, creating
/WSI$ROOT/samples/c/generated/mathSamples
 [idl2code] File: /WSI$ROOT/samples/c/generated/mathServer/build-math-server.com
```

```
generated.
 [idl2code] File: /WSI$ROOT/samples/c/generated/mathServer/methIds.h generated.
 [idl2code] File: /WSI$ROOT/samples/c/generated/mathServer/structkeys.h
generated.
 [idl2code] File: /WSI$ROOT/samples/c/generated/mathServer/math.wsi generated.
 [idl2code] File: /WSI$ROOT/samples/c/generated/mathServer/math.opt generated.
 [idl2code] File: /WSI$ROOT/samples/c/generated/mathServer/math-server.h generated.
 [idl2code] File: /WSI$ROOT/samples/c/generated/mathServer/math-server.c generated.
 [idl2code] File: /WSI$ROOT/samples/c/generated/math/build-math-jb.com generated.
 [idl2code] File: /WSI$ROOT/samples/c/generated/math/Imath.java generated.
 [idl2code] File: /WSI$ROOT/samples/c/generated/math/mathImpl.java generated.
 [idl2code] %WSI-I-GENCREOUT, The specified directory does not exist, creating
/WSI$ROOT/samples/c/generated/mathSamples/POJO
 [idl2code] File: /WSI$ROOT/samples/c/generated/mathSamples/POJO/mathMain.java
generated.
 [idl2code] File: /WSI$ROOT/samples/c/generated/mathSamples/POJO/build-math-
PoJoClient.com generated.
 [idl2code] %WSI-I-GENCREOUT, The specified directory does not exist, creating
/WSI$ROOT/samples/c/generated/mathSamples/JSP
 [idl2code] File: /WSI$ROOT/samples/c/generated/mathSamples/JSP/index.html generated.
 [idl2code] File: /WSI$ROOT/samples/c/generated/mathSamples/JSP/sessiontimeout.html
generated.
 [idl2code] File: /WSI$ROOT/samples/c/generated/mathSamples/JSP/mathMethodList.jsp
generated.
 [idl2code] File: /WSI$ROOT/samples/c/generated/mathSamples/JSP/mathPopulate.jsp
generated.
 [idl2code] File: /WSI$ROOT/samples/c/generated/mathSamples/JSP/mathDoCall.jsp
generated.
 [idl2code] File: /WSI$ROOT/samples/c/generated/mathSamples/JSP/mathVerify.jsp
generated.
 [idl2code] File: /WSI$ROOT/samples/c/generated/mathSamples/JSP/build-math-JspClient.com
generated.
 [idl2code] %WSI-I-GENCREOUT, The specified directory does not exist, creating
/WSI$ROOT/samples/c/generated/mathSamples/JSP/WEB-INF
 [idl2code] File: /WSI$ROOT/samples/c/generated/mathSamples/JSP/WEB-INF/web.xml
generated.
 [idl2code] *** Application math generated! ***

buildserver:
     [echo] Building server ...
     [echo] /WSI$ROOT/samples/c/generated/mathServer
     [echo] @build-math-server.com
     [exec] Begin server build procedure.
     [exec]   ..configuring switches and compiler options
     [exec]   ..compiling native server code
     [exec]   ..linking shareable image
     [exec]   ..installing server image
     [exec] End server build procedure.

buildjavabean:
     [echo] Building Java Bean ...
     [exec] Begin java bean build procedure.
     [exec]   ..Compiling structure classes
     [exec]   ..Compiling math Interface classes
     [exec]   ..Creating math.JAR file from classes
     [exec] End of JavaBean build procedure.

buildpojoclient:
     [echo] Building Sample POJO Client ...
    [javac] Compiling 1 source file to
WSI$ROOT/samples/c/generated/mathSamples/POJO
      [jar] Building jar:
WSI$ROOT/samples/c/generated/mathSamples/POJO/mathClient.jar
     [echo]
     [echo]     To run this client, type the following commands:
     [echo]
     [echo]                 $ @wsi$root:[tools]wsi-setenv - wsi$dev
     [echo]                 $ @wsi$root:[tools]wsi-setenv -
/WSI$ROOT/samples/c/generated/math/math.jar
     [echo]                 $ @wsi$root:[tools]wsi-setenv -
/WSI$ROOT/samples/c/generated/mathSamples/POJO/mathClient.jar
     [echo]                 $ java "math.mathMain"
     [echo]


buildjspclient:
     [echo] Building Sample JSP Client ...
     [exec] Begin JSP client build procedure.
     [exec] Unpacking static files into current location.
     [exec] Copying math.jar into local [.WEB-INF.lib] directory
     [exec] Creating mathjsp.war file
     [exec] End of JSP client build procedure.
     [exec] To deploy this client:
     [exec]     Copy WSI$ROOT:[SAMPLES.C.GENERATED.MATHSAMPLES.JSP]mathjsp.war nto the
deployment
     [exec]     directory for your JSP server.

buildall:
     [echo]
     [echo]     Completed building the math application ...
     [echo]

BUILD SUCCESSFUL
Total time: 1 minute 1 second
$
```

To run a specific target only (for example, the help target), execute the following command in the directory where the build file is located. (For detailed target descriptions, see Section 1.7.5.)

Note: The file wsit-ant-userbuild.xml cannot be used with versions of WSIT earlier than V1.1.

```
$ ant "-f wsit-ant-userbuild.xml help"

Buildfile: wsit-ant-userbuild.xml

help:
[echo]
[echo]     [echo]     Most useful targets:
[echo]
[echo]     buildall        :  Executes all of the targets in this build file.
[echo]     obj2idl         :  Creates IDL file from the 3GL application's object module
                              (IA64 only).
[echo]     stdl2idl        :  Creates IDL file from the ACMS application's STDL file.
```

```
[echo]     validate        :  Verifies the application's IDL file conforms to the
                              schema.
[echo]     idl2code        :  Creates a WSIT server interface wrapper, a WSIT Java Bean
                              and sample client code.
[echo]     buildserver     :  Builds a shareable image by linking the WSIT server
wrapper
                              with the application.
[echo]     buildjavabean   :  Creates a jar file that contains the WSI Java classes to
                              call the server.
[echo]     buildpojoclient :  Builds the generated POJO client code to call the
                              application.
[echo]     buildjspclient  :  Builds the generated JSP client code to call the
                              application.

[echo]     Note: You will need to customize your property values in wsit-ant-
user.properties before running ant
[echo]

BUILD SUCCESSFUL
Total time: 2 seconds
$
```

1.7.4 Ant Property Descriptions

Required: Set the apptype property, which specifies application type, to one of the following values:

3GL.with.OBJ
3GL.with.IDL
ACMS.with.STDL

Name	Description	Value of apptype
apptype	A 3GL application based on an object (OBJ) file, compiled DEBUG (I64 only, not supported on Alpha).	3GL.with.OBJ
	A 3GL application based on an IDL file that you have already written or generated.	3GL.with.IDL
	An ACMS application based on the application's STDL file.	ACMS.with.STDL

Properties for applications of type **3GL.with.OBJ**. **Required** if apptype is set to 3GL.with.OBJ.

Name	Description	Value (example)
obj.file	Specific location and name of object file (compiled debug) from which WSIT will generate IDL.	/disk$ods5/math/source/math.obj
idl.file	Specific location and name of idl file that WSIT will generate using the target OBJ2IDL.	/disk$ods5/math/source/math.xml

Properties for applications of type **3GL.with.IDL**. **Required** if apptype is set to 3GL.with.IDL.

Name	Description	Value (example)
idl.file	Specific location and name of idl file that WSIT will use to generate a JavaBean wrapper.	/disk$ods5/math/source/math.xml

Properties for applications of type **ACMS.with.STDL**. **Required** if apptype is set to ACMS.with.STDL.

Name	Description	Value (example)
Stdl.file	Specific location and name of ACMS STDL file from which WSIT will generate IDL.	/disk$ods5/math/source/math.stdl

idl.file	Specific location and name of idl file that WSIT will generate using the target STDL2IDL.	/disk$ods5/math/source/math.xml

Common properties for all types of applications. (**Required**)

Name	Description	Value (example)
appname	Specify your application name.	Math
build.dir	Specifiy the root of a directory that WSIT should use when generating code.	/disk$ods5/math/generated

Common properties for all types of applications. (**Optional**)

Name	Description	Value (actual)
sample.POJO	Specify if sample POJO client that illustrates how to call the WSIT generated JavaBean should be generated.	True/False
sample.JSP	Specify if sample JSP client that illustrates how to call the WSIT generated JavaBean should be generated.	True/False

1.7.5 Ant Target Descriptions

Name	Description
`buildall`	Executes all of the targets in this build file.
`Obj2idl`	Creates IDL file from the 3GL application's object module (IA64 only).
`Stdl2idl`	Creates IDL file from the ACMS application's STDL file.
`validate`	Verifies the application's IDL file conforms to the schema.
`idl2code`	Creates a WSIT server interface wrapper, a WSIT Java Bean and sample client code.
`buildserver`	Builds a shareable image by linking the WSIT server wrapper with the application.
`buildjavabean`	Creates a jar file that contains the WSI Java classes to call the server.
`buildpojoclient`	Builds the generated POJO client code to call the application.
`buildjspclient`	Builds the generated JSP client code to call the application.
`checkinput`	Verifies all properties have been correctly set.
`getidl`	Determines if IDL file exists, if not calls appropriate target to generate it, and then validates it.
`Help`	Displays help information.

1.7.6 Custom Ant Tasks

WSIT defines custom ant tasks for the IDL2CODE, OBJ2IDL, and STDL2IDL tools.

1.7.6.1 IDL2CODE Task

Runs the Generator (IDL2CODE) to create a server wrapper for the application and a JavaBean client.

1.7.6.2 IDL2CODE Parameters

Attribute	Description	Type
idlfile	Required. Filespec for XML IDL file describing the application to wrap.	java.lang.String
appname	Required. Name to be given to the WSIT generated application.	java.lang.String
outdir	Optional. Directory in which to generate the wrapper files.	java.lang.String
authenticate	Optional. Force OpenVMS authentication to be used with this interface.	boolean
javadoc	Optional. Create JavaDoc based documentation for the generated interface.	boolean

tracinglevel	Optional. Ouput tracing information at runtime, specify level 1 to 5.	int
samplePOJO	Optional. Generate sample POJO client for the generated interface.	boolean
sampleJSP	Optional. Generate sample JSP client for the generated interface.	boolean

1.7.6.3 OBJ2IDL Task

Runs the OBJ2IDL tool to generate an XML interface definition from a 3GL application's object module (I64 only).

1.7.6.4 OBJ2IDL Parameters

Attribute	Description	Type
objfile	Required. Filespec for the object module.	java.lang.String
outfile	Optional. Filespec for XML IDL output file.	java.lang.String
mapfile	Optional. Filespec for map file, default is wsi$root:[tools]openvms-basetypes.xml.	java.lang.String
version	Optional. Display version information for this tool.	boolean

1.7.6.5 STDL2IDL Task

Runs the STDL2IDL tool to generate an XML interface definition from an ACMS application's STDL file.

1.7.6.6 STDL2IDL Parameters

Attribute	Description	Type
stdlfile	Required. Name of the STDL file to parse.	java.lang.String
idlfile	Optional. Filespec for XML IDL output file (relative paths are not supported).	java.lang.String
version	Optional. Display version information for this tool.	boolean

1.8 Using Distributed NetBeans with the Web Services Integration Toolkit

With the Web Services Integration Toolkit and Distributed NetBeans for OpenVMS working together, you can do the following:

- Edit text files generated by the WSIT tools using Distributed NetBeans and a remote FTP filesystem
- Remotely compile your language source files
- Remotely execute DCL command procedures
- Remotely execute Ant scripts

For more information about remote operations and Distributed NetBeans in general, see the Distributed NetBeans online help. The online help is available when you install Distributed NetBeans on your desktop system, and from http://h71000.www7.hp.com/openvms/products/ips/netbeans/documents.html

1.8.1 WSIT Build Templates

The WSIT Build Template files are included with Distributed NetBeans so that you can use the NetBeans template system to create your WSIT build script and property file from within Distributed NetBeans. To create your WSIT Ant build script and property file using the template, perform the following steps:

1. Select the remote directory in the filesystem explorer where you would like to place the build template, right mouse click and select New/All Templates.

2. Select WSIT Templates/WSIT-Build Ant Script Files. Click Next.
3. Name your script, and click OK.

Two files are created in your directory: an Ant build script that is named according to the previous step, and a property file named wsit-ant-user.properties. You must now customize the property file for your application. Follow the instructions in the property file to customize. In addition, you can customize the Ant build script if desired.

Once you have completed your modifications to the build script and property file for your application, you should modify the version of Ant that will used to remote execute your Ant script.

1.8.2 Using the WSIT-Supplied Ant Version

Earlier versions of WSIT bundled the Ant tool. Beginning in V3.0, WSIT no longer includes Ant. The Ant tool is now available as a separate PCSI kit. To download Ant, see http://h71000.www7.hp.com/openvms/products/ips/ant/.

1.9 Security Considerations

The Web Services Integrated Toolkit provides an easy to use set of utilities that can turn standalone applications into distributed applications, making them more widely accessible. While this is great, this new found accessibility may raise security concerns. Because of this, WSIT implements 2 different ways of restricting access to a wrapped application and/or the system resources that the application accesses.

Depending on the environment and the granularity needed, you can either set a blanket setting within the server process that all users are restricted to, or you can force all users to login using their own account.

Each is discussed below.

1.9.1 Server Process Security

In an application environment where the application's generated JavaBean and server wrapper are run in two different processes, you can specify under which OpenVMS account the server process is to run. You do this by modifying the <Account> attribute within the deployment descriptor (.wsi file) associated with the application, as shown in the following example. (The deployment descriptors can be found in the WSI deployment directory, wsi$root:[deploy].)

```
<!-- Server Application Options -->
<Account>MyAccount</Account> <!-- Name of the account the server runs in -->
```

Note: When the <Account></Account > property is not specified within the application deployment configuration file (.wsi), WSIT runs the out-of-process servers in the same account that the wsi$manager is running from. In most cases, this is the SYSTEM account.

This method of restricting access has an application level granularity. This means that all of the application's server processes run under the specified account. For example, you can set up the Payroll application to always run under the Payroll account regardless who is connecting to it.

The server process method of restricting access has both pros and cons, as follows:
Reasons to use server process security:

- It is fast and easy to change during and after deployment.
- All users of a given application have the same access to the system.
- Requires no change to the client.
- Users do not need their own account to use the application.

Potential problems with server process security:

- Does not keep users from accessing the application itself.
- Makes no distinction between users.
- Specified accounts require minimum privileges.
- Requires the JavaBean and server wrapper to run in two different processes.

1.9.2 **Per User Security**

If you need to restrict access to the application itself, or need a finer granularity in limiting access to system resources, you can do that by using the optional per user security. You choose this at generation time by specifying the –L switch on the IDL2CODE command line. When you specify this option, WSIT generates an application with two additional methods in the interface, as follows:

```
OpenVmsLogin (username, password)
OpenVmsLogout()
```

Note: POJO clients are not supported when the -L switch is used on the IDL2CODE command line.

Applications that have these methods in the interface can only be accessed after OpenVmsLogin() has been successfully called. (The error “Must login first” is returned until a successful login occurs.) After the user has successfully logged into an account, that account’s privileges and quotas are used when calling into the application. This means that resources used by the application can be protected on a per user basis.

The per user method of restricting access has both pros and cons, as follows:

Reasons to use per user security:

- Distinguishes between users, allowing better access control over resources.
- Can block access to the application itself.
- Works whether the JavaBean and server wrapper are in the same process or different processes.

Potential problems with per user security:

- Decision to use must be made at code generation time.
- Requires client to call Login and Logout methods.
- All users require an OpenVMS account in order to access the application.

1.10 **WSIT Tools and Parameters**

OBJ2IDL

Usage: obj2idl <parameters>

Required Parameters:

-f	Specify the object file name along with its location

Optional Parameters:

-m	Specify the map file name along with its location. Default is wsi$root:[tools]openvms-basetypes.xml
-o	Specify the output file name along with its location.
-v	Version information.

VALIDATE

Usage: validate <parameters>

Required Parameters:

-x xmlfile	Location and name of the xml file to be validated.
-s schemafile	Location and name of a schema file (usually .xsd) used to validate the XML.

IDL2CODE

Usage: idl2code <parameters>

Required Parameters:

-i <IDL filespec>	XML IDL file describing the application to wrap.
-a <Application Name>	Name to be given to the WSIT-generated application.

Optional Parameters:

-o <Output Directory>	Directory in which to generate the wrapper files.
-p <Velocity prop file>	Velocity properties file to replace WSIT templates.
-l	Require OpenVMS authentication to be used with this interface.

POJO clients do not work with the –l parameter. See Section 1.9.2 for more information.

-j	JavaDoc-based documentation for the generated interface.
-d <Tracing Level>	Output tracing information while the generator is running, 1 -> 5.
-w	Generate the Web Services interface classes.
-c <S|J>	Generate sample client(s) for the generated interface.
-v	Print out the version number for this generator.
-h or –help	Print this list of options.

1.10.1 **In-Process/Out-of-Process Parameters**

JSP and POJO (Plain Old Java Object) sample clients call the application in-process by default. To load your application in a separate process (out-of-process), do the following:

- For a JSP sample client: Specify “outproc” as P1 on the command line when building the JSP sample client.

- For a POJO sample client: Specify “-o” when running the POJO client.

1.10.2 **POJO or JSP Sample Client Parameters**

The optional switch –c is provided to tell the WSIT generator (IDL2CODE) to generate a sample client with a command line interface (S) or generate a sample client with a JSP interface (J). These samples are provided to make testing and development with WSIT easier.

Specifying –c S generates only the POJO command line client. Specifying –c J generates only the JSP client, and –c SJ generates both kinds of clients.

1.11 **OBJ2JAVA.COM**

For your convenience, the WSIT samples directory contains a command procedure called OBJ2JAVA.COM that can generate a WSIT application by issuing the various commands for the different WSIT tools. The procedure has symbols that can be modified to custom build a WSIT application. These symbols control the most often used features of the WSIT product, such as sample generation, tracing and authentication. They are documented in the procedure.

For example:

```
$ @WSI$ROOT:[SAMPLES]OBJ2JAVA.COM

*** issuing command: obj2idl -f WSI$ROOT:[samples.c]math.OBJ;4

*** issuing command: java -jar wsi$root:[tools]validate.jar -x
WSI$ROOT:[samples.c]math.xml -s wsi$root:[tools]openvms-integration.xsd
XML file validated sucessfully

*** issuing command: java "com.hp.wsi.Generator" -i WSI$ROOT:[samples.c]math.xml -a
mathSample  -o [.generatedmathSample]  -c S
The New JAVA$CLASSPATH is:
   "JAVA$CLASSPATH" = "WSI$ROOT:[lib]WSIRTL.JAR" (LNM$JOB_894EAAC0)
        = "[]"
        = "WSI$ROOT:[lib]VELOCITY-DEP-1_4.JAR"
        = "WSI$ROOT:[tools]idl2code.JAR"
%WSI-I-GENCREOUT, The specified Samples directory does not exist, creating
/wsi$root/samples/generatedmathSample/mathSampleSamples
File: /wsi$root/samples/generatedmathSample/mathSampleServer/build-mathSample-
server.com generated.
File: /wsi$root/samples/generatedmathSample/mathSampleServer/methIds.h generated.
File: /wsi$root/samples/generatedmathSample/mathSampleServer/structkeys.h generated.
File: /wsi$root/samples/generatedmathSample/mathSampleServer/mathSample.wsi generated.
File: /wsi$root/samples/generatedmathSample/mathSampleServer/mathSample.opt generated.
File: /wsi$root/samples/generatedmathSample/mathSampleServer/mathSample-server.h
generated.
File: /wsi$root/samples/generatedmathSample/mathSampleServer/mathSample-server.c
generated.
File: /wsi$root/samples/generatedmathSample/mathSample/build-mathSample-jb.com
generated.
File: /wsi$root/samples/generatedmathSample/mathSample/ImathSample.java generated.
File: /wsi$root/samples/generatedmathSample/mathSample/mathSampleImpl.java generated.
%WSI-I-GENCREOUT, The specified directory does not exist, creating
/wsi$root/samples/generatedmathSample/mathSampleSamples/POJO
File: /wsi$root/samples/generatedmathSample/mathSampleSamples/POJO/mathSampleMain.java
generated.
File: /wsi$root/samples/generatedmathSample/mathSampleSamples/POJO/build-mathSample-
PoJoClient.com generated.
*** Application mathSample generated! ***

*** issuing command: @[.generatedmathSample.mathSample]BUILD-mathSample-JB
Begin java bean build procedure.
  ..Compiling structure classes
  ..Compiling mathSample Interface classes
  ..Creating mathSample.JAR file from classes
End of JavaBean build procedure.

*** issuing command: @[.generatedmathSample.mathSampleserver]BUILD-mathSample-SERVER
Begin server build procedure.
  ..configuring switches and compiler options
  ..compiling native server code
  ..linking shareable image
  ..installing server image
End server build procedure.

*** issuing command: @wsi$root:[tools]wsi-setenv -
WSI$ROOT:[samples.generatedmathSample.mathSample]mathSample.jar
The New JAVA$CLASSPATH is:
   "JAVA$CLASSPATH" = "WSI$ROOT:[lib]WSIRTL.JAR" (LNM$JOB_894EAAC0)
        = "[]"
        = "WSI$ROOT:[lib]VELOCITY-DEP-1_4.JAR"
        = "WSI$ROOT:[tools]idl2code.JAR"
        = "WSI$ROOT:[SAMPLES.GENERATEDMATHSAMPLE.MATHSAMPLE]MATHSAMPLE.JAR"

*** issuing command: @[.generatedmathSample.mathSampleSamples.POJO]build-mathSample-
PoJoClient
Begin client build procedure.
  ..Compiling mathSampleMain client class
  ..Packaging client class(es) into jar file, mathSampleClient.jar
End of client build procedure.

To run this client, type the following at the command line:

     $ @wsi$root:[tools]wsi-setenv -
WSI$ROOT:[samples.generatedmathSample.mathSampleSamples.POJO]mathSampleClient.jar
     $ java "mathSample.mathSampleMain"
$
```

2 DEPLOYMENT CONSIDERATIONS

2.1 Types of OpenVMS Applications

Applications running on OpenVMS systems can be roughly divided into two groups, as follows:

- Applications designed for a single client environment
- Applications that can be called by multiple clients

The first group, applications designed for a single client environment, are often older OpenVMS applications that assume a timesharing runtime environment. The user logs into the OpenVMS system, which in turn creates a process. The applications are typically executed entirely in the user's process. In this design, there is a single user (the client). There is an assumed one-to-one relationship between the client and the application.

The second group, applications that can be called by multiple clients, are often newer OpenVMS applications. These applications are designed to serially process multiple clients (one at a time), or to concurrently process multiple clients (all at the same time).

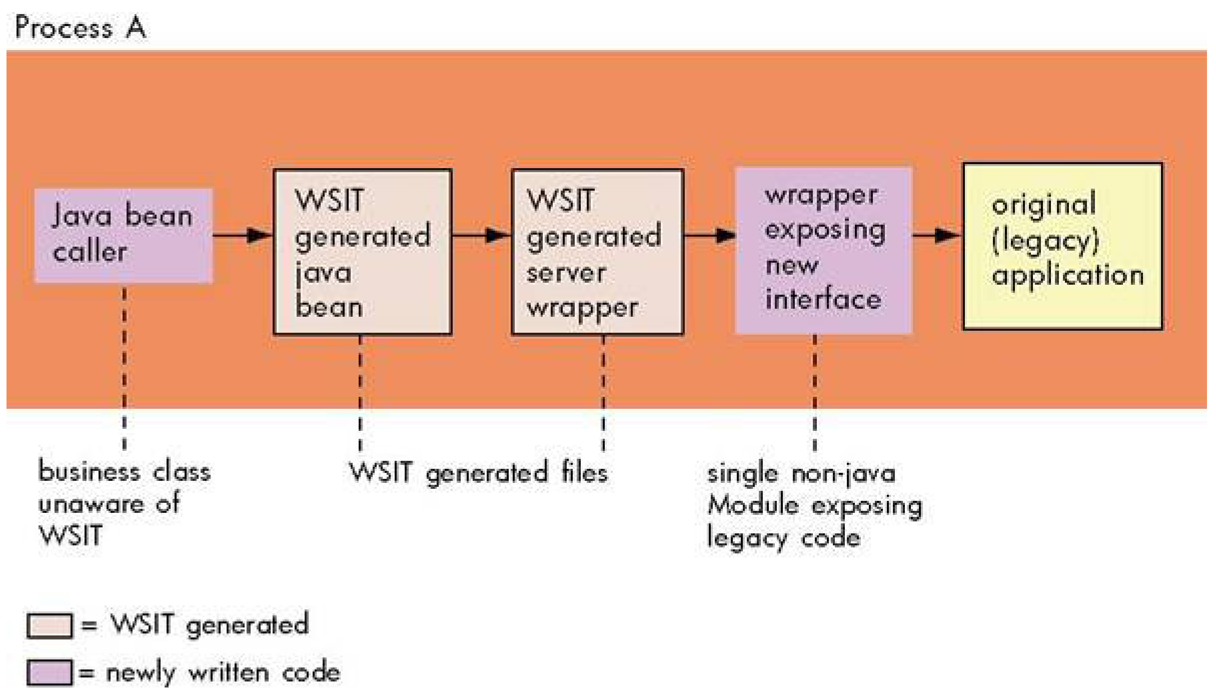
When the Web Services Integration Toolkit exposes an OpenVMS application as a JavaBean, the application becomes callable from the second (newer) design model in which multiple clients can call the application from multiple processes or threads. You should understand in which group your wrapped application belongs (the specific design model) and manage client access to the application accordingly. WSIT provides a number of features to help in managing this interaction, which are discussed in the following sections.

In the following sections, the term application is used to represent the original application being exposed. The term client is used to represent the JavaBean caller which makes calls to the WSIT-generated JavaBean.

2.2 In-Process Deployment

There are two ways in which you can deploy your application using WSIT: in-process deployment and out-of-process deployment.

In-process deployment occurs when the application and the client are called from the same process, as illustrated in the following diagram.


Process A
Java bean caller
WSIT generated java bean
WSIT generated server wrapper
wrapper exposing new interface
original (legacy) application
business class unaware of WSIT
WSIT generated files
single non-java Module exposing legacy code
= WSIT generated
= newly written code

There are advantages and disadvantages to using in-process deployment.

Advantages: Fastest return time for client calls to application. No overhead added by the WSIT runtime.

Disadvantages: A crash will bring down all components in the process (client and application).

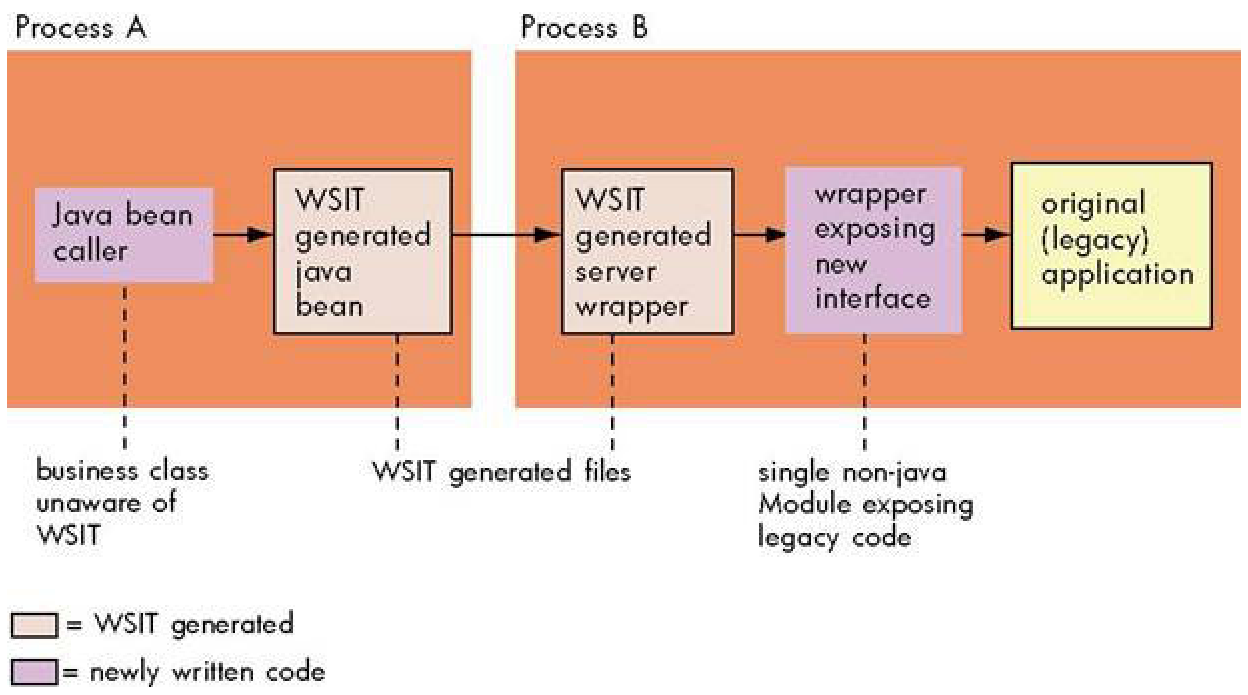
There are no WSIT deployment settings for in-process applications --
the interaction between the client and the application is not managed by the WIST runtime. In-process deployment provides the fastest execution time, but it requires that the developer ensure that the client does not establish an environment in which the application will fail.

For example, some J2EE application servers may use multiple threads to call the client. This requires that the developer determine if the application can successfully operate in this environment. If the developer determines that the application can only support one client at a time, then the client must use a mechanism to order the calls before they are sent to the application (via the WSIT-generated objects).

If you do not specify out-of-process deployment settings (described in the following sections), your application will run in-process by default.

2.3 Out-of-Process Deployment

Out-of-process deployment occurs when the client and application are run in different processes, as illustrated in the following diagram. The WSIT runtime environment manages the interaction between the two processes. You can customize this environment by modifying a deployment descriptor file.



Process A
Process B
Java bean caller
WSIT generated java bean
WSIT generated server wrapper
wrapper exposing new interface
original (legacy) application
business class unaware of WSIT
WSIT generated files
single non-java Module exposing legacy code
= WSIT generated
= newly written code

There are advantages and disadvantages to using out-of-process deployment.

Advantages: Typically scales better than in-process deployments. Allows the use of the WSIT runtime deployment properties.

Disadvantages: Adds complexity and overhead to every call.

Most older applications benefit from using an out-of-process deployment to avoid complex issues that result from mixing older and newer environments. The WSIT deployment properties, described in the following sections, allow out-of-process applications to choose from a wide variety of configurations.

2.3.1 Sessions

A session is the period of time in which a client uses an application. A session can last for:

- The duration of a single call
- The lifetime of the client

The type of session you use should mimic the original design of the application. For example, in older timesharing applications, a session is often the entire time that the client uses the application. In newer applications, the client may use a session to perform a specific task and then declare that it is finished with the session.

WSIT allows the developer to specify when a session with an application begins and when it ends. The WSIT-generated JavaBean has a constructor named <application-name>Impl. For example, the stock sample has a constructor named stockImpl. To establish an out-of-process deployment, call the constructor with an instance of the class WsiIpcContext. The WsiIpcContext constructor can be called with one of three different session types.

1. **LIFETIME_SESSION**: This is the default session type. The session begins when the applications Impl object is created and the session ends when the remove method is called.

2. **NO_SESSION**: The session begins when a method call is made on the application and the session ends when that call returns. The lifetime of the session is a single method call.

3. **TX_SESSION**: The session begins when the client logs into the application by calling the methods AcmsSignIn or OpenVMSLogin of the application Impl object. The session ends when the client calls the methods AcmsSignOut or OpenVMSLogOut.

2.3.2 Application Reusability

The default configuration for all WSIT out-of-process applications is not reusable.

An application is not reusable when it can only be used for one client session. When the session is finished, the application has created state that prevents it from being called again. The next client session requires a new instance of the application.

An application can also be sequentially reusable, concurrently reusable, or concurrently reusable with multiple threads. See Chapter 3 for more information about these types of applications.

2.3.3 Using Multiple Processes to Scale Applications

When deploying an application out-of-process, WSIT allows the creation of a process pool, which is a collection of processes for the application that WSIT manages in the background to improve response time. Each process is running the application. The XML tag <ProcessPooling> is used to configure the properties of the pool.

- Use the tag <MaximumProcesses> to specify an upper limit for the largest number of processes that WSIT can create for the application.

- Use the tag <MinimumProcesses> to specify a lower limit for the fewest number of processes that WSIT should maintain for the application. The number specified will be the number of processes WSIT starts initially.

- Use the tag <MinimumIdleProcesses> to specify the number of non-busy processes to keep on an ongoing basis. WSIT creates more processes as needed to maintain these free processes. WSIT does not create more than <MaximumProcesses> of processes.

- Use the tag <MaxInactivitySeconds> to specify when a process should be removed from the pool and run down. Specify the maximum number of seconds that an application can be idle before it is automatically stopped.

2.3.4 Specifying Out-of-Process Deployment Options

Running your application out-of-process allows you to specify configuration options. These options are contained in the XML file wsi$root:[deploy]application-name.wsi.

The **out-of-process configuration** options are as follows:

Server Application Options	**Description**
Account (Username)	Name of the account you want the server to run in, which determines the access rights and quotas that the server will have. Requires NETMBX and TMPMBX privileges.
WorkingDirectory	Working directory for the server component. This is important if the server component opens files with names relative to some assumed working directory of the application.

SetupCommandFile	File specification of a DCL command file you want to run before the server component starts up.
ServerPath	Location and name of the server component (applications sharable image). If only the name is provided the value of the tag **Working Directory** is used as the location.
StackSize	Stack size to use for each thread within the server component. The default value of 0 means use the default WSIT stack size. The default size is calculated as (*default pthread stack size * 1.5*) OR (*30,000 bytes*), whichever is greater. Single threaded WSIT out-of-process applications can use a size of zero (0) to have the stack size automatically expanded. See Section 3.5 for more information.
Reusable	Default is not reusable. Uncomment this option if the server application is reusable, which means the server can be called by more than one client sequentially. (See Advanced Out-of-Process Configuration chapter.)
MaximumClients	Maximum number of clients handled per server. If the server is not reusable, the default is 1. Modify `MaximumClients` if, in addition to being reusable, the server application process can handle multiple clients concurrently. If this property is greater than 1, the order of client calls coming into the server process is indeterminate. (See Advanced Out-of-Process Configuration chapter.)
MaximumThreads	Maximum number of threads allowed to run concurrently. This option is never greater than `MaximumClients`. If the server is not reusable, the default is 1. Modify `MaximumThreads` if, in addition to being able to handle multiple clients, the server application is also thread safe. (See Advanced Out-of-Process Configuration chapter.)

Server Process Options	**Description**
MaximumProcesses	Defines the maximum number of server processes that are allowed to run concurrently to handle client requests. The total capacity of the application is `MaximumProcesses` multiplied by `MaximumClients`. The default is 5.
MinimumProcesses	Minimum number of server processes that are automatically started to service requests from clients. This value is never greater than `MaximumProcesses`. The default is 0.
MinimumIdleProcesses	Sets the number of server processes that will be maintained as idle to serve requests from clients. As servers become busy, new server processes are started to act as idle servers. The number of idle server processes can reach (but never be greater than) the number of `MaximumProcesses`.
MaxInactivitySeconds	Maximum number of seconds that a server can be idle before it is automatically stopped. The default is 1000 seconds.
MaxStartupSeconds	Maximum number of seconds to wait for a process to startup. Default is 45 seconds.
ClientsWaitForServer	Specifies whether a client request should wait for a server process to become available. If set to 0 (the default), the client request fails with an error if a server is unavailable. If set to 1, the client waits for an available server. Waiting may appear to

	be a hung client if no server processes become available.

2.3.4.1 **Out-of-Process Account Preparation and Requirements**

If you are specifying an account in which to run out-of-process servers, you may want the account to have a minimal amount of privileges.

You can specify an account to run out-of-process servers that has only the NETMBX and TMPMBX privileges. To use an account with these privileges, perform the following steps:

1. Create an identifier within the system UAF with the name WSI$SERVER. (Perform this step one time only.)

2. Grant the WSI$SERVER identifier to each account used to run a WSIT out-of-process server.

If you do not perform these steps, the privileges required by the account are as follows. These privileges must be DEFAULT privileges.

BYPASS
SYSNAM
SYSPRV
IMPERSONATE
DETACH
TMPMBX

2.4 Web Services Integration Toolkit Interfaces

The primary goal of the Web Services Integration Toolkit is to take the interface exposed by a user's application and present it as a Java based interface. These interfaces are defined by their set of routine calls, the parameters passed in and out of these routines, and the mechanisms used to pass those parameters. The following sections discuss this in more detail, and provides a background on the actions WSIT takes to wrap an application and provide it with a new interface.

2.4.1 **Application Interfaces (User Supplied)**

The Application's Programming Interface (API) is where the work begins for WSIT. The application's interface, provided by the user, is parsed by the WSIT tools OBJ2IDL or STDL2IDL. These tools create a WSIT-specific Interface Definition Language (IDL) file describing the application's interface. This definition includes the set of routines included within this interface. For each routine, the IDL describes the parameter list in detail, including the parameter names, the parameter datatypes, and the passing mechanisms used to pass these parameters.

2.4.2 **OpenVMS Datatypes Supported by WSIT**

The datatype specified for each parameter must be one of the following:

- a standard OpenVMS datatype (as defined by the OpenVMS Calling Standard)
- an array of these datatypes
- a structure composed of these datatypes

Internally, WSIT uses the Descriptor datatype definition values, DSC$K_DTYPE_*, to identify all datatypes. However, depending on the language that you are using, these may more readily be recognized as float, double, short, and so on. See the Datatype Mapping section for a table that lists all of the OpenVMS datatypes that WSIT supports, along with their Java type mappings.

2.4.3 Passing Mechanisms

WSIT supports the three passing mechanisms described by the OpenVMS Calling Standard. This standard does not dictate which passing mechanism must be used by a given language compiler. (Note that language semantics and interoperability considerations might require different mechanisms in different situations.) WSIT generates the code needed to pass each parameter using the mechanism specified within the IDL file. The three passing mechanisms are as follows:

- **By "Value"**

An immediate value argument item contains the value of the data item. The argument item, or the value contained in it, is directly associated with the parameter.

- **By "Reference"**

A reference argument item contains the address of a data item such as a scalar, string, array, or structure. This data item is associated with the parameter.

- **By "Descriptor"**

A descriptor argument item contains the address of a descriptor, which contains structural information about the argument's type (such as string length) and the address of a data item. This data item is associated with the parameter.

An example of a C module whose interface has been parsed can be found in:

```
wsi$root:[samples.c]math.c
```

The IDL generated from parsing math.c can be found in the Appendix.

2.4.4 JavaBean Interface (Generated by WSIT)

The previous section discussed what the user's application exposes as an interface and how it gets described. This section discusses the Java based interface that WSIT generates from that description of the user's API. This includes how the OpenVMS datatypes map into Java types, as well as how WSIT accommodates the different passing mechanisms.

For each routine that is exposed by the user's application, a method is generated in the new Java based interface. Although the generated methods are named the same as their routine counterparts, the casing may be different to better accommodate Web Services based clients. The parameters for each method have a 1-to-1 mapping to their user application counterparts. This mapping is discussed in the following section.

2.4.5 Datatype Mapping

When defining the interface within WSIT, you do not regularly need to be concerned with most issues related to datatype conversion. When you specify the OpenVMS datatypes for the parameters, WSIT converts them to appropriate Java types. WSIT converts primitive types from OpenVMS to Java as described in the mapping table below. WSIT also maps arrays of these types to Java arrays, and structures comprising of these types to JavaBean style classes that encapsulate the mapped types.

OpenVMS Type	Description	Java Type	Java In/Out Classes
DSC$K_DTYPE_BU	unsigned byte	byte	ByteHolder

DSC$K_DTYPE_WU	unsigned word	short	ShortHolder
DSC$K_DTYPE_LU	unsigned long	int	IntHolder
DSC$K_DTYPE_QU	unsigned quadword	long	LongHolder
DSC$K_DTYPE_OU	unsigned octaword	BigInteger	BigIntegerHolder
DSC$K_DTYPE_B	Byte	byte	ByteHolder
DSC$K_DTYPE_W	Word	short	ShortHolder
DSC$K_DTYPE_L	Long	int	IntHolder
DSC$K_DTYPE_Q	quadword	long	LongHolder
DSC$K_DTYPE_O	octaword	BigInteger	BigIntegerHolder
DSC$K_DTYPE_F	32bit F float	float	FloatHolder
DSC$K_DTYPE_G	64bit G float	double	DoubleHolder
DSC$K_DTYPE_D	64bit D float	double	DoubleHolder
DSC$K_DTYPE_H	128bit H float	double[1]	DoubleHolder*
DSC$K_DTYPE_FX	128bit IEEE float	double[1]	DoubleHolder*
DSC$K_DTYPE_FS	32bit IEEE float	float	FloatHolder
DSC$K_DTYPE_FT	64bit IEEE float	double	DoubleHolder
DSC$K_DTYPE_T	String[2]	string	StringHolder
DSC$K_DTYPE_VT	varying string	string	StringHolder
DSC$K_DTYPE_NU	decimal string unsigned	BigDecimal	BigDecimalHolder
DSC$K_DTYPE_NL	decimal string left separate sign	BigDecimal	BigDecimalHolder
DSC$K_DTYPE_NLO	decimal string left overpunch sign	BigDecimal	BigDecimalHolder
DSC$K_DTYPE_NR	decimal string right separate sign	BigDecimal	BigDecimalHolder
DSC$K_DTYPE_NRO	decimal string right overpunch	BigDecimal	BigDecimalHolder

	sign		
DSC$K_DTYPE_NZ	decimal string zoned	BigDecimal	BigDecimalHolder
DSC$K_DTYPE_P	Packed-decimal	BigDecimal	BigDecimalHolder
DSC$K_DTYPE_V	aligned bit	boolean	BooleanHolder
DSC$K_DTYPE_ADT	Absolute Date & Time	calendar	CalendarHolder

[1] 128 bit floating point datatypes are mapped to doubles within Java, limiting their range and precision.

[2] See Section 2.4.5.1 for a detailed description of the String datatype.

Note: All unsigned integer types are mapped to their signed counterparts when converted. This shifts the range of values that can be represented by a given datatype. For example, an unsigned word, which has a range of 0 to 65535, is mapped to a short, which has a range of 32767 to -32768. Be sure to account for this in your client if the values are expected to exceed those of the signed counterpart.

2.4.5.1 **String Datatype**

There are three attributes associated with the string datatype (DSC$K_DTYPE_T) within the IDL, as follows:

Size The string size required by the routine being called. WSIT truncates or pads as needed to make the passed in string the size specified. (Note that a specified size of 0 means that the size is dynamic, and that the called routine can handle any size string. It is assumed that the routine has some other way of determining the size of the passed in string, such as another argument, or by using the null terminator.)

NullTerminatedFlag This flag specifies that a null terminator is to be put into the string after the last significant character of the string. If a size is specified and padding is required, the padding occurs after the null character. If a size is specified and truncation is required, then one extra byte is truncated to make room for the null character.

FixedFlag This informational flag specifies how to interpret the size attribute. If a size is specified, then this flag should be set to 1 to indicate that the string has a fixed size. If the size is 0, then this should be set to 0 to specify that the string has a dynamic size. (Note that this attribute is not used by the WSIT Generator.)

For example:

```
<Primitive Name = "AutoGen_NullTermString"
           Size = "0"
           VMSDataType = "DSC$K_DTYPE_T"
           NullTerminatedFlag = "1"
           FixedFlag = "0"/>
```

2.4.6 **Parameter Usages**

The Application Interface section described how parameters are passed using specific passing mechanisms. Although Java does not support these different passing mechanisms for passing parameters, there is one aspect of the passing mechanism that does apply. The usage of a parameter describes how the called routine intends to affect that parameter. The variations are as follows:

- **In Only**

In Only states that the called routine intends to only read the parameter and not modify or write to the parameter. This is the default usage for the by “Value” passing mechanism, but may be used with by “Reference” or by “Descriptor” if the developer is sure that the routine is not going to change the parameter value.

- **In / Out**

In / Out states that the called routine intends to both read, and then modify the contents of the specified parameter. The caller of the routine must pick up the new value for the parameter on return. This is the default usage for both the by “Reference” and by “Descriptor” passing mechanisms.

- **Out Only**

Out Only states that the called routine intends to only write to the specified parameter and not read it. As with In/Out, the caller of this routine must pick up the new value for the parameter on return. This is associated with either the by “Reference” or by “Descriptor” passing mechanisms.

If the usage of a parameter is In Only, then the generated Java method can take the Java type directly, because it does not need to look for a modified parameter value. However, if the usage is In/Out or Out Only, then the generated Java method must take a wrapper or “Holder” class for the mapped Java type. This Holder class allows the client to retrieve the possibly modified parameter value. Each OpenVMS to Java type mapping contains an associated Java Holder class for parameters that have a usage other than In Only. (For more information, see the Mapping table in the previous section under the “Java in/out classes” column.)

The supplied math sample (found in wsi$root:[samples.c]) has the following C based routine:

```
unsigned int sum (int number1, int number2);
```

Based on the mapping above, the Java method generated for it is:

```
int Sum (int number1, int number2)
```

The Java client code is:

```
int result = myapp.Sum (56, 72);
```

If the above C routine was changed to take an in/out parameter, the code would be as follows:

```
void sum (int number1, int number2, int *result);
```

Based on the mapping table above, the Java method generated is:

```
void Sum (int number1, int number2, IntHolder result);
```

The Java client code is:

```
IntHolder result = new IntHolder();
myapp.Sum (56, 72, result);
int iresult = result.value;
```

2.5 Design Restrictions for Wrapped Applications

The Web Services Integration Toolkit is an API level wrapping tool. This means that an appropriate programming interface into the application must be presented to the Toolkit for it to successfully work. This includes items such as no terminal input in the exposed routines, using standard OpenVMS calling mechanisms for passing arguments, and so on.

Beyond the standard restrictions mentioned above, the Web Services Integration Toolkit contains other restrictions that you must be aware of when wrapping your application. These restrictions are discussed in the sections below.

2.5.1 Stack Size Not Automatically Increased Based on Demand

Many legacy applications were designed to be hosted in a process used by a single user. This process would have a single thread of execution that would benefit from the stack size automatically increasing based on demand.

In modern multi-threaded environments, each thread has a separate stack that does not automatically increase based on demand. After the size of the stack is set, it will not expand. It is very important that a WSIT application understand how much stack space it requires. Note that WSIT itself uses very little stack space, however, each application is unique. The application can specify a stack size in the WSI deployment property `<StackSize>`.

2.5.2 Bit Data Types

WSIT does not support primitives with the types DSC$K_DTYPE_V and DSC$K_DTYPE_VU. This would require the marshaling code to copy individual bits which is a feature that WSIT does not currently support. Alternatives include the following:|

- Use a BLOB type DSC$K_DTYPE_BLOB. WSIT will not attempt to marshal the contents of a BLOB so the application is in full control.

- Expose the Parameter or Structure Field as one or more bytes. With this approach, the Java client can use bytes, and the legacy application can still use bits. This impact to the 3GL code is minimal. When the 3GL routine receives a parameter with byte-based data, a simple assignment statement can copy the bytes to bits. For Structures, the 3GL code would use a single call to copy the bytes to bits. This routine would copy the byte-based structure fields to the bit-based structure fields.

  An application can have the WSIT tool IDL2CODE generate this copy routine by adding a template to the tool. For an example of this template see the sample in the directory `WSI$ROOT:[SAMPLES.TEMPLATES]`.

2.5.3 Pointer Types Not Supported

Because of the distributed nature of WSIT-wrapped applications, pointer types are problematic because their value is dependent on the process space in which they were created. Although pointers used within the context of the Pass-by-Reference and Pass-by-Descriptor passing mechanisms are supported, all other uses of pointers are not supported by WSIT.

The following table lists the common cases in which pointers are found, and identifies the pointers that are supported and those that are not supported. (The descriptions are expressed in C syntax but are relevant for all languages.)

Restriction	Description

Routine parameters cannot be defined as “pointer to pointer.”
 	
However, a single pointer, commonly referred to as pass-by-reference, is supported.
	`// This is not supported`
	`void myfunction( int **p)`
	
	`// This is supported`
	`void myfunction( int *p)`

User-defined structures cannot contain pointers to other user-defined structures. (*See Note at end of table.)
 	
However, nested structures are supported.
	`// For the structure buyerData:`
	`typedef struct _buyerData {`
	`        char buyer_name[MAX_STRING];;`
	`} buyerData;`
	
	`// This is not supported`
	`typedef struct _customerData {`
	`         buyerData *pbuyer;`
	`} customerData;`
	
	`// This is supported`
	`typedef struct _customerData {`
	`         buyerData buyer;`
	`} customerData;`

Routine return values must be returned by value and cannot be user-defined structures.
 	
However, the interface can add a special parameter to the routine to return the same structure.
	`// For the structure buyerData:`
	`typedef struct _buyerData {`
	`        char buyer_name[MAX_STRING];;`
	`} buyerData;`
	
	`// This is not supported`
	`buyerData * buy()`
	
	`// This is supported`
	`int  buy(buyerData *return_value)`

Note: If a structure contains a pointer to a type, WSIT passes the pointer as an integer without any regard for the type. The application must handle the memory appropriately. This memory is only valid in the context of the application being wrapped and is not valid in the generated Javabean.

2.5.4 **Single Instantiated WSIT JavaBean Cannot Be Shared Among Multiple Threads**

The WSIT runtime supports a many-to-one relationship between clients and backend servers. However, each client must have its own instance of the JavaBean object (unless you manually add synchronization code to the generated JavaBean class). The JavaBean object acts as the client's personal interface into the backend server. It allows WSIT to make sure that each client gets the correct context within the server. If a single JavaBean instantiation is shared among clients, they will also share a single server context. If concurrent calls are then made without synchronization code put in place, this could lead to unexpected results, including incorrect call data and memory management exceptions.

See Section 4.4, Modifying an Existing Template, for information about how to manually add synchronization code.

2.5.5 **Languages Tested with the OBJ2IDL Tool**

The Web Services Integration Toolkit was written to wrap ACMS applications and any 3GL-based applications that are callable using the defined OpenVMS calling standard. The WSIT runtime is language neutral and supports all OpenVMS languages. The OBJ2IDL.EXE tool has only been tested with the following languages:

- ACMS
- BASIC
- C
- COBOL

Other languages that adhere to the OpenVMS calling standard (including FORTRAN) should work, but have had limited testing only.

2.5.6 **Tips and Hints for Supported Languages**

2.5.6.1 **All Languages**

The following issues apply to all WSIT-supported languages (ACMS, BASIC, C, and COBOL).

- The exception java.lang.UnsatisfiedLinkError: no WSI$JNISHR may be generated:

If you have not started WSIT by calling SYS$STARTUP:WSI$STARTUP, an exception is thrown when you run the generated JavaBean.

2.5.6.2 **BASIC Language**

The following issues apply to the BASIC language only.

- For formal parameters, passed by value, with types other than strings or signed decimal data:

OBJ2IDL.EXE defaults to a passing mechanism of reference and a usage of IN/OUT. Modify the XML to specify a passing mechanism of value and a usage of IN.

- For formal parameters, passed by descriptor:

OBJ2IDL.EXE does not recognize the type of the formal parameter. In such cases, the type defaults to a null terminated string. Modify the XML to specify the correct type for the formal parameter. In some cases, you may need to add the type (primitive or structure) to the XML.

- For formal parameters that are arrays, if the passing mechanism is descriptor:

OBJ2IDL.EXE does not recognize the arrays. Modify the XML to specify the array. (See the example of syntax in the C language section.)

2.5.6.3 **C Language**

The following issues apply to the C language only.

- When passing a formal parameter of byte (type char) by reference:

If a char is being used to represent a single byte and is passed by reference as a formal parameter, then the generated XML will specify the parameter as having a type of type=”AutoGen_NullTermString”. Modify the XML to specify type=”char” which will properly resolve to a byte (DSC$K_DTYPE_B).

- For C applications, OBJ2IDL.EXE does not recognize formal parameters that are arrays:

For example, if an array of userstruct with size 3 is passed as a parameter, then the XML that is generated will be as follows:

```
<Routine Name = "incrementArrayOfStructures" ReturnType = "signed int">
<Parameter Name = "array" Type = "userstruct" PassingMechanism = "Reference"
Usage = "IN/OUT"/>
</Routine>
```

Modify the XML to specify the array as follows:

```
<Routine Name = "incrementArrayOfStructures" ReturnType = "signed int">
<Parameter Name = "array" Type = "userstruct" PassingMechanism = "Reference"
Usage = "IN/OUT" ArrayDimension = "1">
<Array LowerBound = "0" UpperBound = "2"/>
</Parameter>
</Routine>
```

2.5.6.4 **COBOL Language**

The following issues apply to the COBOL language only.

- For all formal parameters:

OBJ2IDL.EXE defaults the usage to IN/OUT.
OBJ2IDL.EXE defaults the passing mechanism to pass by reference.

2.5.7 **Tips and Hints for OpenVMS Alpha Users**

Using I64 generated XML IDL on Alpha: If you are using the Web Services Integration Toolkit on an OpenVMS Alpha system, you can generate your XML file on OpenVMS I64, and in most cases, copy it to OpenVMS Alpha with few or no modifications.

OpenVMS Alpha users who do not have an I64 system can use an OpenVMS I64 system provided by the **HP TestDrive Program**. This system has WSIT installed. To access this resource you must register (for free) at http://www.testdrive.hp.com/accounts/register.shtml.

When using an I64 generated IDL on OpenVMS Alpha, be aware that some compilers may have different default values on I64 than on Alpha. These differences need to be addressed. For example, the C compiler uses a different VMSDataType for primitive types float and double:

C Primitive	**Default Value on I64**	**Default Value on Alpha**
float	`DSC$K_DTYPE_FS`	`DSC$K_DTYPE_F`
double	`DSC$K_DTYPE_FT`	`DSC$K_DTYPE_G`

An application that uses a float must replace the following:

```
<Primitive Name = "float” Size = "4” VMSDataType = "DSC$K_DTYPE_FS"/>
```
with
```
<Primitive Name = "float" Size = "4" VMSDataType = "DSC$K_DTYPE_F"/>
```

An application that uses a double must replace the following:

<Primitive Name = "float” Size = "4” VMSDataType = "DSC$K_DTYPE_FT"/>
with
<Primitive Name = "float" Size = "4" VMSDataType = "DSC$K_DTYPE_G"/>

2.5.8 Programming with Nested Structures

When an application developer instantiates a WSIT structure, the entire structure object, including all nested structure objects, are also instantiated. This allows WSIT to manage all memory associated with a nested structure.

To populate the inner structure, you must first obtain a reference to it. After a reference is obtained, the get and set methods for its fields can be called. For example:

```
    TopLevelStructure mystruct = new TopLevelStructure ();
    InnerStructure inner = mystruct.getInnerStructure ();
    inner.setField1(“somevalue”);
    inner.setField2(“somevalue”);
```

If the Structure `InnerStructure` has a field that is also a Structure, you can obtain a reference by calling:

```
  OtherStructure other = inner.getOtherStructure();
```

3 ADVANCED OUT–OF–PROCESS CONFIGURATION

This chapter is intended for experienced Web Services Integration Toolkit users.

Before you configure the out-of-process deployment file, identify your application's level of reusability. If your application is reusable, you can significantly reduce the number of processes needed to service the clients.

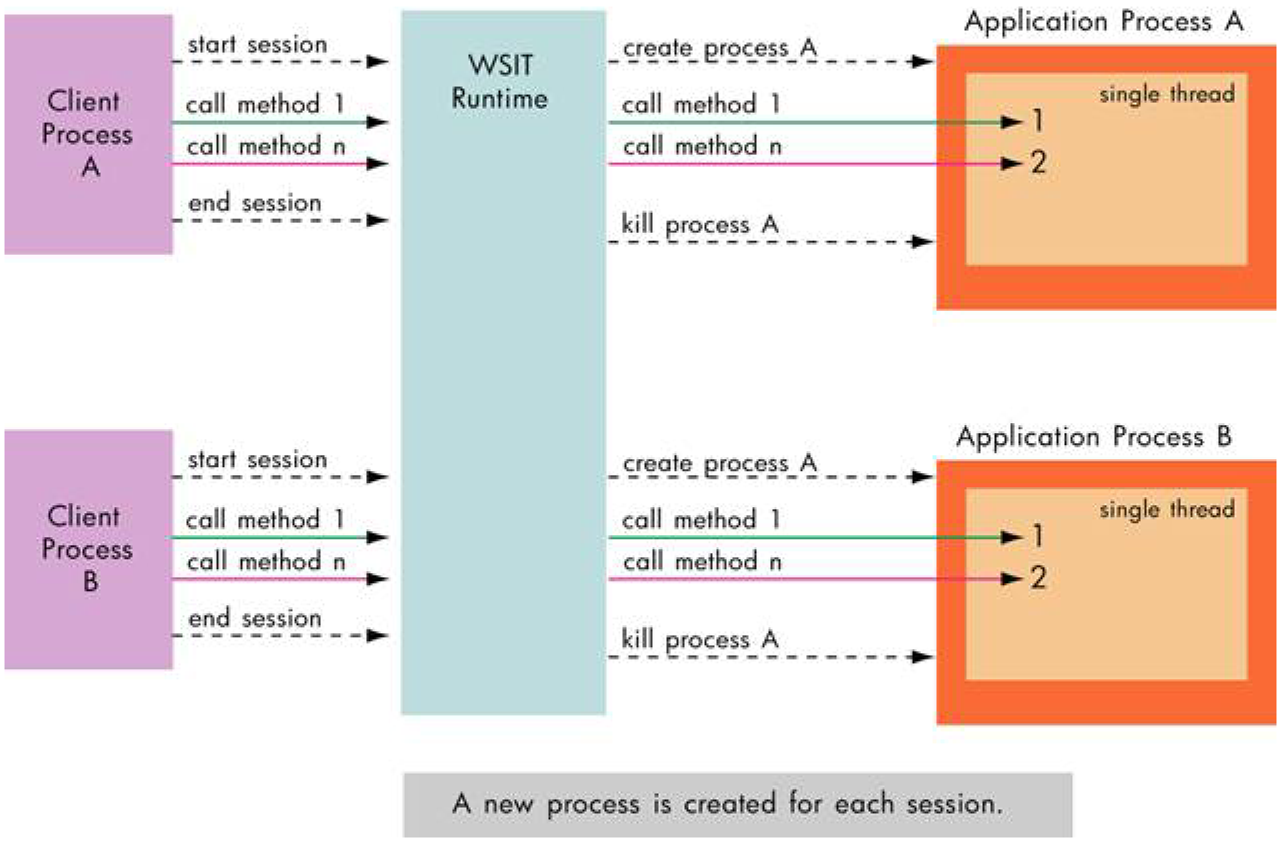
Next, to determine if a single instance of an application can handle multiple clients, consider how you maintain state and manage I/O within your application. Applications are frequently designed to accumulate state from call to call. For example, the first call opens a file, the second call reads from the file, and the third call updates and writes back the modified record. In cases like this, multiple clients within the same application may "step on" each other trying to access the same files using the same channels.

To help you determine your application's level of reusability, the following sections describe four applications, each with a different level of reusability or combination of reusability and multiple threads.

3.1 CASE A: NOT REUSABLE

This is the **default configuration** for all WSIT out-of-process applications.

An application is **not reusable** when it can only be used for **one client session**. When the session is finished, the application has created state that prevents it from being called again. The next client session requires a new instance of the application. This situation can exist in older applications that assume a single long-lived client is their only client. To identify this situation look for global (or static) variables that are used to identify stored client-specific data. The following figure shows an application that is **not reusable**:



For example, an application may not be reusable if it has a global variable to hold a client account number and the account number cannot be modified or reset with a subsequent call or other mechanism. If a second session requires a different account number to be set, then the application is not reusable.

Deploying an application as not reusable is the most restrictive case and has the highest runtime overhead, but is also the safest configuration. When an application is not reusable, WSIT ensures that the client always receive a new instance of the application.

The order of events for a non-reusable application is as follows:

1. The client instantiates the WSIT-generated JavaBean. This starts a session with a free application.

2. WSIT assigns the client the exclusive use of a process that is running the application. The process may be newly created or may have been previously created but never used.

3. The client uses the application as it desires. One or more calls are made as part of the session.

4. The client tells the WSIT runtime that it is finished with the session by calling the remove method of the WSIT-generated JavaBean. This assumes that a session type of LIFETIME_SESSION is being used. A non-reusable application should not use a NO_SESSION session because of the extremely high overhead which occurs from creating and deleting a process for every method call.

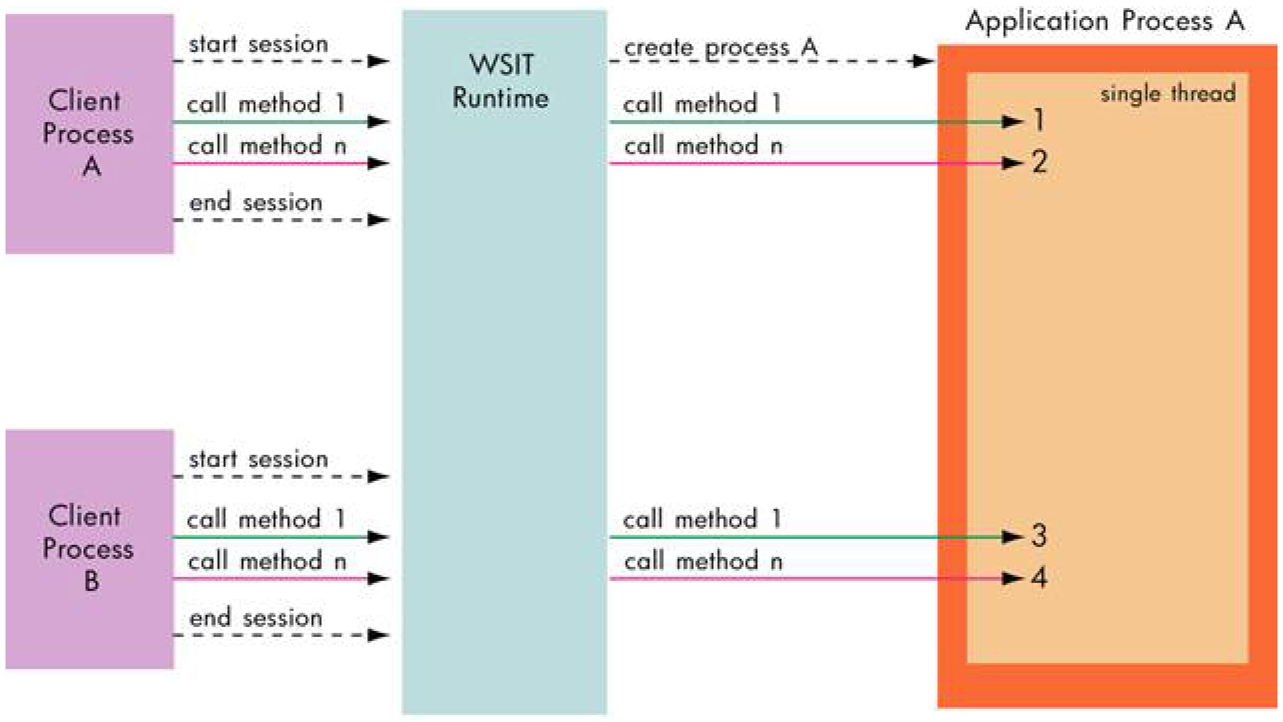
5. WSIT deletes the process.

3.2 CASE B: SEQUENTIALLY REUSABLE

An application is **sequentially reusable** when it is able to process more than one client session, but requires that **exactly one session be active at a time**. The application must initialize its state before processing the next client session.

When an application is sequentially reusable, WSIT will not delete the application process when the client is finished using it. WSIT ensures that only one client can have a session outstanding with the application.

The following figure shows an application that is **sequentially reusable**.



WSIT serializes the client sessions.

For example, an application is serially reusable if it has a global variable to hold a client account number and also a method to initialize (or modify) the account number. In this way, each client can call the initialize method to erase the state of a previous client's session.

The order of events for a sequentially reusable application is as follows:

1. The client instantiates the WSIT generated JavaBean. This starts a session with a free application.

2. WSIT assigns the client the exclusive use of a process that is running the application. The process may be newly created or may have been previously created.

3. The client uses the application as it desires. One or more calls are made as part of the session.

4. The client tells the WSIT runtime it is finished with the session based on the type of session used.

5. WSIT places the application in a pool so that it is available for another client to use.

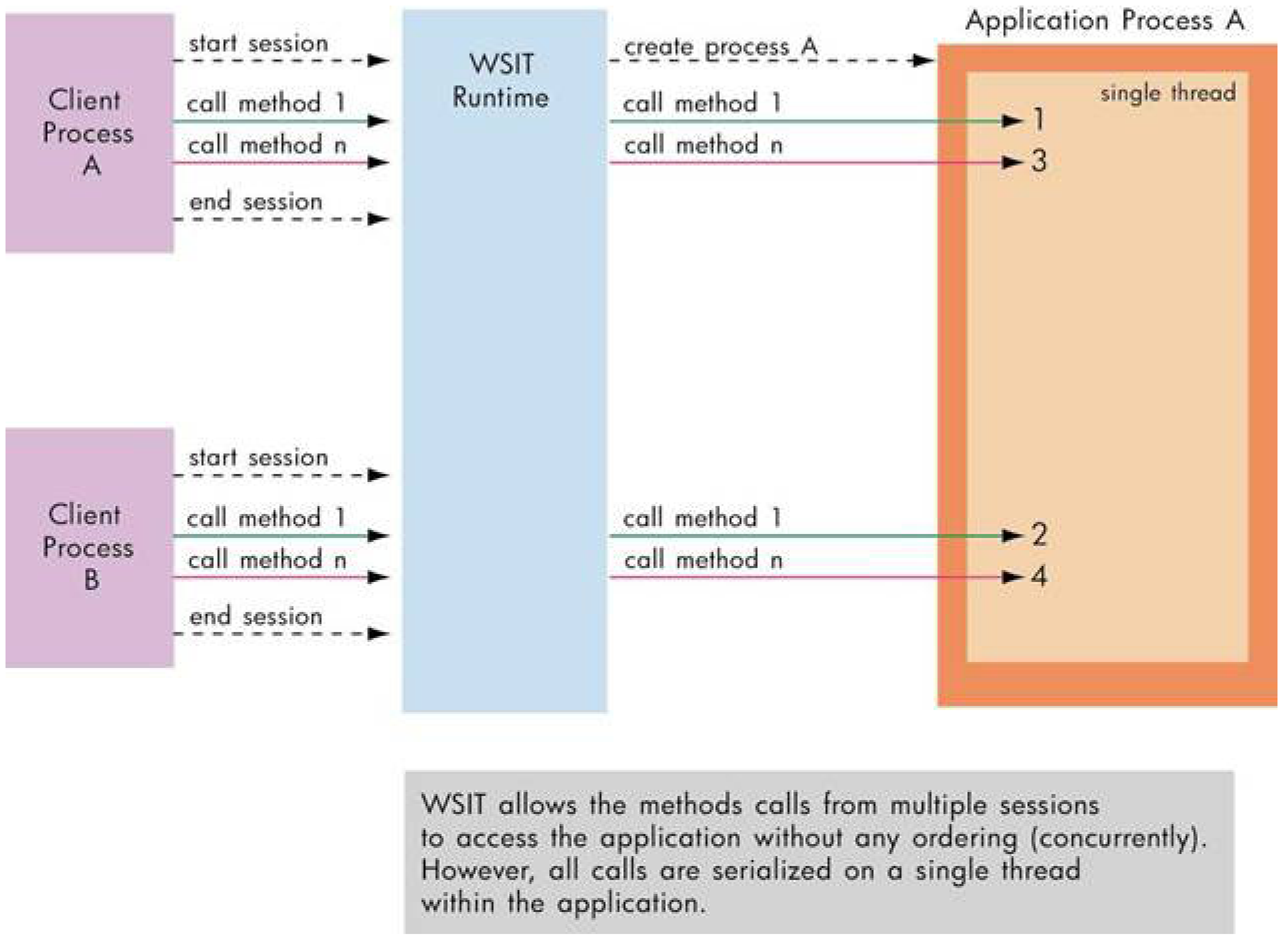
To deploy an application as sequentially reusable, make the following change to the file wsi$root:[deploy]<application-name>.wsi:

- Uncomment the XML tags <Reusable> </Reusable>

3.3 CASE C: CONCURRENTLY REUSABLE

An application is **concurrently reusable** when it can be called from **multiple clients without regard to the order of the clients' sessions**. This type of application has a mechanism for keeping the state of each of the clients separated. WSIT uses a single thread when forwarding the clients' calls to the application. From the application's perspective, the clients' sessions may be nested. This ensures that the application processes one client call at a time.

The following figure shows an application that is **concurrently reusable**.



For example, an application is concurrently reusable if its interface uses a context block to hold client data. In this way, the logic in the application is generic in regard to the clients.

The order of events for a **concurrently reusable** application is as follows:

1. The client instantiates the WSIT-generated JavaBean. This starts a session with a free application.

2. WSIT assigns the client the use of a process that is running the application. The process may be newly created or may have been previously created. Other instances of the client may also be using the same application, but WSIT ensures that all method calls are made one at a time on the same thread.

3. The client uses the application as it desires. One or more calls are made as part of the session.

4. The client tells the WSIT runtime it is finished with the session based on the type of session used.

5. WSIT places the application in a pool so that it is available for another client to use.

To deploy an application as sequentially reusable make the following changes to the file wsi$root:[deploy]<application-name>.wsi:

1. Uncomment the XML tags <Reusable> </Reusable>

2. Uncomment the XML tag <MaximumClients> and specify a number greater than one for the number of client sessions that the application can process

3.4 CASE D: CONCURRENTLY REUSABLE WITH MULTIPLE THREADS

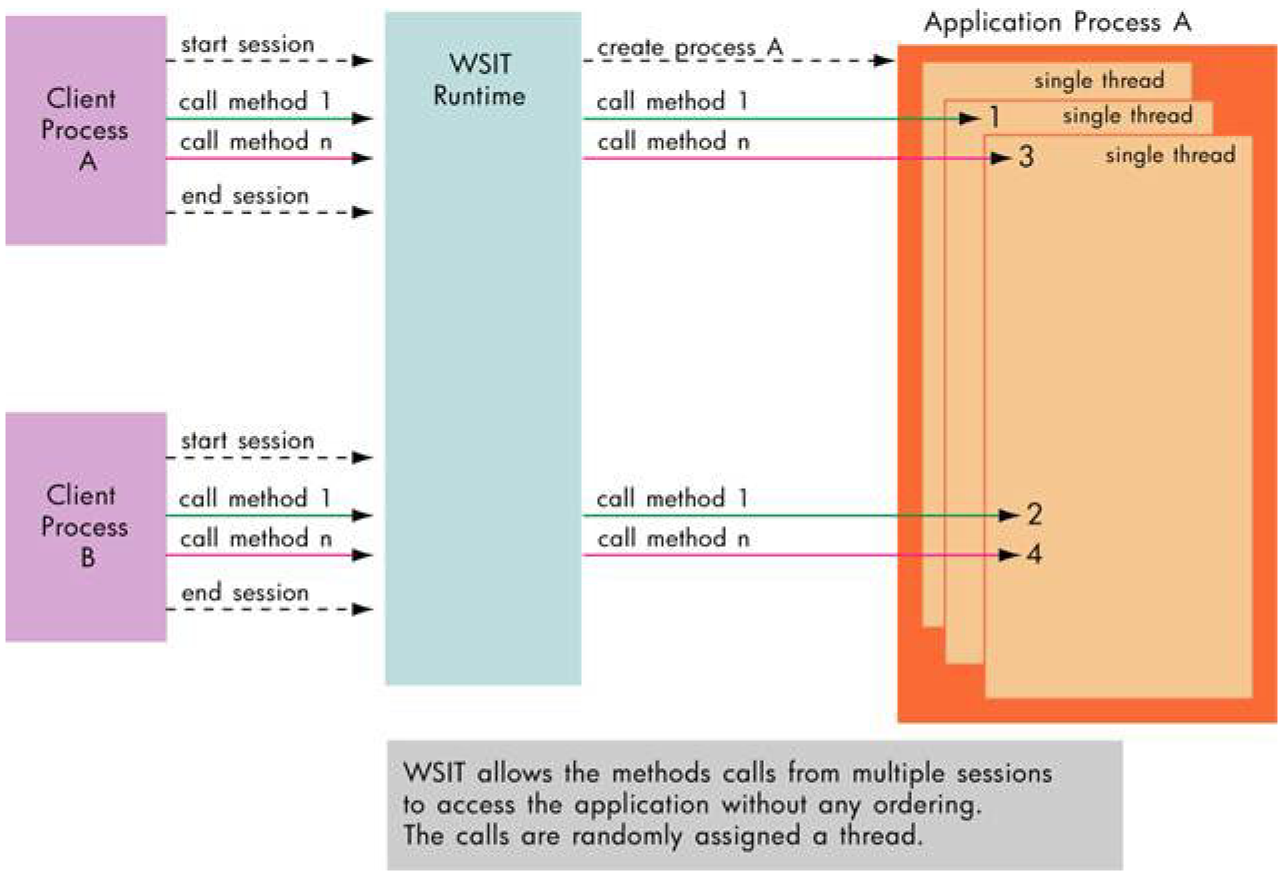
An application is **concurrently reusable and thread-safe** when it can be **called from multiple clients, at the same time, on multiple threads**. WSIT allows multiple client sessions to call the application without any attempt to serialize them. The application was designed to lock shared data when called by multiple threads. It is also written in a language that is capable of generating thread-safe code. (For example, COBOL and BASIC do not generate thread-safe code.)

To determine if the application can handle calls from different clients concurrently, consider the following:

- Are all of the application resources that are shared among clients protected in a thread-safe way? For example, using global symbols can cause problems unless they are protected by a mutex or equivalent concept.

- Is the language that was used to write the application thread-safe?

The following figure shows an application that is **concurrently reusable with multiple threads**.



For example, an application is concurrently reusable and thread safe if its interface uses a context block to hold client data, and all access to global data, such as a global queue of client context blocks, is protected by a thread-safe locking mechanism such as a mutex.

The order of events for a concurrently reusable with multiple threads application is as follows:

1. The client instantiates the WSIT-generated JavaBean. This starts a session with a free application.

2. WSIT assigns the client the use of a process that is running the application. The process may be newly created or may have been previously created. Other instances of the client may also be using the same application. WSIT uses multiple threads to call the application.

3. The client uses the application as it desires. One or more calls are made as part of the session.

4. The client tells the WSIT runtime it is finished with the session based on the type of session used.

5. WSIT places the application in a pool so that it is available for another client to use.

To deploy an application as sequentially reusable make the following changes to the file wsi$root:[deploy]<application-name>.wsi:

- Uncomment the XML tags <Reusable> </Reusable>

- Uncomment the XML tags <MaximumClients> </MaximumClients> and specify a number greater than one for the number of client sessions that the application can process.

- Uncomment the XML tag <MaximumThreads> </MaximumThreads> and specify a number greater than one for the number of threads that WSIT can use to call the application.

The number of threads allowed to run concurrently should be a percentage of the number of clients specified. A good rule of thumb is to look at the average amount of time that each application call is expected to take.

- If the calls are small and quick, then the number of threads allowed to run concurrently could be 25% of the number of clients.

- If you expect calls to take longer, then you should use a larger value, such as 50 to 60%.

For example, if you specify ten clients per application, and each application call will take some time, then allow six threads to run. Note that once a system is in place, this number should be monitored and adjusted as needed.

3.5 Single Threaded Applications – Automatic Stack Expansion

Beginning in WSIT V3.0:

WSIT creates threads to execute the application code in out-of-process servers. This requires the developer to edit the WSI file and specify the maximum thread stack size.

It is often difficult for a developer to know the maximum stack size to specify. As of WSIT V3.0, a modification has been made for single threaded applications. Single threaded application can have the stack size automatically extended as needed.

To use this feature, specify the value 0 for the stack size tag `<StackSize>0<\StackSize>`. You must also indicate that you have a single threaded application. This can be done by not specifying the `<Reusable>` tag. If you do specify the `<Reusable>` tag then you must specify 1 as the maximum threads <`MaximumThreads>1</MaximumThreads>`.

Multithreaded applications must still specify the maximum stack size for each thread.

3.6 Example: Using the Debugger

A WSIT server process can be debugged just like any other OpenVMS detached process. (See the *OpenVMS Debugger Manual* for details.) A summary and an example debugging session follows.

Requirements for using the Symbolic Debugger with WSIT

- The application shareable image must have debug records. The application code must have been compiled and linked debug (or linked to generate a DSF file).

- Depending on the version of the debugger you are using, you may need to use UPPERCASE for the name of the WSIT application in the directory WSI$ROOT:[DEPLOY] and for the global symbols that you wish to reference in your application.

- The debugger requires that the client and server processes are both in the same UIC GROUP. For your WSIT application, this means that the WSI$STARTUP procedure must have been executed from the same account (or a least the same SYSUAF GROUP UIC) as specified in the application .WSI file. For example, if your application WSI file uses `<Account>DEPLOYER</ACCOUNT>`, then the WSI$STARTUP must have been started from the user DEPLOYER or another account in that same UIC group.

General Steps

This example uses the following simple code in a WSIT application.

```
$ type samplewsitdbg.c
#include <stdio.h>
#include <stdlib.h>

unsigned int MYROUTINE ( int number1, int number2) {

  printf("\n");
  printf("We are inside the program");
  printf("\n");

  return number1 + number2;
}
```

Step 1: Compile and link your application with debug records. Deploy to the WSI$ROOT:[DEPLOY] directory.

Step 2: Start the application that you want to debug. This can be done with different techniques:

- By editing the WSI file and declaring the application reusable. You can then create the server process by using your java client to trigger startup.
- By editing the WSI file to establish pre-started servers. This has the advantage that the client does not need to execute a method of the routine to load the application code.

After WSIT has created the detached process, use the `$ show process/m` command shown below to determine the process name. In this example, the process name is SAMPLEWSI_0C09.

Step 3: In another process, such as a telnet window, start the debugger and connect to the detached server process. Note that you must set your image and module names to establish the correct debugger context. This is the point when you should set any breakpoints or other debugger commands that are of interest to you.

```
$ debug/keep

         OpenVMS Alpha Debug64 Version V8.2-017

DBG> connect SAMPLEWSI_0C09
%DEBUG-I-NODSTS, no Debugger Symbol Table: no DSF file found and
-DEBUG-I-NODSTIMG, no symbols in
DISK$ALPHAV82:[VMS$COMMON.SYSEXE]WSI$SERVER.EXE;1
%DEBUG-I-NOLOCALS, image does not contain local symbols
%DEBUG-I-NOGLOBALS, some or all global symbols not accessible
DBG> set image SAMPLEWSITDBG
DBG> set module SAMPLEWSITDBG
DBG> set break MYROUTINE
DBG> go
%DEBUG-I-DYNLNGSET, setting language C
break at routine SAMPLEWSITDBG\MYROUTINE in THREAD 59
  3386:   printf("\n");
DBG>
```

Step 4: In the same window as Step 2, use your Java client to call the application code.

3.7 Generating Tracing for Application Interface

It is often helpful to trace the data being passed into and out of your application interface. The `IDL2CODE` tool is able to generate tracing routines for the interface defined in the XML IDL file.

To use this feature, specify the –t switch when using the tool.

```
$ java "com.hp.wsi.Generator" -i  wsi$root:[samples.c]math.xml -a math  -o
[.generated]  -t
```

When this option is used, the generator produces two extra files:

```
<yourappname>-server-trace.h
<yourappname>-server-trace.c
```

For example:

```
File: /wsi$root/samples/c/generated/mathServer/math-server-trace.h generated.
File: /wsi$root/samples/c/generated/mathServer/math-server-trace.c generated.
```

These files must be compiled and linked into the applications shareable image. If an application has its own build environment to create the shareable image, then you must add these files to it. If you rely on WSIT to generate the build environment, no action is required as the tool automatically includes these files.

After the tracing routines are built into the code, they can be turned on and off using a logical. To turn on tracing, define the logical WSI$APPTRACING. To turn off tracing, deassign the logical.

For example, tracing for the math sample would look similar to the following:

```
[Tue Apr 1 10:24:42 2008] WSI$START_SESSION:  App = math, SessionID = 48676952,
Dispatch = 50922584
[Tue Apr 1 10:24:42 2008] sum (Input): SessionID = 48676952
```

```
    number1 (long by val): 22
    number2 (long by val): 33
[Tue Apr 1 10:24:42 2008] sum (Output): SessionID = 48676952
    Return (unsigned long by val): 55
[Tue Apr 1 10:24:42 2008] WSI$END_SESSION: SessionID = 48676952
```

This tracing provides the name of the routine being called (sum) the values of the parameters and their passing usage. It also provides the return types if any. The tracing routines can trace simple types, structures, arrays and BLOBs.

When the –t switch is specified, the tracing will print out the value of every parameter being passed into and out of the interface routine. When large parameters are being passes this may have a dramatic effect on the performance of the code. To indicate that a parameter should not be traced, modify the IDL for the interface to include the attribute “NoTrace.”

For example:

```
 <Parameter Name = "number1"
                   Type = "signed int"
                   PassingMechanism = "Value"
                   Usage = "IN"
                   NoTrace="1"/>
```

The generated tracing routines are provided as a debugging aid. They are not intended to be used in production code. This tracing should not be used as a replacement for an applications own tracing.

3.8 Creating a Log File

When a WSIT application is executed out-of-process it is often valuable to see the results of tracing statements within the application. If the logical WSI$LOGFILE is defined, WSIT creates a log file in the default directory of the user who issued the WSI$STARTUP.COM command. For example, if the SYSTEM account was used to startup WSIT, then the SYS$SYSROOT:[SYSMGR] directory will have a log file for each detached process. This log file can be used to capture print statements in the application code as well as the tracing controlled by the WSI$APPTRACING logical.

The logical is translated at the time the process is created. If the logical is modified, it will have no effect on processes that already exist.

The name of the log file is based on the node name and application name. It has the following form:

WSI$NODENAME_*YOURAPPNAME*_SEQUENCENUMBER.LOG

For example:

```
WSI$STAR_MATH_00001.LOG
```

4 MAPPING BLOBS AND OTHER UNFORMATTED DATA

This chapter is intended for experienced Web Services Integration Toolkit users.

WSIT provides a clean way to define almost every OpenVMS primitive and aggregate type within the WSIT IDL file. However, some applications may require a large non-typed chunk of memory to be exchanged with it. This may be needed if you want to:

- Exchange a string larger than 65535 with your application
- Exchange a non-standard datatype with your application

In these cases, you define the parameter in the WSIT IDL as a **Binary Large Object (BLOB)**.

Conceptually, a BLOB is a large chunk of memory whose contents is in a format unknown to the underlying runtime. WSIT will not attempt to interpret it when passed into a routine. (The contents only have meaning to the application's java client(s) and user routine(s).) Internally, WSIT handles a BLOB like a resizable array of bytes passed by descriptor. Because of this, the non-java application routine that is to receive a BLOB must have the BLOB parameter defined as an array of bytes passed by descriptor.

An example C function prototype is as follows:

```
            int myStringRtn (struct dsc$descriptor_a *p1);
```

Defining the BLOB parameter within the WSIT IDL is a simple matter of creating a BLOB primitive type, then assigning the parameter to this new type:

```
…
<Primitives>
  <Primitive Name = "myblob"
             MemoryFreeByWSIT = "1"
             VMSDataType = "DSC$K_DTYPE_BLOB" />
  <Primitive Name = "int"
             VMSDataType = "DSC$K_DTYPE_L"/>
</Primitives>

<Routines>
  <Routine Name = "myStringRoutine"
           ReturnType = "int">
           <Parameter Name = "p1"
                      Type = "myblob"
                      PassingMechanism = "Descriptor"
                      Usage = "IN/OUT"/>
  </Routine>
</Routines>
```

Notice that there is a new attribute named `MemoryFreeByWSIT` and it is set to 1. This tells the WSIT runtime to deallocate this memory once it has finished returning the contents to Java. Unless you plan to explicitly deallocate the new memory in a later call, you should let WSIT deallocate this memory for you on return. If you are planning on handling deallocation yourself at a later time, then specify 0 for `MemoryFreeByWSIT`, or don't specify this property at all.

Note that when working with BLOBs, it is the responsibility of the user's routine to correctly modify the array descriptor which is passed in. If the array descriptor isn't correctly updated to reflect the new size and memory location, the WSIT runtime will not pass the BLOB back correctly. A sample C routine that handles this is as follows:

```
int myStringRoutine ( struct dsc$descriptor_a *adx )
{
    char    *somestring =
            "ABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890ABCDEFGHIJKLMNOPQR";
    int     status = 0;
    int     newarysize = 50;
    char    *newmem = NULL;

    // Allocate memory for the new BLOB
    newmem = malloc(newarysize);

    // Fill in the new BLOB with some information
    memcpy(newmem, somestring, newarysize-1);
    newmem[newarysize-1] = '\0';

    //Tell WSIT about the memory...
    adx->dsc$a_pointer = newmem;
    adx->dsc$l_arsize = newarysize;

    return status;
}
```

One benefit of treating BLOBs as byte arrays is that in Java, the String class contains constructors and methods that make converting from a byte array to a String and back again a straightforward process.

*Note that WSIT requires the client to always pass in a valid array for BLOB parameters. If an empty *ObjectHolder*, or a null, is passed in to the routine WSIT will throw an exception.

5 USING TEMPLATES TO GENERATE CODE

This chapter is intended for experienced Web Services Integration Toolkit users.

The Web Services Integration Toolkit uses **Velocity templates**, which encapsulate language syntax to specify the code that will be generated based on the IDL. Velocity is an open source Java-based template engine provided by the **Apache Jakarta** project. The Velocity Template Language (VTL) is the scripting language used in the Velocity engine.

The Web Services Integration Toolkit provides an optional extensibility feature – the ability to modify or replace the Velocity templates that WSIT uses to generate code. (This feature is described in the following sections.) You can change the template to generate different source code. You can also change the template, for example, to improve performance or to add security to your specific application.

For more information about Velocity, see http://jakarta.apache.org/velocity/.

For more information about VTL, see http://jakarta.apache.org/velocity/user-guide.html and http://jakarta.apache.org/velocity/vtl-reference-guide.html.

5.1 Modifying Velocity Templates

The Web Services Integration Toolkit (WSIT) provides a number of different tools that complement each other in the process of wrapping existing OpenVMS applications. One of the tools in the toolkit is IDL2CODE.JAR, also known as the WSIT generator.

The WSIT generator uses a mechanism based on Velocity templates. A set of template files are read, and placeholders within those templates are replaced by application-specific values. This becomes the generated code.

More specifically, the generator reads a WSIT-specific IDL description of the application to be wrapped, then generates code based on this description. The generated wrapping code contains the following:

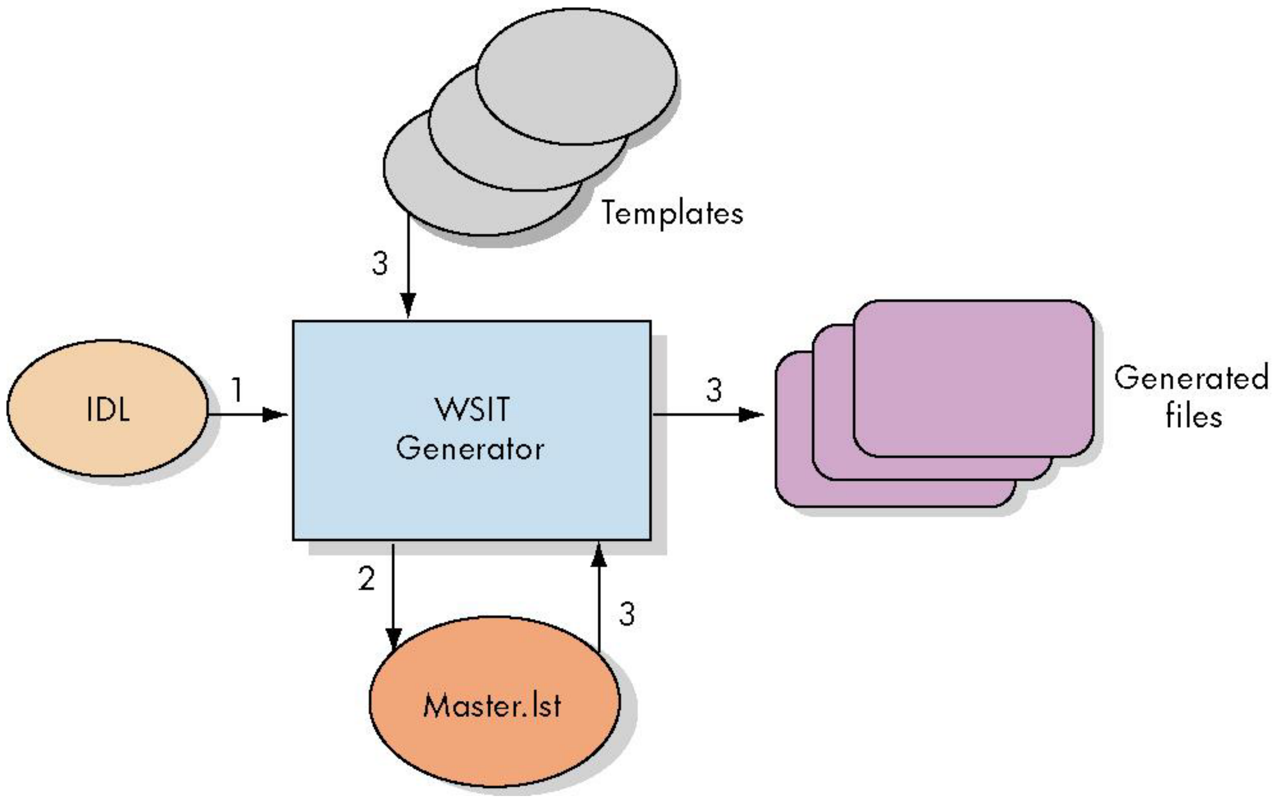
- Server wrapper component that builds against the existing application
- JavaBean component that provides the new interface into this application

The standard code that is generated out of the box has been tested and is robust enough to handle most cases. However, you may want to tailor what is generated by IDL2CODE.JAR. The following sections describe the process that IDL2CODE.JAR uses to generate code, and then describes how you can modify what is generated.

Note: The Velocity templates are contained in the subdirectory WSI$ROOT:[TOOLS.TEMPLATES]. You can modify the current set of Velocity template files, or you can add new template files.

5.2 Generating Code with IDL2CODE.JAR

The generation process occurs in four distinct phases. The first three phases offer you an opportunity to modify what ultimately is generated. The phases are described in the following sections.



Phase 1: Parse IDL File

In Phase 1, the generator reads the WSIT IDL file describing the application, parses it, and then populates an object model representation of its contents. This object model is directly accessed by the templates and template engine in later phases. The IDL should accurately reflect the interface to the application being wrapped. This phase is your first opportunity to affect what is generated.

See Section 1.3, Exposing an OpenVMS 3GL Application, for more information.

Phase 2: Generate File List

In Phase 2, the generator generates a master list called Master.lst of files to generate based on the template file called Master.vm. (In the next phase, the generator steps through this list of files to generate the actual files.) Modifying Master.vm allows you to change the list of files to generate, as well as to change which templates to use in generating these files.

Each line within Master.vm and Master.lst has the following format:

```
<Object> <Name> <Output Filename> <Template Filename> <Output Subdirectory>
```

where:

Object describes the component to which this generated file will belong. Object can have one of the following values:

SW File belongs to the **server wrapper** component
The generated file is placed into the subdirectory [.appnameServer]

JB File belongs to the **JavaBean** component

The generated file is placed into the subdirectory [.appname]

I File represents an **interface** within the JavaBean
The generated file is placed into the subdirectory [.appname]

S File represents a **structure definition** within the Javabean
The generated file is placed into the subdirectory [.appname]

C File is part of a **generated sample client**
The generated file is placed into the subdirectory [.appnameSamples…]

Name identifies the name of the object within the object model that this file represents.

Output filename is the filename of the file to be generated.

Template filename is the filename of the template to use in creating this file.

Output Subdirectory optionally specifies the subdirectory in which to generate the file.
(If used, it overrides the default subdirectory specification.)

Phase 3: Generate Files

In Phase 3, the generator reads the previously generated Master.lst file, then generates the listed files.

Each line within Master.lst contains an output filename and an associated template file to use in its generation. It uses these mappings, along with this previously populated object model, to create the output files.

You can modify the template files to change the contents of the individually generated files. The object model can be accessed using Velocity identifiers.

Phase 4: Generate Javadocs (Optional)

In Phase 4, the generator optionally runs the Javadoc utility against the generated JavaBean files, creating a set of .html files that document the generated interface.

5.3 Example 1: Writing a New Template

The following example shows you how to write a new template and add it to the master list so that it will be used within the generation process.

This example assumes the following simple WSIT IDL:

```
 <?xml version="1.0" encoding="UTF-8"?>
<OpenVMSInterface
       xmlns="hp/openvms/integration"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xsi:schemaLocation="hp/openvms/integration openvms-integration.xsd"
       ModuleName="simple.OBJ"
       Language="C89">
       <Primitives>
         <Primitive Name = "signed int"
                    Size = "4"
                    VMSDataType = "DSC$K_DTYPE_L"/>
       </Primitives>
       <Routines>
         <Routine  Name = "add"
```

```
                    ReturnType = "signed int">
                    <Parameter Name = "p1"
                               Type = "signed int"
                               PassingMechanism = "Value"
                               Usage = "IN"/>
                    <Parameter Name = "p2"
                               Type = "signed int"
                               PassingMechanism = "Value"
                               Usage = "IN"/>
          </Routine>
        </Routines>
</OpenVMSInterface>
```

Step 1: Write Template using Velocity

For this example, we will write a template file using Velocity that generates a log file containing the list of the routines being exposed, along with their parameters. (Save the file as app-logfile.vm.) The completed file will look similar to the following:

```
 #set( $server = $application.Server )

                        Logfile for ${application.Name}
                        ---------------------------------


Routines being exposed           Parameters
----------------------------------------------------------------------

#foreach( $routine in $server.Routines)
  ${routine.Name}
      Description: ${routine.Description}
      Return Type: #if( $routine.Returnparam )
$routine.Returnparam.SWFormalDefinition#else void#end

#foreach( $param in $routine.Parameters)
                                 ${param.Name} ($param.SWFormalDefinition)
#end
#end
```

Note: The Velocity syntax that is used to pull information from the provided object model. Within WSIT:

- All templates are passed $application, which is a reference to the top level genConnection object.
- All structure type templates are passed $structure, which is a reference to the genStructure object.
- All interface templates are passed $interface, which is a reference to the genInterface object.

The template files located in WSI$ROOT:[TOOLS.TEMPLATES]show many different examples of using these tags.

When you finish writing the template, place it where Velocity can find it. The path(s) that the Velocity engine uses to find template files is specified in the file velocity.properties. You can modify this file to add your directory to the search path, or you can copy your newly written template into a directory that is already in the path.

Step 2: Modify Master.vm

Next, modify Master.vm to add the new file to the list of files that are generated. The new file that you created in Step 1 is considered a server wrapper template file because it lists the interface as exposed by the application.

Add the following line to Master.vm in the appropriate place. Type the line exactly as shown below. (Like any other template file, the ${application.Name} placeholder is automatically replaced with the name of the application, causing the generated file to contain the application name in its filename.)

```
        SW ${application.Name} ${application.Name}.log app-logfile.vm
```

Step 3: Run IDL2CODE.JAR

Run the generator and review the newly generated files. If the run is successful, a log file that looks similar to the following can be found in the [.ServerSimple] subdirectory.

```
                        Logfile for Simple
                        --------------------------------


Routines being exposed                        Parameters
----------------------------------------------------------------------

  add
      Description: This is the description for the add routine
      Return Type: signed int

                                        P1 (signed int)
                                        P2 (signed int)
```

5.4 Example 2: Modifying an Existing Template

Example 1 showed you how to write and add your own new template. However, there may be cases in which you want to directly modify the behavior of an existing WSIT template.

For instance, you may want to remove the restriction that every client needs to have its own instantiation of the JavaBean interface class. The way to remove this restriction is to make sure that the generated JavaBean class has appropriate synchronization code to serialize all calls through it. (This is not generated by the default WSIT templates.) This example steps you through this simple process.

Step 1: Set Default Directory

Assuming the default location for the templates, set your default directory to WSI$ROOT:[tools.templates.javabean].

This is where you will find the templates used to generate the javabean files.

Step 2: Edit Files to Add Synchronize Keyword

Assuming that the templates have their default names, edit the files INTERFACE-JAVA.VM and INTERFACEIMPL-JAVA.VM.

These files define the interface, and the implementation of the interface, for the newly generated application.

For every public method definition within the two files, you must add the synchronized keyword. In particular, add the synchronized keyword to the: AcmsSignIn, AcmsSignOut, OpenVmsLogin, OpenVmsLogout, and remove methods in each file.

Next, add the synchronized keyword to each method definition within $interface.Methods and $interface.AcmsMethods.

For example:

Before:

```
    public#if($routine.Returnparam)
$dtutility.getJBtype($routine.Returnparam.Datatype)#else void#end
${routine.WebServiceName} ($paramformal)
                             throws WsiException;
```

After:

```
    Public synchronized#if($routine.Returnparam)
$dtutility.getJBtype($routine.Returnparam.Datatype)#else void#end
${routine.WebServiceName} ($paramformal)
                             throws WsiException;
```

Step 3: Run IDL2CODE.JAR

Run IDL2CODE.JAR to generate an application wrapper. The generated interface methods are synchronized. All method calls to each JavaBean is serialized.

5.5 Example 3: Generating Helper Routines for the Original Application

Users of WSIT can extend the IDL2CODE tool. The IDL2CODE tool reads the users IDL file, populates an in-memory object model and then runs templates over the data. These templates are written in the Apache Velocity Template Language (VTL). To review the template that WSIT uses to generate code, see the directory root `WSI$ROOT:[TOOLS.TEMPLATES…]`.

The list of templates to "run" is located in the file `WSI$ROOT:[TOOLS.TEMPLATES]Master.vm`.

You are free to add your own template to `Master.vm`. When doing so, you can have the WSIT IDL2CODE tool generate any other code which you'd like. All of the files for this sample are located in the directory `WSI$ROOT:[SAMPLES.TEMPLATES]`.

The primary purpose of this template is to illustrate how you can easily leverage the WSIT object model.

This sample shows how you can generate custom routines by using the interface data that the WSIT IDL2CODE tools reads from your IDL file. This sample generates special code to work around a WSIT design restriction. The restriction is that WSIT does not support a Structure that contains Fields whose size is not evenly divisible by eight (not based on a byte). The way this template solves the issue is by generating a copy routine for these special structures. The copy routine will copy from a structure with padded byte field to the original structure with bit fields.

With this helper routine being generated, the original code can simply call the copy routine with the incoming padded structure and then receive a copy which is based on bit-fields. The original application would only need to add a single line to their code to handle the translation.

For example, the sample uses an original structure with bit fields. The structure will be exposed with fields padded to bytes. When a structure with bit fields is being processed by the IDL2CODE.JAR tool the extension will generate a special routine. This routine will be able to copy the padded data structure to the original structure. The prototype for this routine is as follows:

```
extern unsigned int COPY_MYSTRUCT (MYSTRUCT_WITHBYTES *source, MYSTRUCT
*destination)
```

The structure definitions are shown below:

```
// This is the original structure that uses bit feilds.
typedef struct _MYSTRUCT {
        unsigned int field1;
        unsigned field2:1;
        unsigned field3:1;
        unsigned int field4;
} MYSTRUCT;

// This is the version of _MYSTRUCT that pads
// bit fields to byte fields to be passed accross
// WSIT
typedef struct _MYSTRUCT_WITHBYTES {
        unsigned int field1;
        unsigned char field2;
        unsigned char field3;
        unsigned int field4;
} MYSTRUCT_WITHBYTES;
```

The custom template file generates a separate copy routine for each structure in the WSIT IDL with a name ending `in _WITHBYTES`. This can easily be modified as desired.

For example:

```
        <Structure Name = "MYSTRUCT_WITHBYTES"
           <TotalPaddedSize = "10">
           <Field  Name = "field1"
                   Type = "unsigned int"
                   Offset = "0"/>
           <Field  Name = "field2"
                   Type = "byte"
                   Offset = "4"/>
            <Field  Name = "field3"
                    Type = "byte"
                    Offset = "5"/>
            <Field  Name = "field4"
                    Type = "unsigned int"
                    Offset = "6"/>
        </Structure>
```

When the IDL2CODE.JAR tool is run for the IDL above, it will generated the file `[.generatedappextension.appextensionServer]customer-extension.c` . This file is the custom extension and it contains the following generated code. Note: the code below can be in any programming language.

```
extern unsigned int COPY_MYSTRUCT (MYSTRUCT_WITHBYTES *source, MYSTRUCT
*destination)
{
    destination->field1  =  source->field1;
    destination->field2  =  source->field2;
    destination->field3  =  source->field3;
    destination->field4  =  source->field4;

    return 1;
}
```

With this helper routine being generated, the original code can simply call COPY_MYSTRUCT with the incoming padded structure and then receive a copy which is based on bit-fields.

For more details look at the sample in the directory WSI$ROOT:[SAMPLES.TEMPLATES]

```
Directory WSI$ROOT:[SAMPLES.TEMPLATES]

appextension.opt;1  build-appextension-server.com;1          BUILD-TEMPLATE-
SAMPLE.COM;1
codewithbits.c;1    customer-extension.vm;1                  datastructures.h;1
extension.xml;1
```

A command procedure is provided to help you build the sample. Note that this file expects that the following customer template has been added to the WSIT environment.

Use the following steps to add your own template to the WSIT environment:

1) SET DEFAULT WSI$ROOT:[TOOLS.TEMPLATES]

2) Copy new template to directory holding all server-side related templates.

   ```
   $ COPY customer-extension.vm WSI$ROOT:[TOOLS.TEMPLATES.SERVERWRAPPER]
   ```

3) MODIFY the file `WSI$ROOT:[TOOLS.TEMPLATES]Master.vm` to `include customer-extension.vm` in the list of templates to run with the OBJ2IDL tool.

   Add the line below to the section named "! Server Wrapper Files"

   ```
   SW ${application.Name} customer-extension.c customer-extension.vm
   ```

6 MODIFYING IDL FILES

This chapter is intended for experienced Web Services Integration Toolkit users.

To wrap an application, the Web Services Integration Toolkit generates and passes a description of the application's API that is to be wrapped. Although it is primarily the WSIT tools that interact with this interface definition, there may be times when a developer wants to read or modify the IDL manually. For this reason, consideration was given to the layout of the WSIT Interface Definition Language (IDL) file in order to make it as easy as possible for a developer to manually read and modify it.

A WSIT IDL file is an XML file that has an easy to understand nested layout that allows a developer to completely describe their application in a language-neutral way. It does this by allowing the definition of all routines and structures that are to be exposed by the application. Within these routine and structure definitions, all parameter and field datatypes are mapped (translated) into their OpenVMS equivalent datatypes. In general, the mapping takes one of the following two forms:

"User datatype specification" → typedef translation[n] → Primitive translation → > OpenVMS primitive (datatype)

or

"User datatype specification" → typedef translation[n] → Structure definition

Note: The [n] shows that any number of typedef translations may occur before the final translation to an OpenVMS datatype (primitive) or structure definition.

The following sections describe how each component (routine, structure, and so on), and each type of translation (mapping), is defined within the WSIT IDL file.

6.1 OpenVMS Interface Block

The <OpenVMSInterface> block is the main block that encapsulates all of the blocks that collectively describe the application's interface. It has the following format:

```
<OpenVMSInterface
        xmlns="hp/openvms/integration"
        xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        xsi:schemaLocation="hp/openvms/integration
              openvms-integration.xsd"
        ModuleName="DISK:[MYDIR.STOCK]stock.OBJ"
        Language="C89">
        .
        <Enumerations>
        </Enumerations>
        .
        <Typedefs>
        </Typedefs>
        .
        <Primitives>
        </Primitives>
        .
        <Structures>
        </Structures>
        .
```

```
            <Routines>
            </Routines>
            .
        </OpenVMSInterface>
```

Except for the first line in the XML file, `<?xml version="1.0" encoding="UTF-8"?>`, all lines within the WSIT IDL file reside within the <OpenVMSInterface> block.

The properties within the <OpenVMSInterface> tag (in bold above) are primarily generic header information that is required, and is identical, for all WSIT IDL files. The two notable exceptions are the ModuleName and Language properties, described in the following table:

Property Name	**Description**
ModuleName	For 3GL based applications, this is the fully qualified file specification of the OBJ module that contains the application's interface. For ACMS based applications, this is the ACMS application name.
Language	This is the language in which the interface module was written in, such as C89, BASIC, COBOL, and ACMS, …

The blocks nested within the <OpenVMSInterface> block (shown above), contain the collection of definitions corresponding to that component or translation type.

For example, the <Routines> block contains all of the individual <Routine> blocks that describe the exposed routines of an application. The <Structures> block contains the list of <Structure> definitions; the <Primitives> block contains the list of <Primitive> or OpenVMS datatype translations; the <Typedefs> block contains the list of <Typedef> definitions; and the <Enumerations> block contains the list of <Enumeration> definitions.

All of the individual definition blocks and tags are described in greater detail in the following sections.

6.2 Enumeration Block

The collection of <Enumeration> blocks contains all of the constant definitions that are defined as enumerations within the application. An <Enumeration> is made up of a name, an OpenVMS datatype, an optional size in bytes, and the list of Name/Value pairs. The format of the block is as follows:

```
        <Enumerations>
            <Enumeration Name = "myenums"
                            VMSDataType = "DSC$K_DTYPE_L"
                            ByteSize = "4">
                […see Enumerator block for more information…]
            </Enumeration>
        </Enumerations>
```

The properties of the <Enumerations> tag are defined as follows:

Property Name	**Description**
Name	The name given to this collection of enumerators.
VMSDataType	The equivalent OpenVMS datatype of the enumeration. The *DSC$K_DTYPE_** values are used to specify them in a language & application independent way.
ByteSize	The size, in bytes, of the specified datatype.

6.3 Enumerator Block

Each Enumerator within an enumerator collection (an Enumeration) specifies a name/constant value pair. These pairs make up the set of valid values for the Enumeration. The format of an Enumerator is as follows:

```
        <Enumeration …>
                <Enumerator  Name = “PIC$SIZE1”  ConstantValue = “1”/>
                <Enumerator  Name = “PIC$SIZE2”  ConstantValue = “2”/>
        </Enumeration>
```

The properties within the <Enumerator> tag are as follows:

Property Name	Description
Name	The name given to the specified constant value.
ConstantValue	The constant value associated with the specified name.

6.4 Typedef Block

The collection of <Typedef> blocks contains all of the typedef translations used within the application. Each <Typedef> tag describes a user defined mapping of a type name to an equivalent type. In C, this looks similar to the following:

```
        typedef  myint unsigned int;
```

Each <Typedef> tag has the following format:

```
        <Typedef    Name = “myint”
                       TargetName = “unsigned int”/>
```

Where each property is defined below:

Property Name	Description
Name	The user defined name associated with the typedef within the application.
TargetName	The equivalent datatype that this typedef maps to. This may specify another typedef, a primitive, or a structure definition.

6.5 Primitive Block

The collection of <Primitive> blocks contains the datatype translations to their OpenVMS equivalents for all datatypes used within an application. Each <Primitive> mapping contains the datatype, the OpenVMS datatype (primitive) that it maps to, and any other information needed to completely describe that primitive. For example, the format for a <Primitive> tag that describes a Packed Decimal is as follows:

```
  <Primitive Name = "DSC$K_DTYPE_P_5_2"
                    Size = "5"
                    Scale = "2"
                    VMSDataType = "DSC$K_DTYPE_P" />
```

The properties of the <Primitive> tag are described below:

Property Name	Description
Name	The application or language specific name for the specified datatype, such as unsigned int or PIC 9(8). See **Note**.
VMSDataType	The equivalent OpenVMS datatype specification. The

	*DSC$K_DTYPE_** values are used to specify them in a language neutral way.
Size	The size in bytes of the primitive being defined. This is ignored for datatypes whose size is constant, such as *DSC$K_DTYPE_L*. If the datatype is a string, and the size is 0, then the string is considered dynamically sized.
Scale	Only used with scaled numeric datatypes, this property specifies the scale factor for the primitive being defined. Note that a positive scale factor specifies that the decimal point moves to the left. (The example above would represent a number with the format of 123.45.)
FixedFlag	Only used with string datatypes, this informational property specifies that the string being defined is of fixed size. A value of 1 specifies fixed size, while a 0 specifies that the string is dynamically sized.
NullTerminatedFlag	Only used with string datatypes, this property specifies if a null terminator should be appended to the end of the string. For fixed length strings, the string will be truncated if needed in order to append the null terminator. A value of 1 says to append a null, while a value of 0 specifies no null.

Note For datatypes that are the same but differ in size and/or scale, the Primitive Name must be unique. One way to do this is to embed the size and scale values into the Primitive Name itself. (See Packed Decimal example above.)

6.6 Structure Block

The collection of <Structure> blocks contains all of the user defined structure (record) definitions. Each <Structure> block represents a single user defined structure (record) definition. All parameters and fields must eventually map to an OpenVMS primitive, or one of these structure definitions. The format of the <Structure> block is as follows:

```
      <Structures>
             <Structure Name = "MyStruct"
                                   TotalPaddedSize = "128">
             […See Field Block below for more information…]
             </Structure>
       </Structure>
```

The properties of the <Structure> tag are as follows:

Property Name	Description
Name	The user specified name given to this structure (record, workspace, …) definition.
TotalPaddedSize	The size of the structure, including any padding added for alignment purposes.

6.7 Field Block

Each <Field>…</Field> block describes a single field within a structure. The format of a <Field> block is as follows:

```
        <Structure … >
          <Field  Name = "Fld1"
                  Type = "signed int"
```

```
                Offset = "0"/>
              <Field  Name = "Fld2"
                Type = "FixedString16"
                Offset = "4"/>
              <Field  Name = "AryFld3"
                Type = "signed int"
                Offset = "20"
              ArrayDimension = "1"
                RowByColumn = "0">
                <Array LowerBound = "0"
                       UpperBound = "9"/>
        </Field>
    </Structure>
```

The properties of the <Field> tag are as follows:

Property Name	Description
Name	The user specified name given to this field
Type	The language dependant or application specific datatype associated with this field.
Offset	The offset (within the structure) to the start of this field.
ArrayDimension	If this field is an array of elements, this property specifies the number of dimensions within the array.
RowByColumn	If this field is a multi-dimensional array of elements, this property specifies the ordering of the dimensions within memory. All languages, besides Fortran, use a RowByColumn layout. Use a "1" to specify RowByColumn, and a "0" to specify ColumnByRow (Fortran).
<Array> Tag	See below.

6.7 1 **Field Array Tag**

For fields and parameters that are arrays, the <Array> tag is used to specify dimension information for a single dimension. The number of <Array> tags must match the number specified in the ArrayDimension Field property above. The format of the Array tag is shown above.

The properties of the <Array> are as follows:

Property Name	Description
LowerBound	The user specified lower bound of this dimension.
UpperBound	The user specified upper bound of this dimension. Note that the upper bound must be larger than the lower bound.

6.8 **Routine Block**

The collection of <Routine> blocks contains all of the definitions for the routines being exposed by the application. Each <Routine> block contains the complete description of a single exposed routine call, including all parameter & return information. The format for the <Routines> block is as follows:

```
<Routines>
    <Routine Name = "MyRoutine"
                ReturnType = "unsigned int"
                Description = "This is the description for my routine">
    […Refer to the Parameter block section below for more information…]
    <\Routine>
<\Routines>
```

The properties of the <Routine> tag are as follows:

Property Name	**Description**
Name	The user specified name for this exposed routine.
ReturnType	The language dependant or application specific datatype associated with this routine's return type.
Description	A user specified description to be associated with this routine definition.
MethodID	Species a value to use as the internal method ID instead of the one automatically generated for this routine. This is only useful in rare cases for backwards compatibility within the generated interface.
<Parameter> Tag	See below for more information.

6.9 Parameter Block

The <Parameter> Block is used to describe a single parameter within a routine's parameter list. There will be one <Parameter> tag for each parameter passed in or out of the routine. The <Parameter> block has the following formats:

```
<Routine …>
           <Parameter Name = "Param1"
                      Type = "unsigned int"
                      PassingMechanism = "Value"
                      Usage = "IN"/>
           <Parameter Name = "AryParam2"
                      Type = "__int16"
                      PassingMechanism = "Reference"
                      Usage = "IN/OUT"
                      ArrayDimension = "1"
                      RowByColumn = "1"
                      ArrayDescriptorType = "DSC$K_CLASS_A">
                      <Array LowerBound = "0"
                             UpperBound = "10"/>
           </Parameter>
           <Parameter Name = "AryParam3"
                      Type = "__int16"
                      PassingMechanism = "Descriptor"
                      Usage = "IN/OUT"
                      ArrayDimension = "1"
                      RowByColumn = "1"
                      ArrayDescriptorType = "DSC$K_CLASS_A">
           </Parameter>
</Routine>
```

The <Parameter> tag has the following properties:

Property Name	**Description**
Name	The user specified name for this parameter.
Type	The language dependant or application specific datatype associated with this parameter type.
PassingMechanism	The OpenVMS based passing mechanism used to pass this parameter. It can be "Value", "Reference", or "Descriptor".
Usage	This property specifies how this parameter will be effected by the called routine. It is either "IN", which specifies that it doesn't

	modify the value, or “IN/OUT” which specifies that it does modify this value.
ArrayDimension	If this parameter is an array of elements, this property specifies the number of dimensions within the array.
RowByColumn	If this parameter is a multi-dimensional array of elements, this property specifies the ordering of the dimensions within memory. All languages, besides Fortran, use a RowByColumn layout. Use a “1” to specify RowByColumn, and a “0” to specify ColumnByRow (Fortran).
ArrayDescriptorType	If this parameter is an array passed by descriptor, this property specifies the descriptor class that should be used when passing this array. The valid values for this property are, “DSC$K_CLASS_A”, “DSC$K_CLASS_NCA”, DSC$K_CLASS_VSA.
Resizable	Special case only: If this parameter is specified as a single dimensional byte array, passed by descriptor, with a usage of “IN/OUT”, then setting this property to “1” defines this parameter as a resizable byte array.
FreeMemory	Special case only: If this parameter is defined as a resizable byte array, then setting this property to “1” will specify that a freeing of the array memory needs to take place after the call.
<Array> Tag	See below for more information.

6.9.1 Parameter Array Tag

For field arrays, and parameter arrays that are passed by reference, the <Array> tag is used to specify dimension information for a single dimension. For Parameter arrays that are passed by reference, the number of <Array> tags must match the number specified in the ArrayDimension Parameter property above. The format of the Array tag is shown above.

The properties of the <Array> are as follows:

Property Name	Description
LowerBound	The user specified lower bound of this dimension.
UpperBound	The user specified upper bound of this dimension. Note that the upper bound must be larger than the lower bound.

6.10 Example WSIT IDL File

```
<?xml version="1.0" encoding="UTF-8"?>
<OpenVMSInterface
       xmlns="hp/openvms/integration"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xsi:schemaLocation="hp/openvms/integration openvms-integration.xsd"
       ModuleName="disk$:[workshop.lab1]math.obj"
       Language="C89">
       <Primitives>
         <Primitive Name = "unsigned int"
                    Size = "4"
                    VMSDataType = "DSC$K_DTYPE_LU"/>
         <Primitive Name = "signed int"
                    Size = "4"
                    VMSDataType = "DSC$K_DTYPE_L"/>
       </Primitives>
       <Routines>
```

```
         <Routine  Name = "sum"
                   ReturnType = "unsigned int">
                   <Parameter Name = "number1"
                              Type = "signed int"
                              PassingMechanism = "Value"
                              Usage = "IN"/>
                   <Parameter Name = "number2"
                              Type = "signed int"
                              PassingMechanism = "Value"
                              Usage = "IN"/>
         </Routine>
         <Routine  Name = "product"
                   ReturnType = "unsigned int">
                   <Parameter Name = "number1"
                              Type = "signed int"
                              PassingMechanism = "Value"
                              Usage = "IN"/>
                   <Parameter Name = "number2"
                              Type = "signed int"
                              PassingMechanism = "Value"
                              Usage = "IN"/>
         </Routine>
       </Routines>
</OpenVMSInterface>
```

APPENDIX

This appendix contains program listings for the C sample program. Other sample programs can be found in WSI$ROOT:[SAMPLES.ACMS], WSI$ROOT:[SAMPLES.COBOL], and WSI$ROOT:[SAMPLES.FORTRAN].

A Program Listing - STOCK.C

```
$ ty stock.c
//
// This is a sample file intended to be used to demonstrate the WSIT product.
// It defines 2 routines: (buy and sell). Each routine accepts 3 structures:
// buyerData, sellerData, tickerData.
//
// This code is intended only to illustrate the WSIT product and is not intended provide
// a usefull stock trading application.
//
//
#include <string.h>
#include <stdlib.h>
#include <stdio.h>

const MAX_STRING = 20;

typedef struct _buyerData {
        char buyer_name[MAX_STRING];
        unsigned int member_number;
        unsigned int balance_dollars;
        unsigned int number_shares_desired;
} buyerData;

typedef struct _sellerData {
        char owner_name[MAX_STRING];
        unsigned int member_number;
        unsigned int balance_dollars;
        unsigned int number_shares_available;
} sellerData;

typedef struct _tickerData {
        char symbol[MAX_STRING];
        char company_name[MAX_STRING];
} tickerData;

unsigned int buy (unsigned int max_price, tickerData *symbol, sellerData *pSeller,
buyerData *pBuyer) {

        //
        // Sell as many shares as possible
        //
        unsigned int shares_purchased = 0;
        if ( pSeller->number_shares_available >= pBuyer->number_shares_desired) {
           shares_purchased = pBuyer->number_shares_desired;
        } else {
           shares_purchased = pSeller->number_shares_available;
        }

        pSeller->number_shares_available = pSeller->number_shares_available -
           shares_purchased;

        return shares_purchased;
}
```

```
unsigned int sell (unsigned int min_price, tickerData *symbol, sellerData *pSeller,
buyerData *pBuyer) {

        //
        // Sell as many shares as possible
        //
        unsigned int shares_sold = 0;
        if ( pSeller->number_shares_available >= pBuyer->number_shares_desired) {
           shares_sold = pBuyer->number_shares_desired;
        } else {
           shares_sold = pSeller->number_shares_available;
        }

        pSeller->number_shares_available = pSeller->number_shares_available -
           shares_sold;

        return shares_sold;
}
$
```

B Program Listing - STOCK.XML

```
<?xml version="1.0" encoding="UTF-8"?>
<OpenVMSInterface
       xmlns="hp/openvms/integration"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xsi:schemaLocation="hp/openvms/integration openvms-integration.xsd"
       ModuleName="wsi$root:[samples.c]stock.obj"
       Language="C89">
       <Primitives>
         <Primitive Name = "unsigned int"
                    Size = "4"
                    VMSDataType = "DSC$K_DTYPE_LU"/>
         <Primitive Name = "AutoGen_FixedString19"
                    Size = "19"
                    VMSDataType = "DSC$K_DTYPE_T"
                    NullTerminatedFlag = "0"
                    FixedFlag = "1"/>
       </Primitives>
       <Typedefs>
         <Typedef   Name = "tickerData"
                    TargetName = "_tickerData"/>
         <Typedef   Name = "sellerData"
                    TargetName = "_sellerData"/>
         <Typedef   Name = "buyerData"
                    TargetName = "_buyerData"/>
       </Typedefs>
       <Structures>
         <Structure Name = "_tickerData"
                    TotalPaddedSize = "40">
                    <Field  Name = "symbol"
                            Type = "AutoGen_FixedString19"
                            Offset = "0"/>
                    <Field  Name = "company_name"
                            Type = "AutoGen_FixedString19"
                            Offset = "20"/>
         </Structure>
         <Structure Name = "_sellerData"
                    TotalPaddedSize = "32">
                    <Field  Name = "owner_name"
                            Type = "AutoGen_FixedString19"
                            Offset = "0"/>
```

```
             <Field  Name = "member_number"
                     Type = "unsigned int"
                     Offset = "20"/>
             <Field  Name = "balance_dollars"
                     Type = "unsigned int"
                     Offset = "24"/>
             <Field  Name = "number_shares_available"
                     Type = "unsigned int"
                     Offset = "28"/>
  </Structure>

  <Structure Name = "_buyerData"
             TotalPaddedSize = "32">
             <Field  Name = "buyer_name"
                     Type = "AutoGen_FixedString19"
                     Offset = "0"/>
             <Field  Name = "member_number"
                     Type = "unsigned int"
                     Offset = "20"/>
             <Field  Name = "balance_dollars"
                     Type = "unsigned int"
                     Offset = "24"/>
             <Field  Name = "number_shares_desired"
                     Type = "unsigned int"
                     Offset = "28"/>
</Structure>
</Structures>
<Routines>
  <Routine  Name = "buy"
            ReturnType = "unsigned int">
            <Parameter Name = "max_price"
                       Type = "unsigned int"
                       PassingMechanism = "Value"
                       Usage = "IN"/>
            <Parameter Name = "symbol"
                       Type = "tickerData"
                       PassingMechanism = "Reference"
                       Usage = "IN/OUT"/>
            <Parameter Name = "pSeller"
                       Type = "sellerData"
                       PassingMechanism = "Reference"
                       Usage = "IN/OUT"/>
            <Parameter Name = "pBuyer"
                       Type = "buyerData"
                       PassingMechanism = "Reference"
                       Usage = "IN/OUT"/>
  </Routine>
  <Routine  Name = "sell"
            ReturnType = "unsigned int">
            <Parameter Name = "min_price"
                       Type = "unsigned int"
                       PassingMechanism = "Value"
                       Usage = "IN"/>
            <Parameter Name = "symbol"
                       Type = "tickerData"
                       PassingMechanism = "Reference"
                       Usage = "IN/OUT"/>
            <Parameter Name = "pSeller"
                       Type = "sellerData"
                       PassingMechanism = "Reference"
                       Usage = "IN/OUT"/>
            <Parameter Name = "pBuyer"
                       Type = "buyerData"
```

```
                              PassingMechanism = "Reference"
                              Usage = "IN/OUT"/>
        </Routine>
      </Routines>
</OpenVMSInterface>
$
```

C Program Listing - StockCaller.Java

```
$ type stockcaller.java
import stock.*;
import java.io.*;
import javax.xml.rpc.holders.StringHolder;
import javax.xml.rpc.holders.StructureHolder;

public class stockcaller {

    /** Creates a new instance of Main */
    public stockcaller() {
    }

    public static void main(String[] args) {

        try {

          stockImpl stock = new stockImpl();

          // create a seller object and place in holder
   _sellerData sellerData = new _sellerData("Mr Seller", 12345, 1000000, 1000);
          ObjectHolder seller =  new ObjectHolder (sellerData);

          // create a buyer object and place in holder
          _buyerData buyerData = new _buyerData("Mr Buyer", 67890, 5000, 995);
                ObjectHolder buyer =  new ObjectHolder (buyerData);

          // create a ticker object and place in holder
          _tickerData tickerData = new _tickerData("HPQ", "Hewitt Packard");
          ObjectHolder ticker =  new ObjectHolder (tickerData);

          System.out.println("The sellers number_shares_available: " +
              sellerData.getNumber_shares_available());
          stock.buy(27, ticker, seller, buyer);
          System.out.println("The sellers number_shares_available: " +
              sellerData.getNumber_shares_available());

        } catch (Exception e) {
                System.out.println("Exception thrown");
        }
    }
}
$
```

D Program Listing – MATH.C

```
unsigned int sum ( int number1, int number2) {
  return number1 + number2;
}

unsigned int product ( int number1, int number2) {
  return number1 * number2;
}
```

E Program Listing – MATH.XML

```
<?xml version="1.0" encoding="UTF-8"?>
<OpenVMSInterface
       xmlns="hp/openvms/integration"
       xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
       xsi:schemaLocation="hp/openvms/integration openvms-integration.xsd"
       ModuleName="DISK$ODS5:[aaa.wsit.math]math.OBJ"
       Language="C89">
       <Primitives>
         <Primitive Name = "unsigned int"
                    Size = "4"
                    VMSDataType = "DSC$K_DTYPE_LU"/>
         <Primitive Name = "signed int"
                    Size = "4"
                    VMSDataType = "DSC$K_DTYPE_L"/>
       </Primitives>
       <Routines>
         <Routine  Name = "sum"
                   ReturnType = "unsigned int">
                   <Parameter Name = "number1"
                              Type = "signed int"
                              PassingMechanism = "Value"
                              Usage = "IN"/>
                   <Parameter Name = "number2"
                              Type = "signed int"
                              PassingMechanism = "Value"
                              Usage = "IN"/>
         </Routine>
         <Routine  Name = "product"
                   ReturnType = "unsigned int">
                   <Parameter Name = "number1"
                              Type = "signed int"
                              PassingMechanism = "Value"
                              Usage = "IN"/>
                   <Parameter Name = "number2"
                              Type = "signed int"
                              PassingMechanism = "Value"
                              Usage = "IN"/>
         </Routine>
       </Routines>
</OpenVMSInterface>
```

F Program Listing – mathcaller.java

```
import math.*;
import java.io.*;

public class mathcaller {

    /** Creates a new instance of Main */
    public mathcaller() {
    }

    public static void main(String[] args) {

        try {
                        mathImpl math = new mathImpl();

                int num1 = 10;
                int num2 = 15;
                int result;

                result = math.sum(num1, num2);
                System.out.println("Sum of " + num1 + " and " + num2 + " is " + result);

                result = math.product(num1, num2);
                System.out.println("Product of " + num1 + " and " + num2 + " is " +
                  result);


        } catch (Exception e) {
                System.out.println("Exception thrown");
                e.printStackTrace();
        }
    }
}
```