ORBacus
For C++ and Java

Version 3.1.1

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CHAPTER 1

Introduction

1.1 What is ORBacus?

ORBACUS is an Object Request Broker (ORB) that is compliant with the Common Object Request Broker Architecture (CORBA) specification as defined in “The Common Object Request Broker: Architecture and Specification” [2] and “IDL/Java Language Mapping” [3].

These are some of the highlights of the ORBACUS 3.1 release:

- Full CORBA IDL support
- Complete CORBA IDL-to-C++ mapping
- Complete CORBA IDL-to-Java mapping
- Includes the Basic CORBA Services *Naming, Event* and *Property*
- Pluggable Protocols with IIOP as the default plug-in
- Single- and Multi-Threaded support with several concurrency models: *Blocking*, *Reactive*, *Threaded*, *Thread-per-Client*, *Thread-per-Request* and *Thread Pool*
- Nested method invocations, even in the single-threaded version
- Support for timeouts
- Seamless event loop integration with X11 and Windows
- Full support for dynamic programming: Dynamic Invocation Interface, Dynamic Skeleton Interface, Interface Repository and DynAny

- IDL-to-HTML and IDL-to-RTF translators for generating "javadoc"-style documentation

This version of ORBACUS has the following limitations:

- Only persistent (i.e., manually launched) servers are currently supported.

For platform availability, please refer to the ORBACUS home page at `http://www.ooc.com/ob/`.

1.2 How is it licensed?

ORBACUS is licensed as "free for non-commercial use." See the license agreement in Appendix C for details. For information on commercial licenses, please see the pricing information on our Web site, or contact `support@ooc.com`.

1.3 About this Document

This manual is - except for the "Getting Started" chapter - no replacement for a good CORBA book. This manual also does not contain the precise specifications of the CORBA standard, which are freely available on-line. A good grasp of the CORBA specifications in [2] and [3] is absolutely necessary to effectively use this manual. In particular, the chapters in [2] covering CORBA IDL and the IDL-to-C++ mapping should be studied thoroughly.

Do not expect any of the introductory CORBA books to provide a reference for the IDL-to-C++ mapping. The books that are currently available only give an overview and are neither complete nor up-to-date. *There is no substitute for the official CORBA specification as defined in [2].*

What this manual does contain, however, is information on *how* ORBACUS implements the CORBA standard. A shortcoming of the current CORBA specification is that it leaves a high degree of freedom to the CORBA implementation. For example, the precise semantics of a oneway call are not specified by the standard.

To make it easier to get started with ORBACUS, this manual contains a "Getting Started" chapter, explaining some ORBACUS basics with a very simple example.

1.4 Getting Help

Should you need any assistance with ORBACUS, do not hesitate to contact us at `support@ooc.com`. You might also consider joining our ORBACUS mailing list. To do so, send a message to `majordomo@ooc.com` (not `ob@ooc.com`) with

```
subscribe ob
```

in the body (not in the `Subject:` field) of your message. To unsubscribe, use

```
unsubscribe ob
```

in the body of your message. To send a message to the list, mail to `ob@ooc.com` (not `majordomo@ooc.com`).

An archive of the ORBACUS mailing list can be found at `http://www.ooc.com/ob/mailing-list.html`.

CHAPTER 2

Getting Started

2.1 The “Hello World” Application

The example described in this chapter is founded on a well-known application: A “Hello World!” program presented here in a special client-server version.

Many books on programming start with this tiny demo program. In introductory C++ books you'll probably find the following piece of code in the very first chapter:

```
// C++

#include <iostream.h>

int
main(int, char*[], char*[])
{
   cout << "Hello World!" << endl;
   return 0;
}
```

Or in introductory Java books:

```
// Java

public class Greeter
{
   public static void main(String args[])
```

```
    {
        System.out.println("Hello World!");
    }
}
```

These applications simply print "Hello World!" to standard output and that is exactly what this chapter is about: Printing "Hello World!" with a CORBA-based client-server application. In other words, we will develop a client program that invokes a `hello` operation on an object in a server program. The server responds by printing "Hello World!" on its standard output.

2.2 The IDL Code

How do we write a CORBA-based "Hello World!" application? The first step is to create a file containing our IDL definitions. Since our sample application isn't a complicated one, the IDL code needed for this example is simple:

```
1 // IDL
2
3 interface Hello
4 {
5     void hello();
6 };
```

3 An interface with the name `Hello` is defined. An IDL interface is conceptually equivalent to a pure abstract class in C++, or to an interface in Java.

5 The only operation defined is `hello`, which neither takes any parameters nor returns any value.

2.3 Implementing the Example in C++

The next step is to translate the IDL code to C++ using the IDL-to-C++ translator. Save the IDL code shown above to a file called `Hello.idl`. Now translate the code to C++ using the following command:

```
idl Hello.idl
```

This command will create the files `Hello.h`, `Hello.cpp`, `Hello_skel.h` and `Hello_skel.cpp`.

2.3.1 Implementing the Server

To implement the server, we need to define an implementation class for the `Hello` interface. To do this, we create a class `Hello_impl` that is derived from the “skeleton” class `Hello_skel`, defined in the file `Hello_skel.h`. The definition for `Hello_impl` looks like this:

```
 1  // C++
 2
 3  #include <Hello_skel.h>
 4
 5  class Hello_impl : public Hello_skel
 6  {
 7  public:
 8
 9     virtual void hello();
10  };
```

3 Since our implementation class derives from the skeleton class `Hello_skel`, we must include the file `Hello_skel.h`.

5 Here we define `Hello_impl` as a class derived from `Hello_skel`.

9 Our implementation class must implement all operations from the IDL interface. In this case, this is just the operation `hello`.

The implementation for `Hello_impl` looks as follows:

```
 1  // C++
 2
 3  #include <OB/CORBA.h>
 4  #include <Hello_impl.h>
 5
 6  void
 7  Hello_impl::hello()
 8  {
 9     cout << "Hello World!" << endl;
10  }
```

3 We must include `OB/CORBA.h`, which contains definitions for the standard CORBA classes, as well as for other useful things.

4 We must also include the `Hello_impl` class definition, contained in the header file `Hello_impl.h`.

6-10 The `hello` function simply prints “Hello World!” on standard output.

Save the class definition of `Hello_impl` in the file `Hello_impl.h` and the implementation of `Hello_impl` in the file `Hello_impl.cpp`.

Now we need to write the server's `main` program, which looks like this:

```
 1 // C++
 2
 3 #include <OB/CORBA.h>
 4 #include <Hello_impl.h>
 5
 6 #include <fstream.h>
 7
 8 int
 9 main(int argc, char* argv[], char*[])
10 {
11     CORBA_ORB_var orb = CORBA_ORB_init(argc, argv);
12     CORBA_BOA_var boa = orb -> BOA_init(argc, argv);
13
14     Hello_var p = new Hello_impl;
15
16     CORBA_String_var s = orb -> object_to_string(p);
17     const char* refFile = "Hello.ref";
18     ofstream out(refFile);
19     out << s << endl;
20     out.close();
21
22     boa -> impl_is_ready(CORBA_ImplementationDef::_nil());
23 }
```

3-6 Several header files are included. Of these, `OB/CORBA.h` provides the standard CORBA definitions, and `Hello_impl.h` contains the definition of the `Hello_impl` class.

11,13 The first thing a CORBA program has to do is to initialize the ORB[1] and the BOA[2]. This is done by `CORBA_ORB_init` and `BOA_init`. Both operations expect the parameters with which the program was started. These parameters may or may not be used by the `ORB` and `BOA`, depending on the CORBA implementation. ORBACUS recognizes certain options that will be explained later.

1. **O**bject **R**equest **B**roker
2. **B**asic **O**bject **A**dapter

14 An instance of `Hello_impl` is created. `Hello_var`, like all `_var` types, is a “smart” pointer, i.e., `p` will release the object created by `new Hello_impl` automatically when `p` goes out of scope.

16-20 The client must be able to access the implementation object. This can be done by saving a “stringified” object reference to a file which can be read by the client and converted back to the actual object reference.[1] The operation `object_to_string()` converts a CORBA object reference into its string representation.

22 Finally, in order to react to incoming requests, the server must enter its event loop. This is done by calling `impl_is_ready`. Since ORBACUS does not use the `CORBA_ImplementationDef` argument, `CORBA_ImplementationDef::_nil()` can be used as a dummy argument.

Save this to a file with the name `Server.cpp`.

2.3.2 Implementing the Client

Writing the client requires less work than writing the server, since the client, in this example, only consists of the `main` function. In several respects the client's `main` is similar to the server's `main` function:

```
// C++

#include <OB/CORBA.h>
#include <Hello.h>

#include <fstream.h>

int
main(int argc, char* argv[], char*[])
{
   CORBA_ORB_var orb = CORBA_ORB_init(argc, argv);

   const char* refFile = "Hello.ref";
   ifstream in(refFile);
   char s[1000];
   in >> s;
   CORBA_Object_var obj = orb -> string_to_object(s);

```

1. If your application contains more than one object, you do not need to save object references for all objects. Usually you save the reference of one object which provides operations that can subsequently return references to other objects.

```
19      Hello_var hello = Hello::_narrow(obj);
20
21      hello -> hello();
22  }
```

4 In contrast to the server, the client does not need to include `Hello_impl.h`. Only the generated file `Hello.h` is needed.

11 Like the server's implementation of `main`, the client's `main` starts with the initialization of the `ORB`. It's not necessary to initialize the BOA, because the BOA is only needed by server applications.

13-17 The "stringified" object reference written by the server is read and converted to a `CORBA_Object` object reference.

19 The `_narrow` operation generates a `Hello` object reference from the `CORBA_Object` object reference.[1]

21 Finally, the `hello` operation on the `hello` object reference is invoked, causing the server to print "Hello World!".

Save this into the file `Client.cpp`.

2.3.3 Compiling and Linking

Both the client and the server must be linked with the compiled `Hello.cpp`, which usually has the name `Hello.o` under Unix and `Hello.obj` under Windows. The compiled `Hello_skel.cpp` and `Hello_impl.cpp` are only needed by the server.

Compiling and linking is to a large degree compiler- and platform-dependent. Many compilers require unique options to generate correct code. To build ORBACUS programs, you must at least link with the ORBACUS library `libOB.a` (Unix) or `ob.lib` (Windows). Additional libraries are required on some systems, such as`libsocket.a` and `libnsl.a` for Solaris or `wsock32.lib` for Windows.

The ORBACUS distribution comes with various `README` files for different platforms which give hints on the options needed for compiling and the libraries necessary for linking. Please consult these `README` files for details.

1. Although CORBA's `T::_narrow` for an interface `T` works similar to `dynamic_cast<T>()` for a plain C++ class `T`, `dynamic_cast<T>()` must not be used for CORBA object references.

2.3.4 Running the Application

Our “Hello World!” application consists of two parts: the client program and the server program. The first program to be started is the server, because it must create the file `Hello.ref` that the client needs in order to connect to the server. As soon as the server is running, you can start the client. If all goes well, the “Hello World!” message will appear on the screen.

2.4 Implementing the Example in Java

In order to implement this application in Java, the interface specified in IDL is translated to Java classes similar to the way the C++ code was created. The ORBACUS IDL-to-Java translator `jidl` is used like this:

```
jidl --package hello Hello.idl
```

This command results in several Java source files on which the actual implementation will be based. The generated files are `Hello.java`, `HelloHelper.java`, `HelloHolder.java`, `StubForHello.java` and `_HelloImplBase.java`, all generated in a directory with the name `hello`.

2.4.1 Implementing the Server

The server's `Hello` implementation class looks as follows:

```
 1  // Java
 2
 3  package hello;
 4
 5  public class Hello_impl extends _HelloImplBase
 6  {
 7     public void hello()
 8     {
 9        System.out.println("Hello World!");
10     }
11  }
```

5 The implementation class `Hello_impl` must inherit from the generated class `_HelloImplBase`.

7-9 As with the C++ implementation, the `hello` method simply prints “Hello World!” on standard output.

Save this class to the file `Hello_impl.java`.

We also have to write a class which holds the server’s `main` method. We call this class `Server`, saved in the file `Server.java`:

```
 1 // Java
 2 
 3 package hello;
 4 
 5 public class Server
 6 {
 7    public static void main(String args[])
 8    {
 9       org.omg.CORBA.ORB orb =
10          org.omg.CORBA.ORB.init(args, new java.util.Properties());
11       org.omg.CORBA.BOA boa =
12          orb.BOA_init(args, new java.util.Properties());
13 
14       Hello_impl p = new Hello_impl();
15 
16       try
17       {
18          String ref = orb.object_to_string(p);
19          String refFile = "Hello.ref";
20          java.io.PrintWriter out = new PrintWriter(
21             new java.io.FileOutputStream(refFile));
22          out.println(ref);
23          out.flush();
24       }
25       catch(java.io.IOException ex)
26       {
27          System.err.println("Can't write to ‘" +
28                             ex.getMessage() + "'");
29          System.exit(1);
30       }
31 
32       boa.impl_is_ready(null);
33    }
34 }
```

9-12 The ORB and BOA must be initialized. This is done using `ORB.init` and `ORB.BOA_init`. Note that all standard CORBA definitions are in the package `org.omg.CORBA`. That is, you must either import this package, or, as shown in our example, you must use `org.omg.CORBA` explicitly.

14 An instance of `Hello_impl` is created. This instance is released automatically when it is not used anymore.

16-30 The object reference is “stringified” and written to a file.

32 Finally, the server enters its event loop to receive incoming requests.

2.4.2 Implementing the Client

Save this to a file with the name `Client.java`:

```
 1 // Java
 2 
 3 package hello;
 4 
 5 public class Client
 6 {
 7    public static void main(String args[])
 8    {
 9       org.omg.CORBA.ORB orb =
10          org.omg.CORBA.ORB.init(args, new java.util.Properties());
11 
12       String ref = null;
13       try
14       {
15          String refFile = "Hello.ref";
16          java.io.BufferedReader in =
17             new java.io.BufferedReader(new FileReader(refFile));
18          ref = in.readLine();
19       }
20       catch(java.io.IOException ex)
21       {
22          System.err.println("Can't read from ‘" +
23                             ex.getMessage() + "'");
24          System.exit(1);
25       }
26       org.omg.CORBA.Object obj = orb.string_to_object(ref);
27 
28       Hello p = HelloHelper.narrow(obj);
29 
30       p.hello();
31    }
32 }
```

9-10 The ORB is initialized. BOA initialization is not necessary for clients.

12-26 The stringified object reference is read and converted to an object.

28 The object reference is “narrowed” to a reference to a `Hello` object. A simple Java cast doesn’t work here, since it is possible that the client has to ask the server whether the object is really of type `Hello`.

30 Finally the `hello` operation is invoked, causing the server to print “Hello World!” on standard output.

2.4.3 Compiling

To compile the implementation classes and the classes generated by the ORBACUS IDL-to-Java translator, use `javac` (or the Java compiler of your choice):

```
javac *.java hello/*.java
```

Ensure that your `CLASSPATH` environment variable includes the ORBACUS Java classes, i.e., the `OB.jar` file. If you are using the Unix Bourne shell or a compatible shell, you can do this with the following commands:

```
CLASSPATH=your_orbacus_directory/lib/OB.jar:$CLASSPATH
export CLASSPATH
```

Replace `your_orbacus_directory` with the name of the directory where ORBACUS is installed.

If you are running ORBACUS on a Windows-based system, you can use the following command within the Windows command interpreter:

```
set CLASSPATH=your_orbacus_directory/lib/OB.jar;%CLASSPATH%
```

Note that for Windows you must use “;” and not “:” as the delimiter.

2.4.4 Running the Application

The “Hello World” Java server is started with:

```
java hello.Server
```

And the client with:

```
java hello.Client
```

Again, make sure that your `CLASSPATH` environment variable includes the `OB.jar` file.

You might also want to use a C++ server together with a Java client (or vice versa). This is one of the primary advantages of using CORBA: If something is defined in CORBA IDL, the programming language used for the implementation is irrelevant. CORBA applications can talk with each other, regardless of the language they are written in.

2.5 Summary

At this point, you might be inclined to think that this is the most complicated method of printing a string that you have ever encountered in your career as a programmer. At first glance, a CORBA-based approach may indeed seem complicated. On the other hand, think of the benefits this kind of approach has to offer. You can start the server and client applications on different machines with exactly the same results. Concerning the communication between the client and the server, you don't have to worry about platform-specific methods or protocols at all, provided there is a CORBA ORB available for the platform and programming language of your choice. If possible, get some hands-on experience and start the server on one machine, the client on another[1]. As you will see, CORBA-based applications run interchangeably in both local and network environments.

One last point to note: you likely won't be using CORBA to develop systems as simple as our "Hello, World!" example. The more complex your applications become (and today's applications *are* complex), the more you will learn to appreciate having a high-level abstraction of your applications' key interfaces captured in CORBA IDL.

2.6 Where to go from here

To understand the remaining chapters of this manual, you *must* have read the CORBA specifications in [2] and [3]. You will not be able to understand the chapters that follow without a good knowledge of CORBA in general, CORBA IDL and the IDL-to-C++ and IDL-to-Java mappings.

1. Note that after the startup of the server program, you have to copy the stringified object reference, i.e., the file `Hello.ref`, to the machine where the client program is to be run.

CHAPTER 3

The ORBacus Code Generators

3.1 Overview

ORBACUS includes the following code generators and Interface Repository tools:

`idl`	The ORBACUS IDL-to-C++ Translator
`jidl`	The ORBACUS IDL-to-Java Translator
`hidl`	The ORBACUS IDL-to-HTML Translator
`ridl`	The ORBACUS IDL-to-RTF Translator
`irserv`	The ORBACUS Interface Repository Server
`irfeed`	The ORBACUS Interface Repository Feeder
`irdel`	The ORBACUS Interface Repository Deleter
`irgen`	The ORBACUS Interface Repository C++ Code Generator

3.2 Synopsis

`idl` [options] idl-files...

`jidl` [options] idl-files...

`hidl` [options] idl-files...

`ridl` [options] idl-files...

`irserv` [options] [idl-files...]

`irfeed` [options] idl-files...

`irdel` [options] scoped-name...

`irgen` name-base

3.3 Description

`idl` is the ORBacus IDL-to-C++ translator. It translates IDL files into C++ files. For each IDL file, four C++ files are generated. For example,

```
idl MyFile.idl
```

produces the following files:

`MyFile.h`	Header file containing `MyFile.idl`'s translated data types and interface stubs
`MyFile.cpp`	Source file containing `MyFile.idl`'s translated data types and interface stubs
`MyFile_skel.h`	Header file containing skeletons for `MyFile.idl`'s interfaces
`MyFile_skel.cpp`	Source file containing skeletons for `MyFile.idl`'s interfaces

`jidl` translates IDL files into Java files. For every construct in the IDL file that maps to a Java class or interface, a separate class file is generated. Directories are automatically created for those IDL constructs that map to a Java package (e.g., a `module`).

`jidl` can also add comments from the IDL file starting with `/**` to the generated Java files. This allows you to use the `javadoc` tool to produce documentation from the generated Java files. See "Using javadoc" on page 39 for additional information.

`hidl` creates HTML files from IDL files. An HTML file is generated for each module and interface defined in an IDL file. Comments in the IDL file are preserved and `javadoc` style keywords are supported. The section "Documenting IDL Files" on page 36 provides more information.

`ridl` creates Rich Text Format (RTF) files from IDL files. An RTF file is generated for each module and interface defined in an IDL file. Comments in the IDL file are preserved and `javadoc` style keywords are supported. The section “Documenting IDL Files” on page 36 provides more information.

`irserv` is the Interface Repository Server. Together with `irfeed`, a program that feeds the Interface Repository with IDL code, and `irgen`, the Interface Repository C++ Code Generator, it is possible to generate C++ code directly from the contents of an Interface Repository. See “The IDL-to-C++ Translator and the Interface Repository” on page 35 for an example.

3.4 Options for idl

`-h, --help`

Show a short help message.

`-v, --version`

Show the ORBACUS version number.

`-e, --cpp NAME`

Use `NAME` as the preprocessor program.

`-d, --debug`

Print diagnostic messages. This option is for ORBACUS internal debugging purposes only.

`-DNAME`

Defines `NAME` as `1`. This option is directly passed to the preprocessor.

`-DNAME=DEF`

Defines `NAME` as `DEF`. This option is directly passed to the preprocessor.

`-UNAME`

Removes any definition for `NAME`. This option is directly passed to the preprocessor.

`-IDIR`

Adds `DIR` to the include file search path. This option is directly passed to the preprocessor.

`--no-skeletons`

Don’t generate skeleton classes.

`--no-type-codes`

Don’t generate type codes and insertion and extraction functions for the Any type. Use of this option will cause the translator to generate more compact code.

`--locality-constrained`

Generate locality-constrained objects.

`--no-virtual-inheritance`

Don't use virtual C++ inheritance. If you use this option, you cannot use multiple interface inheritance in your IDL code, and you also cannot use multiple C++ inheritance to implement your servant classes.

`--tie`

Generate tie classes for delegate-based interface implementations. Tie classes depend on the corresponding skeleton classes, i.e., you must not use `--no-skeletons` in combination with `--tie`.

`--c-suffix SUFFIX`

Use `SUFFIX` as the suffix for source files. The default value is `.cpp`.

`--h-suffix SUFFIX`

Use `SUFFIX` as the suffix for header files. The default value is `.h`.

`--all`

Generate code for included files instead of inserting `#include` statements. See “Include Statements” on page 35.

`--no-relative`

When generating code, `idl` assumes that the same `-I` options that are used with `idl` are also going to be used with the C++ compiler. Therefore `idl` will try to make all `#include` statements relative to the directories specified with `-I`. The option `--no-relative` suppresses this behavior, in which case `idl` will not make `#include` statements for included files relative to the paths specified with the `-I` option.

`--header-dir DIR`

This option can be used to make `#include` statements for header files relative to a specific directory.

`--other-header-dir DIR`

This option works like `--header-dir`, but it only applies to header files for included IDL files.

`--output-dir DIR`

Write generated files to directory DIR.

`--dll-import DEF`

Put `DEF` in front of every symbol that needs an explicit DLL import statement.

3.5 *Options for jidl*

```
-h, --help
-v, --version
-e, --cpp NAME
-d, --debug
-DNAME
-DNAME=DEF
-UNAME
-IDIR
--no-skeletons
--locality-constrained
--all
--tie
```

These options are the same as for the `idl` command.

`--no-comments`

The default behavior of `jidl` is to add any comments from the IDL file starting with `/**` to the generated Java files. Specify this option if you don't want these comments added to your Java files.

`--package PKG`

Specifies a package name for the generated Java classes. Each class will be generated relative to this package.

`--prefix-package PRE PKG`

Specifies a package name for a particular prefix[1]. Each class with this prefix will be generated relative to the specified package.

`--auto-package`

1. Prefix refers to the value of the `#pragma prefix` statement in an IDL file. For example, the statement `#pragma prefix ooc.com` defines "ooc.com" as the prefix. The prefix is included in the Interface Repository identifiers for all types defined in the IDL file.

Derives the package names for generated Java classes from the IDL prefixes. The prefix `ooc.com`, for example, results in the package `com.ooc`.

```
--output-dir DIR
```

Specifies a directory where `jidl` will place the generated Java files. Without this option the current directory is used.

```
--clone
```

Generates a `clone` method for struct, union, enum and exception types.

3.6 *Options for hidl*

```
-h, --help
-v, --version
-e, --cpp NAME
-d, --debug
-DNAME
-DNAME=DEF
-UNAME
-IDIR
```

These options are the same as for the `idl` command.

```
--no-sort
```

Don’t sort symbols alphabetically.

```
--output-dir DIR
```

Write HTML files to the directory DIR.

3.7 *Options for ridl*

```
-h, --help
-v, --version
-e, --cpp NAME
-d, --debug
-DNAME
-DNAME=DEF
-UNAME
-IDIR
```

These options are the same as for the `idl` command.

```
--no-sort
```

Don’t sort symbols alphabetically.

`--output-dir DIR`

Write RTF files to the directory DIR.

`--single-file FILE`

Create a single `.rtf` file called FILE.

`--with-index`

Create index entries.

`--font NAME`

Use font NAME as the font for the text body.

`--literal-font NAME`

Use font NAME as the font for literals.

`--title-font NAME`

Use font NAME as the font for the title.

`--heading-font NAME`

Use font NAME as the font for headings.

`--font-size SIZE`

Text body font size in points.

`--literal-font-size SIZE`

Literal font size in points.

`--title-font-size SIZE`

Title font size in points.

`--heading-font-size SIZE`

Heading font size in points.

3.8 Options for irserv

```
-h, --help
-v, --version
-e, --cpp NAME
-d, --debug
```

```
-DNAME
-DNAME=DEF
-UNAME
-IDIR
```

These options are the same as for the `idl` command.

```
-i, --ior
```

Print the stringified IOR of the Interface Repository on standard output.

The arguments to `irserv` are zero or more IDL files. If no IDL files are specified on the command line, the Interface Repository server can be populated dynamically using the `irfeed` command.

3.9 Options for irfeed

```
-h, --help
-v, --version
-e, --cpp NAME
-d, --debug
-DNAME
-DNAME=DEF
-UNAME
-IDIR
```

These options are the same as for the `idl` command.

The arguments to `irfeed` are one or more IDL files.

3.10 Options for irdel

```
-h, --help
-v, --version
```

These options are the same as for the `idl` command.

The arguments to `irdel` are one or more scoped names. A scoped name has the form “X::Y::Z”. For example, an interface `I` defined in a module `M` can be identified by the scoped name “M::I”.

3.11 Options for irgen

```
-h, --help
-v, --version
--no-skeletons
```

```
--no-type-codes
--locality-contrained
--no-virtual-inheritance
--tie
--c-suffix SUFFIX
--h-suffix SUFFIX
--header-dir DIR
--other-header-dir DIR
--output-dir DIR
```

These options are the same as for the `idl` command.

The argument to `irgen` is the pathname to use as the base name of the output filenames. For example, if the pathname you supply is `output/file`, then `irgen` will produce `output/file.cpp`, `output/file.h`, `output/file_skel.cpp` and `output/file_skel.h`.

Note that `irgen` will generate code for *all* of the type definitions contained in the Interface Repository server.

3.12 *The IDL-to-C++ Translator and the Interface Repository*

The ORBACUS IDL-to-C++ and IDL-to-Java translators internally use the Interface Repository for generating code. That is, these programs have their own private Interface Repository that is fed with the specified IDL files. All code is generated from that private Interface Repository.

It is also possible to generate C++ code from a global Interface Repository. First, the command `irserv` must be used to start the Interface Repository. Then the Interface Repository must be fed with the IDL code, using the command `irfeed`. Finally, the `irgen` command can be used to generate the C++ code. For example:

```
irserv --ior > IntRep.ref &
irfeed -ORBrepository ‘cat IntRep.ref‘ file.idl
irgen -ORBrepository ‘cat IntRep.ref‘ file
```

The IDL-to-C++ translator `idl` performs all these steps at once, in a single process with a private Interface Repository. Thus, you only have to run a single command:

```
idl file.idl
```

3.13 *Include Statements*

If you use the `#include` statement in your IDL code, the ORBACUS IDL-to-C++ translator `idl` will not create code for included IDL files. The translator will insert the appropriate `#include` statements in the generated header files instead. Please note that there are several restrictions on where to place the `#include` statements in your IDL files for this feature to work properly:

- `#include` may only appear at the beginning of your IDL files. All `#include` statements must be placed before the rest of your IDL code.[1]
- Type definitions, such as `interface` or `struct` definitions, may not be split among several IDL files. In other words, no `#include` statement may appear within such definitions.

If you don't want these restrictions to be applied, you can use the translator option `--all` with `idl`. With this option the IDL-to-C++ translator treats code from included files as if the code appeared in your IDL file at the position where it is included. This means that the compiler will not place `#include` statements in the automatically-generated header files, regardless of whether the code comes directly from your IDL file or from files included by your IDL file.

Note that when generating code from an Interface Repository using `irgen`, the translator behaves identically to `idl` with the `--all` option. In other words, the `irgen` command will not place `#include` statements in the generated files, but rather generates code for all IDL definitions in the Interface Repository.

3.14 *Documenting IDL Files*

With the ORBACUS IDL-to-HTML and IDL-to-RTF translators, `hidl` and `ridl`, you can easily generate HTML and RTF files containing IDL interface descriptions. The translators will generate a nicely-formatted file for each IDL module and interface. Figure 3.1 shows an HTML example and Figure 3.2 an RTF example.

The formatting syntax supported by `hidl` and `ridl` is similar to that used by `javadoc`. The following keywords are recognized:

`@author` *`author`*

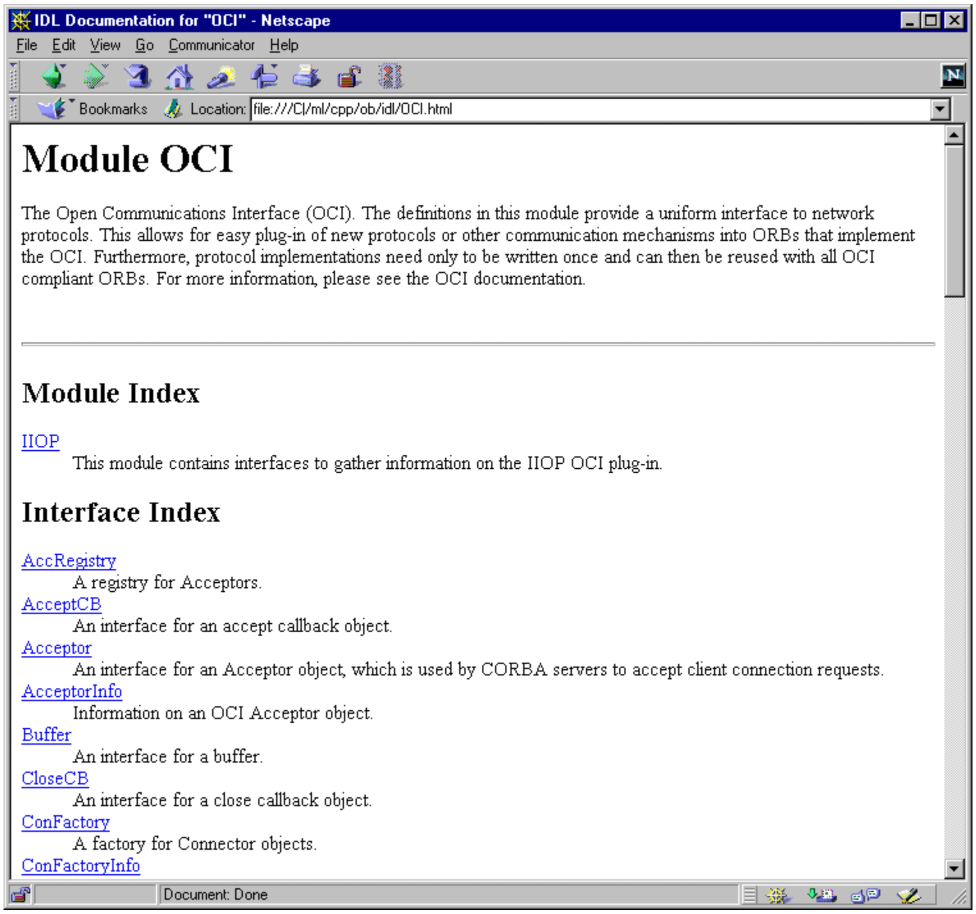
Denotes the author of the interface.

`@exception` *`exception-name description`*

Adds an exception description to the exception list of an operation.

`@member` *`member-name description`*

1. Preprocessor statements like `#define` or `#ifdef` may be placed before your `#include` statements.


IDL Documentation for "OCI" - Netscape
File Edit View Go Communicator Help
Bookmarks
Location: file:///C|/ml/cpp/ob/idl/OCI.html
Document: Done

Module OCI

The Open Communications Interface (OCI). The definitions in this module provide a uniform interface to network protocols. This allows for easy plug-in of new protocols or other communication mechanisms into ORBs that implement the OCI. Furthermore, protocol implementations need only to be written once and can then be reused with all OCI compliant ORBs. For more information, please see the OCI documentation.

Module Index

IIOP
This module contains interfaces to gather information on the IIOP OCI plug-in.

Interface Index

AccRegistry
A registry for Acceptors.
AcceptCB
An interface for an accept callback object.
Acceptor
An interface for an Acceptor object, which is used by CORBA servers to accept client connection requests.
AcceptorInfo
Information on an OCI Acceptor object.
Buffer
An interface for a buffer.
CloseCB
An interface for a close callback object.
ConFactory
A factory for Connector objects.
ConFactoryInfo

Figure 3.1: Documentation generated with the IDL-to-HTML translator

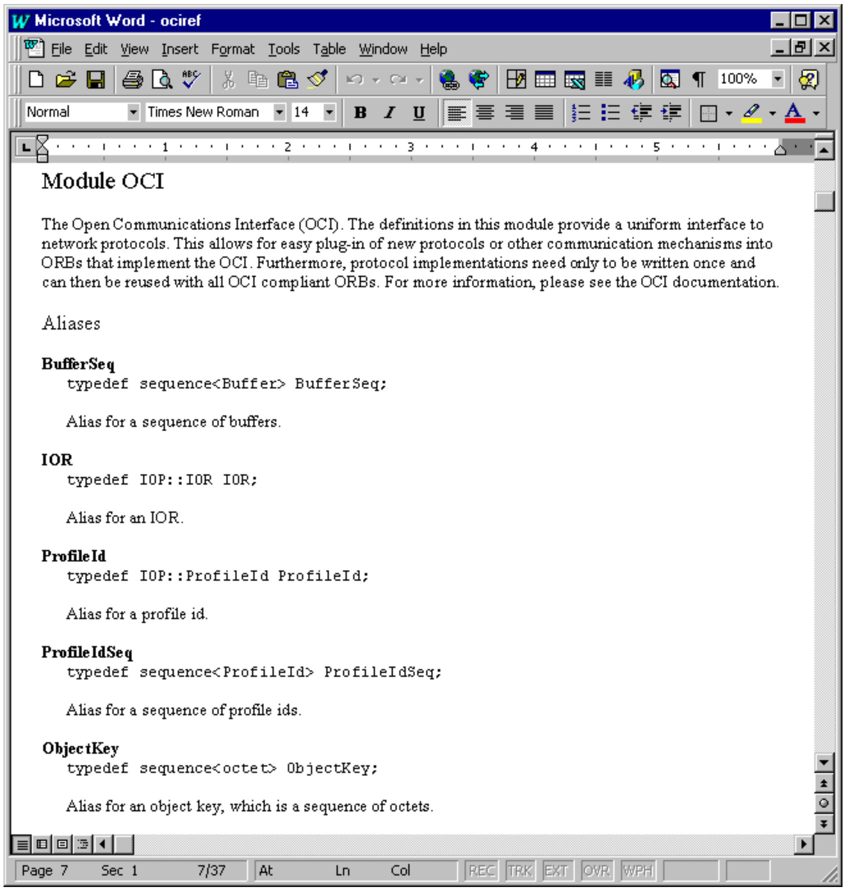
Adds a member description to the member list of a struct, union, enum or exception type.

`@param` *`parameter-name description`*

Adds a parameter description to the parameter list of an operation.

`@return` *`description`*

Adds descriptive text for the return value of an operation.


Microsoft Word - ociref
File Edit View Insert Format Tools Table Window Help
100%
Normal
Times New Roman
14
Page 7 Sec 1 7/37 At Ln Col REC TRK EXT OVR WPH

Module OCI

The Open Communications Interface (OCI). The definitions in this module provide a uniform interface to network protocols. This allows for easy plug-in of new protocols or other communication mechanisms into ORBs that implement the OCI. Furthermore, protocol implementations need only to be written once and can then be reused with all OCI compliant ORBs. For more information, please see the OCI documentation.

Aliases

BufferSeq
```
typedef sequence<Buffer> BufferSeq;
```
Alias for a sequence of buffers.

IOR
```
typedef IOP::IOR IOR;
```
Alias for an IOR.

ProfileId
```
typedef IOP::ProfileId ProfileId;
```
Alias for a profile id.

ProfileIdSeq
```
typedef sequence<ProfileId> ProfileIdSeq;
```
Alias for a sequence of profile ids.

ObjectKey
```
typedef sequence<octet> ObjectKey;
```
Alias for an object key, which is a sequence of octets.

Figure 3.2: Documentation generated with the IDL-to-RTF translator

`@see` *`reference`*

Adds a “See also” note.

`@since` *`since-text`*

Comment related to the availability of new features.

`@version` *`version`*

The interface’s version number.

Like `javadoc`, `hidl` and `ridl` use the first sentence in the documentation comment as the summary sentence. This sentence ends at the first period that is followed by a blank, tab or line terminator, or at the first `@`.

`ridl` understands most basic HTML tags and will produce an equivalent format in the generated RTF files. The following HTML tags are supported:

```
<B> <BR> <CODE> <EM> <HR> <P> <U> <UL>
```

3.15 Using javadoc

If not explicitly suppressed with the `--no-comments` option, the ORBACUS IDL-to-Java translator `jidl` adds comments starting with `/**` from the IDL file to the generated Java files, so that `javadoc` can be used to generate documentation (as long as the comments are in a format compatible with `javadoc`).

Here is an example showing how to include documentation in an IDL interface description file. Let's assume we have an interface `I` in a module `M`:

```
// IDL

module M
{

/**
 *
 * This is a comment related to interface I.
 *
 * @author Uwe Seimet
 *
 * @version 1.0
 *
 **/
interface I
{

    /**
     *
     * This comment describes exception E.
     *
     **/
    exception E { };

    /**
     *
     * The description for operation S.
     *
     * @param arg A dummy argument.
     *
     * @return A dummy string.
     *
     * @exception E Raised under certain circumstances.
     *
     **/
    string S(in long arg)
       raises(E);
};

};
```

When running `jidl` on this file the comments will automatically be added to the generated Java files `M/I.java` and `M/IPackage/E.java`. For `I.java` the generated code looks as follows:

```
// Java

package M;

//
// IDL:M/I:1.0
//
/**
 * This is a comment related to interface I.
 *
 * @author Uwe Seimet
 *
 * @version 1.0
 *
 **/
public interface I extends org.omg.CORBA.Object
{
    //
    // IDL:M/I/S:1.0
    //
    /**
     *
     * The description for operation S.
     *
     * @param arg A dummy argument.
     *
     * @return A dummy string.
     *
     * @exception M.IPackage.E Raised under certain circumstances.
     *
     **/
    public String
    S(int arg)
        throws M.IPackage.E;
}
```

Note that `jidl` automatically inserts the fully-qualified Java name for the exception `E`, in this case `M.IPackage.E`.

These are the contents of `IPackage/E.java`:

```
// Java

package M.IPackage;

//
// IDL:M/I/E:1.0
//
/**
 *
 * This comment describes exception E.
 *
 **/
final public class E extends org.omg.CORBA.UserException
{
    public
    E()
    {
    }
}
```

Now you can use `javadoc` to extract the comments from the generated Java files and produce nicely-formatted HTML documentation.

For additional information please refer to the `javadoc` documentation.

CHAPTER 4

ORB and BOA Initialization

4.1 ORB Initialization

4.1.1 Initializing the C++ ORB

In C++ the ORB is initialized with `CORBA_ORB_init()`. For example:

```
// C++
int main(int argc, char* argv[], char*[])
{
   CORBA_ORB_var orb = CORBA_ORB_init(argc, argv);
   // ...
}
```

The `CORBA_ORB_init()` call interprets arguments starting with `-ORB`. All of these arguments, passed through the `argc` and `argv` parameters, are automatically removed from the argument list.

4.1.2 Initializing the Java ORB for Applications

A Java application can initialize the ORB in the following manner:

```
// Java
import org.omg.CORBA.*;
public static void main(String args[])
{
   ORB orb = ORB.init(args, new java.util.Properties());
   // ...
}
```

The `ORB.init()` call interprets arguments starting with `-ORB`. Unlike the C++ version, these arguments are not removed (see “Filtering Command-line Options” on page 49 for more information).

4.1.3 Initializing the Java ORB for Applets

A different overloading of `ORB.init()` is provided for use by applets:

```
// Java
import org.omg.CORBA.*;
public void init()
{
   ORB orb = ORB.init(this, new java.util.Properties());
   // ...
}
```

See “Applets” on page 59 for more information on using ORBACUS in an applet.

4.2 BOA Initialization

4.2.1 Initializing the C++ BOA

In C++ the BOA is initialized with `CORBA_ORB::BOA_init()`. For example:

```
// C++
int main(int argc, char* argv[], char*[])
{
   CORBA_ORB_var orb = CORBA_ORB_init(argc, argv);
   CORBA_BOA_var boa = orb -> BOA_init(argc, argv);
   // ...
}
```

`BOA_init()` removes all arguments starting with `-OA` passed through the `argc` and `argv` parameters.

4.2.2 Initializing the Java BOA

In Java the BOA initialization looks like this:

```
// Java
import org.omg.CORBA.*;
```

```
public static void main(String args[])
{
   ORB orb = ORB.init(args, new java.util.Properties());
   BOA boa = orb.BOA_init(args, new java.util.Properties());
   // ...
}
```

4.3 *Configuring the ORB and BOA*

ORBACUS applications can tailor the behavior of the ORB and BOA objects using a collection of properties[1]. These properties can be defined in a number ways:

- using a configuration file
- using system properties (Java)
- using command-line options
- programmatically at run-time

4.3.1 Properties

The ORBACUS configuration properties are described in the sections below. Unless otherwise noted, every property can be used in both C++ and Java applications.

ORB Properties

ooc.orb.add_iiop_connector

Value: `true`, `false`

Determines whether the ORB should register an IIOP connector during initialization. The default value is `true`.

ooc.orb.conc_model

Value: `blocking`, `reactive`, `threaded`

Selects the client-side concurrency model. The reactive concurrency model is not currently available in ORBACUS for Java. The default value is `blocking` for both C++ and Java applications. See Chapter 9 for more information on concurrency models.

1. Note that these properties have nothing to do with the Property Service as described in “The Property Service” on page 162.

ooc.orb.id

Value: *id*

Specifies the identifier of the ORB to be used by the application. The only valid identifier is `OB_ORB`.

ooc.orb.trace_level

Value: *level* >= 0

Defines the output level for diagnostic messages printed by ORBACUS. A level of 1 produces information about connection events. The default level is 0, which produces no output.

ooc.service.name

Value: *ior*

Adds an initial service to the ORB's internal list. This list is consulted when the application invokes the ORB operation `resolve_initial_references`. *name* is the key that is associated with a stringified IOR created using `object_to_string`. For example, the property `ooc.service.NameService` adds "NameService" to the list of initial services. See "Stringified Object References" on page 85 and "Initial Services" on page 90 for more information.

BOA Properties

ooc.boa.add_iiop_acceptor

Value: `true`, `false`

Determines whether the BOA should register an IIOP acceptor during initialization. The default value is `true`.

ooc.boa.conc_model

Value: `blocking`, `reactive`, `threaded`, `thread_per_client`, `thread_per_request`, `thread_pool`

Selects the server-side concurrency model. The reactive concurrency model is not available in ORBACUS for Java. The default value is `reactive` for C++ applications and `threaded` for Java applications. See Chapter 9 for more information on concurrency models. If this property is set to `thread_pool`, then the property `ooc.boa.thread_pool` determines how many threads are in the pool.

ooc.boa.disable_iiop_acceptor

Value: `true`, `false`

Determines whether the BOA should disable the IIOP acceptor after registering it. The default value is `false`.

ooc.boa.host

Value: *hostname*

Explicitly defines the hostname to be used in object references generated by the BOA. The default value is the canonical hostname of the machine. This property is especially useful if a host has more than one name. Note that this property is ignored if `ooc.boa.numeric` is `true`.

ooc.boa.id

Value: *id*

Specifies the identifier of the BOA to be used by the application. The only valid identifier is `OB_BOA`.

ooc.boa.numeric

Value: `true`, `false`

If `true`, the BOA will generate object references that contain an internet (IP) address in dotted decimal notation instead of the canonical hostname. The default value is `false`.

ooc.boa.port

Value: 0 <= *port* <= 65535

Specifies the port number on which the server should listen for new connections. If no port is specified, one will be selected automatically by the BOA. Use this property if you plan to publish an IOR (e.g., in a file, a naming service, etc.) and you want that IOR to remain valid across executions of your server. Without this property, your server is likely to use a different port number each time the server is executed. See Chapter 6 for more information.

ooc.boa.thread_pool

Value: $n > 0$

Determines the number of threads to reserve for servicing incoming requests. The default value is `10`. This property is only effective when the `ooc.boa.conc_model` property has the value `thread_pool`.

4.3.2 Command-line Options

There are equivalent command-line options for many of the ORBACUS properties. The options and their equivalent property settings are shown in Table 4.1. Refer to “Properties” on page 45 for a description of the properties.

Option	**Property**
`-OAblocking`	`ooc.boa.conc_model=blocking`
`-OAdisable_iiop_acceptor`	`ooc.boa.disable_iiop_acceptor=true`
`-OAhost` *host*	`ooc.boa.host=`*host*
`-OAid` *id*	`ooc.boa.id=`*id*
`-OAnumeric`	`ooc.boa.numeric=true`
`-OAport` *port*	`ooc.boa.port=`*port*
`-OAreactive`	`ooc.boa.conc_model=reactive`
`-OAthreaded`	`ooc.boa.conc_model=threaded`
`-OAthread_per_client`	`ooc.boa.conc_model=thread_per_client`
`-OAthread_per_request`	`ooc.boa.conc_model=thread_per_request`
`-OAthread_pool` *n*	`ooc.boa.conc_model=thread_pool` `ooc.boa.thread_pool=`*n*
`-ORBblocking`	`ooc.orb.conc_model=blocking`
`-ORBid` *id*	`ooc.orb.id=`*id*
`-ORBnaming` *ior*	`ooc.service.NameService=`*ior*
`-ORBreactive`	`ooc.orb.conc_model=reactive`
`-ORBrepository` *ior*	`ooc.service.InterfaceRepository=`*ior*

Table 4.1: Command-line Options

Option	Property
`-ORBservice` *name ior*	`ooc.service.`*name*`=`*ior*
`-ORBthreaded`	`ooc.orb.conc_model=threaded`
`-ORBtrace_level` *level*	`ooc.orb.trace_level=`*level*

Table 4.1: Command-line Options

A few additional command-line options are supported that do not have equivalent properties. These options are described in Table 4.2.

Option	Description
`-ORBversion`	Causes the ORB to print its version to standard output.
`-ORBlicense`	Causes the ORB to print its license to standard output.

Table 4.2: Additional Command-line Options

4.3.3 Filtering Command-line Options

In C++, all command-line options recognized by ORBACUS are automatically removed from the `argv` array after initializing the ORB and BOA.

In Java, command-line options are not automatically removed by ORBACUS. If you would like to have ORBACUS-specific options removed from the argument list, you will need to do so using two additional methods.

The example below demonstrates how to remove the ORB and BOA options in Java:

```
1 // Java
2 org.omg.CORBA.ORB orb = org.omg.CORBA.ORB.init(args, null);
3 org.omg.CORBA.BOA boa = orb.BOA_init(args, null);
4 String[] noOrbArgs = ((com.ooc.CORBA.ORB)orb).filter_options(args);
5 String[] noBoaArgs =
6     ((com.ooc.CORBA.BOA)boa).filter_options(noOrbArgs);
```

2,3 Initialize the ORB and BOA.

4 Remove the ORB options (i.e., options starting with `-ORB`) from `args`. The array `noOrbArgs` contains the filtered options.

5,6 Remove the BOA options (i.e., options starting with `-OA`). By passing `noOrbArgs` to this method, we ensure that both ORB and BOA options have been removed.

Note that the casts for the ORB and BOA are necessary because `filter_options` is an ORBACUS-specific operation, which only exists in the ORB and BOA classes residing in the `com.ooc.CORBA` package, and not in the `org.omg.CORBA` package.

4.3.4 Using a Configuration File

A convenient way to define a group of properties is to use a configuration file. A sample configuration file is shown below:

```
# Concurrency models
ooc.orb.conc_model=threaded
ooc.boa.conc_model=thread_pool
ooc.boa.thread_pool=5

# Initial services
ooc.service.NameService=iiop://myhost:5000/DefaultNamingContext
ooc.service.EventService=iiop://myhost:5001/DefaultEventChannel
ooc.service.TradingService=iiop://myhost:5002/TradingService
```

You can define the name of the configuration file[1] using a command-line option, an environment variable (C++), or a system property (Java):

- Command-line option:

  `-ORBconfig` *filename*
- Environment variable:

  `ORBACUS_CONFIG=`*filename*
- Java system property:

  `ooc.config=`*filename*

The file is read once when the ORB is initialized, and is not read again for the lifetime of the application process.

4.3.5 Defining Properties in Java

Java applications can use the standard Java mechanism for defining system properties, because ORBACUS will also search the system properties during ORB and BOA initialization.

1. ORBACUS for Java also accepts a URL specification as the filename.

For example:

```
1 // Java
2 java.util.Properties props = System.getProperties();
3 props.put("ooc.orb.conc_model", "threaded");
4 props.put("ooc.boa.port", "10000");
5 org.omg.CORBA.ORB orb = org.omg.CORBA.ORB.init(args, null);
```

2 Obtain the system properties.

3,4 Define ORBACUS properties.

5 Initialize the ORB.

Java virtual machines typically allow you to define system properties on the command line. For example, using Sun's JVM you can do the following:

```
java -Dooc.boa.port=5000 MyServer
```

You can also use the `java.util.Properties` object that is passed to the `org.omg.CORBA.ORB.init()` and `org.omg.CORBA.ORB.BOA_init()` methods to provide ORBACUS property definitions:

```
1 // Java
2 java.util.Properties props = new java.util.Properties();
3 props.put("ooc.boa.numeric", "true");
4 org.omg.CORBA.ORB orb = org.omg.CORBA.ORB.init(args, props);
5 org.omg.CORBA.BOA boa = orb.BOA_init(args, props);
```

2 Create a `java.util.Properties` object to hold our properties.

3 Define ORBACUS properties.

4,5 Initialize the ORB and BOA using the `java.util.Properties` object.

4.3.6 Precedence of Properties

Given that properties can be defined in several ways, it's important to establish the order of precedence used by ORBACUS when collecting and processing the property definitions. The order of precedence is listed below, from lowest to highest. Properties defined at a higher precedence override the same properties defined at a lower precedence.

- Configuration file
- User-supplied properties (Java only)
- System properties (Java only)

- Command-line options

For example, a property defined using a command-line option overrides the same property defined in a configuration file.

4.3.7 Advanced Property Usage

If you need explicit control of the properties from within your application, you may also elect to use ORBACUS-specific classes to create and retrieve property definitions.[1]

In Java, this class is `com.ooc.CORBA.Properties`, and in C++ the class is `OBProperties`. These classes are used internally by ORBACUS, but you can also use them in your applications.

```
// Java
package com.ooc.CORBA;

class Properties
{
   public static Properties init(String[] args);
   public static Properties instance();

   public String getProperty(String key);
   public void setProperty(String key, String value);
   public String[] getKeys(String prefix);
   public String[] getKeys();
}

// C++
class OBProperties
{
public:
   static OBProperties* init(int& argc, char** argv);
   static OBProperties* instance();

   typedef OBStrSeq KeySeq;

   void setProperty(const char* key, const char* value);
   const char* getProperty(const char* key);
   KeySeq getKeys(const char* prefix);
   KeySeq getKeys();
```

1. The `Properties` class is probably more useful for C++ applications, since Java applications can use system properties to achieve the same effect.

```
};
```

In the discussion below, these classes are referred to generically as the `Properties` class.

To use a `Properties` class correctly, you must be aware of the initialization steps taken by the ORB and BOA objects. The `Properties` class is a *Singleton* class, in that only one instance of the class is allowed. The ORB initializes the `Properties` object during its own initialization. However, if you need to use the `Properties` class before the ORB has been initialized (e.g., if you need to define an ORB property), then you will need to initialize the `Properties` class manually.

Defining ORB Properties

The code below demonstrates a situation where an application needs to define a property prior to initializing the ORB. First, we'll show the example in C++:

```
1 // C++
2 #include <OB/CORBA.h>
3 #include <OB/Properties.h>
4
5 // ...
6
7 OBProperties* properties = OBProperties::init(argc, argv);
8 properties -> setProperty("ooc.orb.conc_model", "reactive");
9 CORBA_ORB_var orb = CORBA_ORB_init(argc, argv);
```

2,3 Include the necessary header files.

7 The call to `OBProperties::init()` creates the `OBProperties` object and initializes it with the contents of a configuration file (if necessary).

8 Set the ORB concurrency model using a property.

9 Initialize the ORB.

The code looks very similar in Java:

```
1 // Java
2 com.ooc.CORBA.Properties properties =
3    com.ooc.CORBA.Properties.init(args);
4 properties.setProperty("ooc.orb.conc_model", "threaded");
5 org.omg.CORBA.ORB orb = org.omg.CORBA.ORB.init(args, null);
```

2,3 Creates the `com.ooc.CORBA.Properties` object and initializes it with the contents of a configuration file (if necessary).

4 Set the ORB concurrency model using a property.

5 Initialize the ORB.

Defining BOA Properties

In a situation where you don’t need access to the `Properties` object until after the ORB has been initialized, you can simply do the following:

```
 1 // C++
 2 #include <OB/CORBA.h>
 3 #include <OB/Properties.h>
 4
 5 // ...
 6
 7 CORBA_ORB_var orb = CORBA_ORB_init(argc, argv);
 8 OBProperties* properties = OBProperties::instance();
 9 properties -> setProperty("ooc.boa.conc_model", "reactive");
10 CORBA_BOA_var boa = orb -> BOA_init(argc, argv);
```

2,3 Include the necessary header files.

7 Initialize the ORB. The ORB will initialize the `Properties` object.

8 Obtain the `OBProperties` instance.

9,10 Set the BOA concurrency model using a property and initialize the BOA.

Note that in this example we are defining a BOA property prior to initializing the BOA. Also note that the `Properties` object has already been initialized by the ORB, so the application simply needs to obtain a pointer to the object using the `instance` method.

Here’s the same example in Java:

```
1 // Java
2 org.omg.CORBA.ORB orb = org.omg.CORBA.ORB.init(args, null);
3 com.ooc.CORBA.Properties properties =
4    com.ooc.CORBA.Properties.instance();
5 properties.setProperty("ooc.boa.conc_model", "threaded");
6 org.omg.CORBA.BOA boa = orb.BOA_init(args, null);
```

2 Initialize the ORB. The ORB will initialize the `Properties` object.

3,4 Obtain the `Properties` instance.

5,6 Set the BOA concurrency model using a property and initialize the BOA.

Application-specific Properties

Another situation where the `Properties` class can be useful is if you'd like to obtain application-specific properties from the ORBACUS configuration file. Suppose your configuration file looks as follows:

```
# ORBacus configuration file
ooc.orb.conc_model=threaded
# Application-specific settings
acme.widget_count=20
```

The following C++ example demonstrates how to access your application-specific properties:

```
1  // C++
2  #include <OB/CORBA.h>
3  #include <OB/Properties.h>
4
5  // ...
6
7  CORBA_ORB_var orb = CORBA_ORB_init(argc, argv);
8  OBProperties* properties = OBProperties::instance();
9  const char* value = properties -> getProperty("acme.widget_count");
```

2,3 Include the necessary header files.

7 The ORB must be initialized so that the configuration file is processed.

8,9 Obtain the `OBProperties` instance and then retrieve the value of the property.

And in Java:

```
1  // Java
2  org.omg.CORBA.ORB orb = org.omg.CORBA.ORB.init(args, null);
3  com.ooc.CORBA.Properties properties =
4     com.ooc.CORBA.Properties.instance();
5  String value = properties.getProperty("acme.widget_count");
```

2 The ORB must be initialized so that the configuration file is processed.

3-5 Obtain the `Properties` instance and then retrieve the value of the property.

Finally, it is important to remember the precedence rules for ORBACUS properties. Specifically, command-line options will *always* override any existing property definitions, including those you set within your application.

4.4 Server Event Loop

A server's event loop is entered by calling `BOA::impl_is_ready`. For example, in Java:[1]

```
// Java
org.omg.CORBA.BOA boa = ... // Get the BOA somehow
boa.impl_is_ready(null);
```

And in C++:

```
// C++
CORBA_BOA_var boa = ... // Get the BOA somehow
boa -> impl_is_ready(CORBA_ImplementationDef::_nil());
```

`impl_is_ready` only returns, if:

- The blocking concurrency model (see Chapter 9) has been chosen for the server, and the client disconnects.
- `deactivate_impl` is called (see "Deactivating the Server" on page 57).

4.4.1 Mixed Client/Server Applications

In case the reactive or one of the threaded concurrency models has been chosen (see Chapter 9) it is possible to service requests without calling `impl_is_ready`. This is especially useful in mixed client/server applications. For example, consider a mixed client/server program that wants to invoke operations on a server in the program's `main` function, but still wants to be able to receive "callbacks" from this server. In order to receive these "callback" requests, usually `impl_is_ready` would have to be called in `main`. However, this is not possible, since `impl_is_ready` blocks, which makes it impossible for the mixed client/server program to invoke operations on the server after the call to `impl_is_ready`.

To solve this problem, ORBACUS provides the operation `init_servers`. Here's how `init_servers` is called in Java:

```
// Java
org.omg.CORBA.BOA boa = ... // Get the BOA somehow
((com.ooc.CORBA.BOA)boa).init_servers();
```

1. The argument to `impl_is_ready` is currently unused by ORBACUS, therefore the "dummy" argument `null` (Java) or `CORBA_ImplementationDef::_nil()` (C++) is used.

This is similar to `impl_is_ready`, except that `init_servers` does not block. Note that the cast for the BOA is necessary because `init_servers` is an ORBACUS-specific operation, which only exists in `com.ooc.CORBA.BOA`, and not in `org.omg.CORBA.BOA`.

The C++ version look similar:

```
// C++
CORBA_BOA_var boa = ... // Get the BOA somehow
boa -> init_servers();
```

4.4.2 Deactivating the Server

A server can be deactivated with a call to `BOA::deactivate_impl`. This causes `BOA::impl_is_ready` to return. For example, consider a server which can be shut down by a client by calling a `deactivate` operation on one of the server's objects. First the IDL code:

```
// IDL
interface ShutdownObject
{
   void deactivate();
};
```

On the server side, `ShutdownObject` can be implemented like this:

```
// C++

class ShutdownObject_impl : public virtual ShutdownObject_skel
{
   CORBA_BOA_var boa_;

public:

   ShutdownObject_impl(CORBA_BOA_ptr boa)
       : boa_(CORBA_BOA::_duplicate(boa))
   {
   }

   virtual void deactivate()
   {
      boa_ -> deactivate_impl(CORBA_ImplementationDef::_nil());
   }
};
```

3 A servant class for ShutdownObject is defined. For more information on how to implement servant classes, see Chapter 5.

5 A BOA is needed to call deactivate_impl.

9-12 The constructor initializes the BOA member.

14-17 deactivate calls deactivate_impl on the BOA.

Here's the main code for this example:

```
 1 // C++
 2
 3 int main(int argc, char* argv[], char*[])
 4 {
 5    CORBA_ORB_var orb = CORBA_ORB_init(argc, argv);
 6    CORBA_BOA_var boa = orb -> BOA_init(argc, argv);
 7
 8    ShutdownObject_var shutdownObj = new ShutdownObject_impl(boa);
 9
10    boa -> impl_is_ready(CORBA_ImplementationDef::_nil());
11
12    return 0;
13 }
```

5,6 ORB and BOA initialization.

8 The shutdown object is created.

10 The impl_is_ready main event loop is entered. This call only returns if deactivate is called.

12 The server was deactivated, so main can now return.

The client can use the deactivate call as shown below:

```
// C++

int main(int argc, char* argv[], char*[])
{
   CORBA_ORB_var orb = CORBA_ORB_init(argc, argv);

   ShutdownObject_var shutdownObj = ... // Get a reference somehow

   try
   {
      shutdownObj -> deactivate();
12     }
13     catch(const CORBA_COMM_FAILURE& ex)
14     {
15     }
16
17     return 0;
18 }
```

5 Initialize the ORB.

7 Get a reference to the server’s shutdown object somehow, for example by reading in a “stringified” object reference (see “Stringified Object References” on page 85).

9-15 Call `deactivate` on the shutdown object. `COMM_FAILURE` exceptions must be ignored, since the server may shut down immediately, without any chance for a proper reply message to be delivered back to the client. Therefore, the client will usually get a `COMM_FAILURE` exception at this point.

4.5 *Applets*

4.5.1 Adding ORBacus Applets to Web Pages

Like any other applet, ORBACUS applets can be added to HTML pages with the `APPLET` tag:

```
<APPLET CODE=”Client.class” ARCHIVE=”OB.jar” WIDTH=500 HEIGHT=300>
</APPLET>
```

It is necessary to tell the Web browser where to find the ORBACUS Java classes. This is best done with the `ARCHIVE` attribute as shown above. An alternative is to use the `CODEBASE` attribute and to extract the `OB.jar` archive in the directory defined by `CODEBASE`. For more information, please consult your Java Development Kit documentation.

4.5.2 Defining ORB and BOA Options for an Applet

The `PARAM` tag is used in HTML to define parameters for an applet. When initialized by an applet, the ORB looks for the parameters `ORBparams` and `BOAparams`, whose values should be command-line options separated by spaces.

For example, the HTML code below uses the `-ORBconfig` option to specify the URL of the ORB configuration file:

```
<APPLET CODE=”Client.class” ARCHIVE=”OB.jar” WIDTH=500 HEIGHT=300>
```

```
   <PARAM NAME=”ORBparams” VALUE=”-ORBconfig http://www/orb.cfg”>
</APPLET>
```

Your applet can also define ORBACUS configuration properties using Java system properties, or using the `java.util.Properties` object passed to `org.omg.CORBA.ORB.init()`. See “Configuring the ORB and BOA” on page 45 for more information.

4.5.3 Defining the ORB Class Parameters

Some Web browsers[1] have a built-in ORB. In order to use ORBACUS instead of this built-in ORB, you must set the following applet parameters:

```
<APPLET CODE=”Client.class” ARCHIVE=”OB.jar” WIDTH=500 HEIGHT=300>
   <PARAM NAME=”org.omg.CORBA.ORBClass”
         VALUE=”com.ooc.CORBA.ORB”>
   <PARAM NAME=”org.omg.CORBA.ORBSingletonClass”
         VALUE=”com.ooc.CORBA.ORBSingleton”>
</APPLET>
```

4.5.4 Security Issues

Web browsers generally place several security restrictions on applets that you need to be aware of when developing an applet using ORBACUS:

- Applets can only communicate with the host from which the applet was downloaded.
- Applets cannot accept connections from any host.

The first limitation forces you to run any CORBA server applications that your applet communicates with on your Web server host.[2] The second limitation prevents your applet from acting as a CORBA server, which is often necessary when a client wishes to receive callbacks from a server.

These limitations are the most common causes of security exceptions in an applet. You must ensure that any object references used by your applet refer to objects on the Web server host. Furthermore, you must not attempt to enable CORBA server functionality in your applet by initializing the BOA.

1. For example, Netscape v4 has a built-in ORB.
2. Netscape v4 also does not normally allow CORBA applets to be loaded from a local (i.e., filesystem) HTML file, causing a `SecurityException` when the applet attempts to connect to the CORBA server. To workaround this problem, CORBA applets must be downloaded from a Web server.

CHAPTER 5

CORBA Objects

5.1 Overview

A *CORBA object* is an object with an interface defined in CORBA IDL. CORBA objects have different representations in clients and servers.

- A *server* implements a CORBA object in a concrete programming language, for example in C++ or Java. This is done by writing an *implementation class* for the CORBA object and by instantiating this class. The resulting object is called a *servant*.
- A *client* that wants to make use of a servant implemented by a server creates an object that delegates all operation calls to the servant via the ORB. Such an object is called a *proxy*.

When a client invokes a method on the local proxy object, the ORB packs the input parameters and sends them to the server, which in turn unpacks these parameters and invokes the actual method on the servant. Output parameters and return values, if any, follow the reverse path back to the client. From the client's perspective, the proxy acts just like the servant since it hides all the communication details within itself.

A servant must somehow be connected to the ORB, so that the ORB can invoke a method on the servant when a request is received from a client. This connection is handled by the object adapter, as shown in Figure 5.1.

ORBACUS comes with an object adapter called the "Basic Object Adapter" (BOA). Unfortunately, the specification for the BOA [2] is quite incomplete, leaving a lot of freedom to

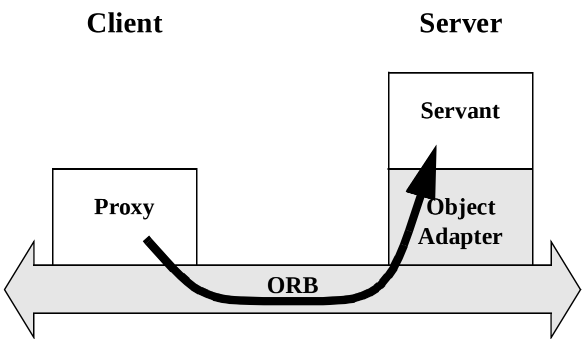


Figure 5.1: Servants, Proxies and the Object Adapter

ORB implementors.[1] Therefore all BOAs are in fact more or less vendor specific. It is therefore necessary to have a chapter explaining how servants are implemented in ORBACUS and how they are connected to the ORBACUS BOA implementation.

5.2 *Implementing Servants*

In this chapter, we will implement servant classes (or “implementation classes”) for the IDL interfaces defined below:

```
// IDL

interface A
{
   void op_a();
};

interface B
{
   void op_b();
};

interface I : A, B
{
```

1. Because of these problems, the OMG is currently defining a new object adapter, the so-called “Portable Object Adapter” (POA). Future versions of ORBACUS will implement the POA.

```
15    void op_i();
16 };
```

3-6 An interface `A` is defined with the operation `op_a`.

8-11 An interface `B` is defined with the operation `op_b`.

13-16 Interface `I` is defined, which is derived from `A` and `B`. It also defines a new operation `op_i`.

5.2.1 Implementing Servants using Inheritance

ORBACUS for C++ and ORBACUS for Java both support the use of inheritance for interface implementation. To implement an interface using inheritance, you write a servant class that inherits from a skeleton class generated by the IDL translator. By convention, the name of the servant class should be the name of the interface with the suffix `_impl`, e.g., for an interface `I`, the implementation class is named `I_impl`.[1]

Inheritance using C++

In C++, `I_impl` must inherit from the skeleton class `I_skel` that was generated by the IDL-to-C++ translator. If `I` inherits from other interfaces, for example from the interfaces `A` and `B`, then `I_impl` must also inherit from the corresponding implementation classes `A_impl` and `B_impl`.

```
// C++

class A_impl : virtual public A_skel
{
public:
    virtual void op_a();
};

class B_impl : virtual public B_skel
{
public:
    virtual void op_b();
};

class I_impl : virtual public I_skel,
               virtual public A_impl,
```

1. These naming rules are not mandatory, they are just a recommendation.

```
17                 virtual public B_impl
18 {
19 public:
20     virtual void op_i();
21 };
```

3-7 The servant class `A_impl` is defined, inheriting from the skeleton class `A_skel`. If `op_a` had any parameters, these parameters would be mapped according to the standard IDL-to-C++ mapping rules [2].

9-14 This is the servant class for `B_impl`.

15-21 The servant class for `I_impl` is not only derived from `I_skel`, but also from the servant classes `A_impl` and `B_impl`.

Note that `virtual public` inheritance must be used. The only situation in which the keyword `virtual` is not necessary is for an interface `I` which does not inherit from any other interface and from which no other interface inherits. This means that the implementation class `I_impl` only inherits from the skeleton class `I_skel` and no implementation class inherits from `I_impl`.

It is not strictly necessary to have an implementation class for every interface. For example, it is sufficient to only have the class `I_impl` as long as `I_impl` implements all interface operations, including the operations of the base interfaces:

```
1 // C++
2
3 class I_impl : virtual public I_skel
4 {
5 public:
6     virtual void op_a();
7     virtual void op_b();
8     virtual void op_i();
9 };
```

3 Now `I_impl` is only derived from `I_skel`, but not from the other servant classes.

6-8 `I_impl` must implement all operations from the interface `I` as well as the operations of all interfaces from which `I` is derived.

Inheritance using Java

Several files are generated by the ORBACUS IDL-to-Java translator for an interface `I`, including:

- `I.java`, which defines a Java interface `I` containing public methods for the operations and attributes of `I`, and
- `_IImplBase.java`, which is an abstract skeleton class that serves as the base class for servant classes.

In contrast to C++, Java’s lack of multiple inheritance currently makes it impossible for a servant class to inherit operation implementations from other servant classes. For our interface `I` it is therefore necessary to implement all operations in a single servant class `I_impl`, regardless of whether those operations are defined in `I` or in an interface from which `I` is derived.

```
 1 // Java
 2
 3 public class I_impl extends _IImplBase
 4 {
 5     public void op_a()
 6     {
 7     }
 8
 9     public void op_b()
10     {
11     }
12
13     public void op_i()
14     {
15     }
16 }
```

3-16 The servant class `I_impl` is defined, which implements `op_i`, as well as the inherited operations `op_a` and `op_b`.

5.2.2 Implementing Servants using Delegation

Sometimes it is not desirable to use an inheritance-based approach for implementing an interface. This is especially true if the use of inheritance would result in an implementation being incompatible with existing legacy code. Therefore, another alternative is available for implementing servants which does not use inheritance. A special class, known as a *tie class*, can be used to delegate the implementation of an interface to another class.

Delegation using C++

The ORBACUS IDL-to-C++ translator can automatically generate a tie class for an interface in the form of a template class. A tie template class is derived from the corresponding skeleton class and has the same name as the skeleton, with the suffix `_tie` appended.

For the interface `I` from the C++ example above, the template `I_skel_tie` is generated and must be instantiated with a class that implements all operations of `I`. By convention, the name of this class should be the name of the interface with `_impl_tie` appended.[1]

In contrast to the inheritance-based approach, it is not necessary that the class implementing `I`'s operations, i.e., `I_impl_tie`, be derived from any skeleton class. Instead, an instance of `I_skel_tie` delegates all operation calls to `I_impl_tie`, as shown in Figure 5.2.

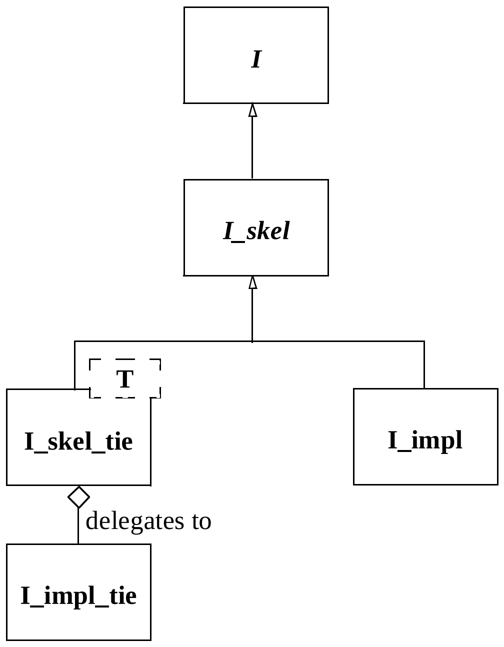


Figure 5.2: Class Hierarchy for Inheritance and Delegation Implementation in C++

1. Again, you are free to choose whatever name you like. This is just a recommendation.

Here is our definition of `I_impl_tie`:

```
1 // C++
2
3 class I_impl_tie
4 {
5 public:
6    virtual void op_a();
7    virtual void op_b();
8    virtual void op_i();
9 };
```

3 `I_impl_tie` is defined, which is not derived from any other class.

6-8 `I_impl_tie` must implement all of `I`'s operations, including inherited operations.

A servant class for `I` can then be defined using the `I_skel_tie` template:

```
1 // C++
2 typedef I_skel_tie< I_impl_tie > I_impl;
```

2 The servant class `I_impl` is defined as a template instance of `I_skel_tie`, parameterized with `I_impl_tie`.

Delegation using Java

The ORBACUS IDL-to-Java translator generates two additional files to support delegation-based servant implementation for an interface `I`:

- `IOperations.java`, an interface that defines public methods for all attributes and operations of `I`, and
- `_IImplBase_tie.java`, the tie class that inherits from `_IImplBase` and delegates all requests to an instance of `IOperations`.

To implement our servant class using delegation, we need to write a class that implements the `IOperations` interface:

```
// Java

public class I_impl_tie implements IOperations
{
   public void op_a()
   {
   }

```

```
 9     public void op_b()
10     {
11     }
12
13     public void op_i()
14     {
15     }
16 }
```

3 The servant class `I_impl_tie` is defined to implement the `IOperations` interface.

5-15 `I_impl_tie` must implement all of `I`'s operations, including inherited operations.

Figure 5.3 illustrates the relationship between the classes generated by the IDL-to-Java translator and the servant implementation classes.

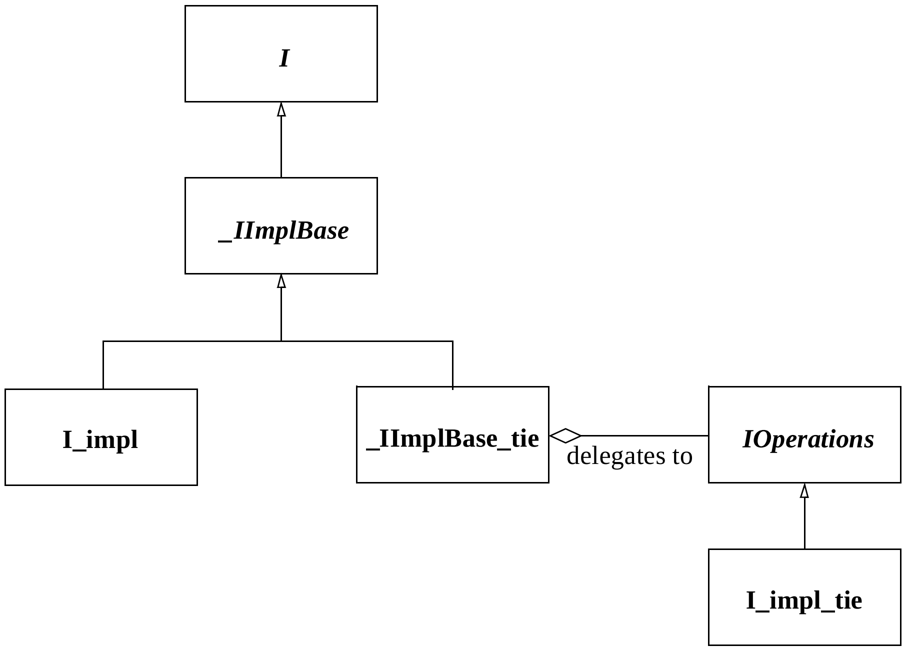


Figure 5.3: Class Hierarchy for Inheritance and Delegation Implementation in Java

5.3 Creating Servants

Servants are created the same way in both C++ and Java: once your servant class is written, you simply instantiate a servant with `new`.

5.3.1 Creating Servants using C++

Here is how to create servants using C++:

```
1 // C++
2 I_var impl = new I_impl;
3 I_var anotherImpl = new I_impl;
```

2,3 Two servants, `impl` and `anotherImpl`, are created with `new`.

In case the servant class was written using the delegation approach, an object of the class implementing `I`'s operations must be passed to the servant's constructor:

```
1 // C++
2 I_impl_tie* impl = new I_impl_tie;
3 I_var tie = new I_skel_tie< I_impl_tie >(impl, CORBA_TRUE);
```

2 A new `I_impl_tie` is created with `new`.

3 An instance of `I_skel_tie` parameterized with `I_impl_tie` is created, taking `impl` as a parameter. All operation calls to `tie` will then be delegated to `impl`.

In this example, the lifetime of `impl` is coupled to the lifetime of the servant `tie`. That is, when `tie` is destroyed, `delete impl` is called. In case you don't want the lifetime of `impl` to be coupled to the lifetime of `tie`, for example because you want to create `impl` on the stack and not on the heap (making it illegal to call `delete` on `impl`), use the following code:

```
1 // C++
2 I_impl_tie impl;
3 I_var tie = new I_skel_tie< I_impl_tie >(&impl, CORBA_FALSE);
```

2 A new `I_impl_tie` is created, this time on the stack, not on the heap.

3 An instance of `I_skel_tie` is created. The `CORBA_FALSE` parameter tells `tie` not to call `delete` on `impl`.

5.3.2 Creating Servants using Java

This example demonstrates how to create servants using Java:

```
 1 // Java
 2 I impl = new I_impl();
 3 I anotherImpl = new I_impl();
```

2,3 Two servants, `impl` and `anotherImpl`, are created with `new`.

In case the servant class was written using the delegation approach, an object implementing the `IOperations` interface must be passed to the servant's constructor:

```
 1 // Java
 2 I_impl_tie impl = new I_impl_tie();
 3 _IImplBase_tie tie = new _IImplBase_tie(impl);
```

2 A new `I_impl_tie` is created.

3 An instance of `_IImplBase_tie` is created, taking `impl` as a parameter. All operation calls to `tie` will then be delegated to `impl`.

Every tie class generated by the IDL-to-Java translator includes methods for accessing and changing the implementation object:

```
 1 // Java
 2
 3 public class _IImplBase_tie extends _IImplBase
 4 {
 5    ...
 6
 7    public IOperations _delegate() { ... }
 8
 9    public void _delegate(IOperations delegate) { ... }
10
11    ...
12 }
```

3 The tie class for interface `I` is defined.

7 This method returns the current delegate (i.e., implementation) object.

9 This method changes the delegate object.

5.4 *Connecting Servants*

Servants must be connected to the object adapter in order to receive requests from clients. Usually this is done automatically whenever an object reference to a servant is passed to a client as a parameter or return value. Servants are also connected implicitly when used in calls to operations like `object_to_string`. However, it is also possible to connect a servant explicitly.

5.4.1 Connecting Servants using C++

The following code shows how to explicitly connect a servant:

```
1 // C++
2 CORBA_ORB_var orb = ... // Get a reference to the ORB somehow
3 I_var impl = new I_impl;
4 orb -> connect(impl);
```

2 To connect a servant, we need the ORB.

3 A new servant `impl` is created.

4 The new servant is connected to the object adapter.

A servant can also be disconnected from the object adapter. This is done with the `disconnect` call:

```
1 // C++
2 orb -> disconnect(impl);
```

2 The servant `impl` is disconnected from the object adapter. From now on, requests from clients to this servant will cause an `OBJECT_NOT_EXIST` exception to be raised.

5.4.2 Connecting Servants using Java

This is how Java servants are explicitly connected to the object adapter:

```
1 // Java
2 org.omg.CORBA.ORB orb = ... // Get a reference to the ORB somehow
3 I impl = new I_impl();
4 orb.connect(impl);
```

2 To connect a servant, we need the ORB.

3 A new servant `impl` is created.

4 The new servant is connected to the object adapter.

A servant can also be disconnected from the object adapter. This is done with the `disconnect` call:

```
1 // Java
2 orb.disconnect(impl);
```

2 The servant `impl` is disconnected from the object adapter. From now on, requests from clients to this servant will cause an `OBJECT_NOT_EXIST` exception to be raised.

5.4.3 Named Servants

ORBACUS for C++ and ORBACUS for Java support the notion of named servants, in which a name is assigned to a servant when it is connected to the object adapter, allowing a client to identify a servant by its name. The ORB operation `get_inet_object` is used on the client side to resolve a named servant within a specific server (see “Connecting to Named Objects” on page 88).

For named servants, a parameter for the servant’s name must be provided to `connect`. For example, in C++:

```
// C++
CORBA_ORB_var orb = ... // Get a reference to the ORB somehow
orb -> connect(impl, "MyName");
```

And in Java;

```
// Java
org.omg.CORBA.ORB orb = ... // Get a reference to the ORB somehow
((com.ooc.CORBA.ORB)orb).connect(impl, "MyName");
```

In both examples, the servant `impl` is connected to the object adapter, using the name “MyName”.

The cast to `com.ooc.CORBA.ORB` is necessary because the Java overloading of `connect` in support of named servants is an ORBACUS-specific extension and is not available in `org.omg.CORBA.ORB`.

The name assigned to a servant must be unique among all servants in a server. In case the name is already in use, the `INV_IDENT` exception is raised.

5.5 Factory Objects

It is quite common to use the Factory [10] design pattern in CORBA applications. In short, a factory object provides access to one or more additional objects. In CORBA applications, a factory object can represent a focal point for clients. In other words, the object reference of the factory object can be published in a well-known location, and clients know that they only need to obtain this object reference in order to gain access to other objects in the system, thereby minimizing the number of object references that need to be published.

The Factory pattern can be applied in a wide variety of situations, including the following:

- **Security** - A client is required to provide security information before the factory object will allow the client to have access to another object.
- **Load-balancing** - The factory object manages a pool of objects, often representing some limited resource, and assigns them to clients based on some utilization algorithm.
- **Polymorphism** - A factory object enables the use of polymorphism by returning object references to different implementations depending on the criteria specified by a client.

These are only a few examples of the potential applications of the Factory pattern. The examples listed above can also be used in any combination, depending on the requirements of the system being designed.

A simple application of the Factory pattern, in which a new object is created for each client, is illustrated below. The implementation uses the following interface definitions:

```
 1 // IDL
 2 interface Product
 3 {
 4     void destroy();
 5 };
 6
 7 interface Factory
 8 {
 9     Product createProduct();
10 };
```

2-5 The `Product` interface is defined. The `destroy` operation allows a client to destroy the object when it is no longer needed.

7-10 The `Factory` interface is defined. The `createProduct` operation returns the object reference of a new `Product`.

5.5.1 Factory Objects using C++

First, we'll implement the `Product` interface:

```
 1  // C++
 2  class Product_impl : public virtual Product_skel
 3  {
 4     CORBA_ORB_var orb_;
 5
 6  public:
 7     void Product_impl(CORBA_ORB_ptr orb)
 8        : orb_(CORBA_ORB::_duplicate(orb))
 9     {
10     }
11
12     virtual void destroy()
13     {
14        orb_ -> disconnect(this);
15     }
16  };
```

2 Servant class `Product_impl` is defined as an implementation of the `Product` interface.

7-8 The constructor takes an ORB parameter and saves it for later use.

14 The `destroy` operation disconnects the object from the object adapter. A side-effect of disconnecting the object is that the object adapter no longer holds a reference to the servant. If there are no other references to this servant in the server, then the servant will be destroyed. See "Releasing Proxies and Servants" on page 98 for more information.

Next, we'll implement the factory:

```
 1  // C++
 2  class Factory_impl : public virtual Factory_skel
 3  {
 4     CORBA_ORB_var orb_;
 5
 6  public:
 7     void Factory_impl(CORBA_ORB_ptr orb)
 8        : orb_(CORBA_ORB::_duplicate(orb))
 9     {
10     }
11
12     virtual Product_ptr createProduct()
13     {
```

```
14        Product_ptr result = new Product_impl(orb_);
15        orb_ -> connect(result);
16        return result;
17     }
18  };
```

2 Servant class `Factory_impl` is defined as an implementation of the `Factory` interface.

7-8 The constructor takes an ORB parameter and saves it for later use.

14-16 The `createProduct` operation instantiates a new `Product` servant, connects it to the object adapter, and returns an object reference to the client. Use of the `connect` operation is optional; an object will be connected automatically if it has not already been connected at the time a reference to the object is transmitted to a client.

Users familiar with other CORBA implementations may think there is an error in the `createProduct` method because `_duplicate` is not being used. However, the code is correct. See Chapter 7 for a complete discussion of reference counts.

5.5.2 Factory Objects using Java

Here is our Java implementation of the `Product` interface:

```
 1  // Java
 2  public class Product_impl extends _ProductImplBase
 3  {
 4     org.omg.CORBA.ORB orb_;
 5
 6     public Product_impl(org.omg.CORBA.ORB orb)
 7     {
 8        orb_ = orb;
 9     }
10
11     public void destroy()
12     {
13        orb_.disconnect(this);
14     }
15  }
```

2 Servant class `Product_impl` is defined as an implementation of the `Product` interface.

13 The `destroy` operation disconnects the object from the object adapter. As long as no other references to the servant are held in the server, the object will be eligible for garbage collection. See “Reference Counting in Java” on page 95 for more information on garbage collection of servant objects.

Here's our implementation of the factory:

```
 1 // Java
 2 public class Factory_impl extends _FactoryImplBase
 3 {
 4    org.omg.CORBA.ORB orb_;
 5
 6    public Factory_impl(org.omg.CORBA.ORB orb)
 7    {
 8       orb_ = orb;
 9    }
10
11    public Product createProduct()
12    {
13       Product result = new Product_impl(orb_);
14       orb_.connect(result);
15       return result;
16    }
17 }
```

2 Servant class `Factory_impl` is defined as an implementation of the `Factory` interface.

13-16 The `createProduct` operation instantiates a new `Product` servant, connects it to the object adapter, and returns an object reference to the client. Like in the C++ version, the explicit call to `connect` is optional.

5.5.3 Caveats

In these simple examples, the factory objects do not maintain any references to the `Product` servants they create; it is the responsibility of the client to ensure that it destroys a `Product` object when it is no longer needed. This design has a significant potential for resource leaks in the server, as it is quite possible that a client will not destroy its Product objects, either because the programmer who wrote the client forgot to invoke `destroy`, or because the client program crashed before it had a chance to clean up. You should keep these issues in mind when designing your own factory objects.[1]

1. Two possible strategies for handling this issue include: time-outs, in which a servant that has not been used for some length of time is automatically released; and expiration, in which an object reference is only valid for a certain length of time, after which a client must obtain a new reference. The implementation of these solutions is beyond the scope of this manual.

5.6 *Getting a Servant from a Reference*

In some situations it may be necessary to obtain the servant implementation object of an object reference (typically because you need to invoke a method on the servant implementation object that is not available via its IDL interface).

In ORBACUS, servant classes are derived from skeleton classes, which are derived from proxy classes (so-called “stub” classes). Therefore, you can simply cast an object reference to its servant class.

5.6.1 Getting a Servant using C++

In C++, `dynamic_cast<>` can be used to obtain a pointer to the servant, as shown below:

```
 1 // C++
 2 
 3 class I_impl : virtual public I_skel
 4 {
 5 };
 6 
 7 void foo(I_ptr ref)
 8 {
 9     I_impl* p = dynamic_cast<I_impl*>(ref);
10 
11     if(p)
12     {
13         // The implementation for ref is in the same process
14     }
15     else
16     {
17         // The implementation for ref is not in the same process
18     }
19 }
```

3 A servant class for an interface `I` is defined.

7 The operation `foo` takes an object reference `ref` to an object `I` as a parameter.

9 `dynamic_cast<>` is used on `ref` to get a pointer to an `I_impl`.

11-18 The call to `dynamic_cast<>` returns a pointer to the servant if the object referred to by `ref` was local, or a null pointer otherwise.

In case your compiler does not support RTTI[1], you can use the `OB_MAKE_NARROW_IMPL` macros from the ORBACUS header file `Narrow_impl.h` to obtain a pointer to a servant class:

```
 1 // C++
 2
 3 #include <OB/Narrow_impl.h>
 4
 5 class I_impl : virtual public I_skel
 6 {
 7    OB_MAKE_NARROW_IMPL(I_impl)
 8 };
 9 OB_MAKE_NARROW_IMPL_1(I_impl, I_skel)
10
11 void foo(I_ptr ref)
12 {
13    I_impl* p = I_impl::_narrow_impl(ref);
14
15    if(p)
16    {
17       // The implementation for ref is local
18    }
19    else
20    {
21       // The implementation for ref is not local
22    }
23 }
```

3 The file `<OB/Narrow_impl.h>` must be included for the definitions of the `OB_MAKE_NARROW_IMPL` macros.

5-9 A servant class for I is defined with `OB_MAKE_NARROW_IMPL` as shown.

13 The only other difference is that now `I_impl::_narrow_impl` must be used instead of `dynamic_cast<>`.

The macro `OB_MAKE_NARROW_IMPL_1` can only be used if the servant class has exactly one super class (the skeleton class). If the servant class has two or more super classes, use the macro `OB_MAKE_NARROW_IMPL_`**n**, where **n** is the number of super classes. For example:

1. RunTime Type Identification.

```
 1 // C+++
 2
 3 class C_impl : virtual public C_skel,
 4                virtual public A_impl,
 5                virtual public B_impl
 6 {
 7    OB_MAKE_NARROW_IMPL(C_impl)
 8 };
 9
10 OB_MAKE_NARROW_IMPL_3(C_impl, C_skel, A_impl, B_impl)
```

3-5 `C_impl` is derived from three classes, `C_skel`, `A_impl` and `B_impl`.

10 Now `OB_MAKE_NARROW_IMPL_3` must be used, with the names of all super classes as arguments.

If you are using ORBACUS on multiple platforms, where some support RTTI and others don’t, it might be best to always use `OB/Narrow_impl.h`, since `_narrow_impl` will automatically use `dynamic_cast<>` on those platforms where it is available.

5.6.2 Getting a Servant using Java

This example demonstrates how to cast an object reference to the servant class in Java:

```
 1 // Java
 2
 3 public class I_impl extends _IImplBase
 4 {
 5 }
 6
 7 public void foo(I ref)
 8 {
 9    try
10    {
11       I_impl impl = (I_impl)ref;
12       // The implementation for ref is local
13    }
14    catch(ClassCastException ex)
15    {
16       // The implementation for ref is not local
17    }
18 }
```

3-5 Servant class `I_impl` is defined.

7 The method `foo` takes an object reference `ref` to an `I` object as a parameter.

11 An attempt is made to cast `ref` to `I_impl`. If this cast succeeded, then the servant is local (i.e., the servant is in the same address space as the program).

16 If the cast failed, then `ClassCastException` will be thrown, indicating that the servant is not in the same address space as the program. In other words, the reference `ref` is really the proxy for a remote object, therefore you cannot obtain a reference to the servant.

CHAPTER 6 Locating Objects

6.1 Obtaining Object References

Using CORBA, an object can obtain a reference to another object in a multitude of ways. One of the most common ways is by receiving an object reference as the result of an operation, as demonstrated by the following example:

```
1 // IDL
2 interface A
3 {
4 };
5
6 interface B
7 {
8    A getA();
9 };
```

3-5 An interface `A` is defined.

7-10 An interface `B` is defined with an operation returning an object reference to an `A`.

On the server side, `A` and `B` can be implemented in C++ as follows:

```
1 // C++
2 class A_impl : virtual public A_skel
3 {
 4 };
 5
 6 class B_impl : virtual public B_skel
 7 {
 8    A_var a_;
 9
10 public:
11
12    void B_impl()
13    {
14       a_ = new A_impl;
15    }
16
17    virtual A_ptr getA()
18    {
19       return A::_duplicate(a_);
20    }
21 };
```

2-4 The servant class `A_impl` is defined, which inherits from the skeleton class `A_skel`.

6-21 The servant class `B_impl` is defined, which inherits from the skeleton class `B_skel`.

12-15 `B_impl`’s constructor creates a new `A_impl` servant.

17-20 `getA` returns an object reference to the `A_impl` servant.

In Java, the interfaces can be implemented like this:

```
// Java
public class A_impl extends _AImplBase
{
}

public class B_impl extends _BImplBase
{
   A a_;

   public B_impl()
   {
      a_ = new A_impl();
   }

   A getA()
   {
      return a_;
18     }
19 }
```

2-4 The servant class `A_impl` is defined, which inherits from the skeleton class `_AImplBase`.

6-19 The servant class `B_impl` is defined, which inherits from the skeleton class `_BImplBase`.

10-13 `B_impl`’s constructor creates a new `A_impl` servant.

15-18 `getA` returns an object reference to the `A_impl` servant.

A client written in C++ could use code like the following to get references to `A`:

```
1 // C++
2 B_var b = ... // Get a B object reference somehow
3 A_var a = b -> getA();
```

3 Invoke `getA` to obtain an object reference for an `A`.

And in Java:

```
1 // Java
2 B b = ... // Get a B object reference somehow
3 A a = b.getA();
```

3 Invoke `getA` to obtain an object reference for an `A`.

In this example, once your application has a reference to a `B` object, it can obtain a reference to an `A` object using `getA`. The question that arises, however, is How do I obtain a reference to a `B` object? This chapter answers that question by describing a number of ways an application can *bootstrap* its first object reference.

6.2 *Lifetime of Object References*

All of the strategies described in this chapter involve the publication of an object reference in some form. A common source of problems for newcomers to CORBA is the lifetime and validity of object references. Using IIOP, an object reference can be thought of as encapsulating several pieces of information:

- hostname
- port number
- object key

If any of these items were to change, any published object references containing the old information would likely become invalid and their use might result in an `INV_OBJREF` exception being raised. The sections below discuss each of these components and describe the steps you can take to ensure that a published object reference remains valid.

6.2.1 Hostname

By default, the hostname in an object reference is the canonical hostname of the host on which the server is running. Therefore, running the server on a new host invalidates any previously published object references for the old host.

ORBACUS provides the `-OAhost` option to allow you to override the hostname in any object references published by the server. This option can be especially helpful when used in conjunction with the Domain Name System (DNS), in which the `-OAhost` option specifies a hostname alias that is mapped by DNS to the canonical hostname.

See “Configuring the ORB and BOA” on page 45 for more information on the `-OAhost` option.

6.2.2 Port Number

Each time a server is executed, the BOA selects a new port number on which to listen for incoming requests. Since the port number is included in published object references, subsequent executions of the server could invalidate existing object references.

To overcome this problem, ORBACUS provides the `-OAport` option that causes the BOA to use the specified port number. You will need to select an unused port number on your host, and use that port number every time the server is started.

See “Configuring the ORB and BOA” on page 45 for more information on the `-OAport` option.

6.2.3 Object Key

Each object created by a server is assigned a unique key that is included in object references published for the object. Furthermore, the order in which your server creates its objects affects the keys assigned to those objects.

To ensure that your objects always have the same keys, ORBACUS allows you to specify a unique name to be used as the key for an object. See “Named Servants” on page 72 for more information.

6.3 *Stringified Object References*

The CORBA specification defines two operations on the ORB interface for converting object references to and from strings.

```
// IDL
module CORBA
{
   interface ORB
   {
      string object_to_string(in Object obj);
      Object string_to_object(in string ref);
   };
};
```

Using "stringified" object references is the simplest way of bootstrapping your first object reference. In short, the server must create a stringified object reference for an object and make the string available to clients. A client obtains the string and converts it back into an object reference, and can then invoke on the object.

The examples discussed in the sections below are based on the IDL definitions presented at the beginning of this chapter.

6.3.1 Using a File

One way to publish a stringified object reference is for the server to create the string using `object_to_string` and then write it to a well-known file. Subsequently, the client can read the string from the file and use it as the argument to `string_to_object`. This method is shown in the following C++ and Java examples.

First, we'll look at the relevant server code:

```
1 // C++
2 CORBA_ORB_var orb = ... // Get a reference to the ORB somehow
3 B_var impl = new B_impl;
4 CORBA_String_var s = orb -> object_to_string(impl);
5 ofstream out("object.ref")
6 out << s << endl;
7 out.close();
```

3 A servant for the interface `B` is created.

4 The object reference of the servant is "stringified".

5-7 The stringified object reference is written to a file.

In Java, the server code looks like this:

```
1 // Java
2 org.omg.CORBA.ORB orb = ... // Get a reference to the ORB somehow
3 B impl = new B_impl();
4 String ref = orb.object_to_string(impl);
5 java.io.PrintWriter out = new PrintWriter(
6    new java.io.FileOutputStream("object.ref"));
7 out.println(ref);
8 out.flush();
```

3 A servant for the interface `B` is created.

4 The object reference of the servant is “stringified”.

5-8 The stringified object reference is written to a file.

Now that the stringified object reference resides in a file, our clients can read the file and convert the string to an object reference:

```
1 // C++
2 CORBA_ORB_var orb = ... // Get a reference to the ORB somehow
3 ifstream in("object.ref");
4 char s[1000];
5 in >> s;
6 CORBA_Object_var obj = orb -> string_to_object(s);
7 B_var b = B::_narrow(obj);
```

3-5 The stringified object reference is read.

6 `string_to_object` creates an object reference from the string.

7 Since the return value of `string_to_object` is of type `CORBA_Object_ptr`, `B::_narrow` must be used to get a `B_ptr` (which is assigned to a self-managed `B_var`, in this example).

```
1 // Java
2 org.omg.CORBA.ORB orb = ... // Get a reference to the ORB somehow
3 java.io.BufferedReader in =
4    new java.io.BufferedReader(new FileReader("object.ref"));
5 String ref = in.readLine();
6 org.omg.CORBA.Object obj = orb.string_to_object(ref);
7 B b = BHelper.narrow(obj);
```

3-5 The stringified object reference is read.

6 `string_to_object` creates an object reference from the string.

7 Use `BHelper.narrow` to narrow the return value of `string_to_object` to `B`.

6.3.2 Using a URL

It is sometimes inconvenient or impossible for clients to have access to the same filesystem as the server in order to read a stringified object reference from a file. A more flexible method is to publish the reference in a file that is accessible by clients as a URL. Your clients can then use HTTP or FTP to obtain the contents of the file, freeing them from any local filesystem requirements. This strategy only requires that your clients know the appropriate URL, and is especially suited for use in applets.

Note: This example will only be shown in Java, because of its built-in support for URLs, but the strategy can also be used in C++.

```
 1 // Java
 2 import java.io.*;
 3 import java.net.*;
 4
 5 String location = "http://www.mywebserver/object.ref";
 6 org.omg.CORBA.ORB orb = ... // Get a reference to the ORB somehow
 7
 8 URL url = new URL(location);
 9 URLConnection conn = url.openConnection();
10 BufferedReader in =
11    new BufferedReader(
12       new InputStreamReader(conn.getInputStream()));
13 String ref = in.readLine();
14 in.close();
15
16 org.omg.CORBA.Object object = orb.string_to_object(ref);
17 B b = BHelper.narrow(object);
```

5 `location` is the URL of the file containing the stringified object reference.

8-14 Read the string from the URL connection.

16 Convert the string to an object reference.

17 Narrow the reference to a `B` object.

6.3.3 Using Applet Parameters

In addition to using the URL method described in the previous section, an applet can also use an applet parameter to obtain a stringified object reference. The following HTML illustrates this concept:

```
<APPLET CODE="Client.class" ARCHIVE="OB.jar" WIDTH=500 HEIGHT=300>
   <PARAM NAME="ref" VALUE="IOR:000012031...">
</APPLET>
```

The stringified object reference is inserted directly into the HTML file and passed to the applet as a parameter. The applet can retrieve this parameter and convert it to an object reference as shown below:

```
1 // Java
2 org.omg.CORBA.ORB orb = ... // Get a reference to the ORB somehow
3 String ref = getParameter("ref");
4 org.omg.CORBA.Object object = orb.string_to_object(ref);
5 B b = BHelper.narrow(object);
```

3 Obtain the applet parameter `ref`.

4 Convert the string to an object reference.

5 Narrow the object reference to a `B` object.

The presence of the stringified object reference in the HTML file could present a maintenance problem. One solution is for the server to write the entire HTML file, thereby ensuring that the object reference is always up to date. You can find an example of this approach in the `demo/hello` subdirectory.

See “Applets” on page 59 for more information on using ORBACUS in applets.

6.4 Connecting to Named Objects

In some applications, it may be necessary for the client to have no resource dependencies (e.g., files, URLs, etc.) in order to bootstrap an object reference. In this case, you can use the ORBACUS-specific `iiop://` notation for IORs or the ORB operation `get_inet_object`. The only prerequisites are that the object must have been assigned a name by the server (see “Named Servants” on page 72), and the client must be able to determine the hostname and port number of the server and the name of the desired object.

The services included with ORBACUS all use named objects that can be accessed using `get_inet_object`. The names for these objects can be found in “Object Names for the Basic Services” on page 153.

6.4.1 Using the iiop:// Notation

The standard string representation of an object reference is completely opaque and can be quite long, making it difficult to use. ORBACUS also supports a non-standard but more human-friendly string representation of an object reference that uses URL notation:

```
iiop://hostname:port/object-name
```

This notation is only suitable for referring to named objects, but it can be used anywhere a normal stringified object reference is expected.

6.4.2 Using get_inet_object

The ORB operation `get_inet_object` is defined as follows:

```
// IDL
module CORBA
{
   interface ORB
   {
       Object get_inet_object(in string host,
                              in unsigned short port,
                              in string name);
   };
};
```

Here's an example of using `get_inet_object` in C++:

```
1 // C++
2 CORBA_ORB_var orb = ... // Get a reference to the ORB somehow
3 CORBA_Object_var obj = orb -> get_inet_object(host, port, "MyName");
4 B_var b = B::_narrow(obj);
```

3 `get_inet_object` is called with the hostname, the port number and the object name, which in this case is "MyName".

4 As with `string_to_object`, the reference returned by `get_inet_object` must be narrowed to a `B` reference.

Here is an identical implementation in Java:

```
1 // Java
2 org.omg.CORBA.ORB orb = ... // Get a reference to the ORB somehow
3 org.omg.CORBA.Object obj =
4      ((com.ooc.CORBA.ORB)orb).get_inet_object(host, port, "MyName");
5   B b = BHelper.narrow(obj);
```

3-4 The operation `get_inet_object` is only defined in `com.ooc.CORBA.ORB` (because it is ORBACUS-specific), therefore the cast is necessary.

5 Again, we must narrow to the derived type `B`.

6.5 *Initial Services*

The CORBA specification provides another standard way to bootstrap an object reference through the use of *initial services*, which denote a set of unique services whose object references, if available, can be obtained using the ORB operation `resolve_initial_references`, which is defined as follows:

```
// IDL
module CORBA
{
   interface ORB
   {
      typedef string ObjectId;
      exception InvalidName {};

      Object resolve_initial_references(in ObjectId identifier)
         raises(InvalidName);
   };
};
```

Initial services are intended to have well-known names, and the OMG has standardized the names for some of the CORBAservices [4]. For example, the Naming Service has the name “NameService”, and the Trading Service has the name “TradingService”.

6.5.1 Resolving an Initial Service

An example in which the ORB is queried for a Naming Service object reference will demonstrate how to use `resolve_initial_references`. The example assumes that the ORB has already been initialized as usual. First the Java version:

```
1   // Java
2   org.omg.CORBA.Object obj = null;
3   org.omg.CosNaming.NamingContext ctx = null;
4
5   try
6   {
    obj = orb.resolve_initial_references("NameService");
}
catch(org.omg.CORBA.ORBPackage.InvalidName ex)
{
    // An error occured, service is not available
}

if(obj == null)
{
    // The object reference is invalid
}

ctx = org.omg.CosNaming.NamingContextHelper.narrow(obj);
if(ctx == null)
{
    // This object does not implement a NamingContext
}
```

And here’s the C++ version:

```
// C++
CORBA_Object_var obj;
CosNaming_NamingContext_var ctx;

try
{
    obj = orb -> resolve_initial_references("NameService");
}
catch(CORBA_InvalidName&)
{
    // An error occured, service is not available
}

if(CORBA::object_is_nil(obj))
{
    // The object reference is invalid
}

ctx = CosNaming_NamingContext::narrow(ctx);
if(CORBA::object_is_nil(ctx))
{
    // This object does not implement NamingContext
}
```

5-12 Try to resolve the name of a particular service. If a service of the specified name is not known to the ORB, an `InvalidName` exception is thrown.

19-23 The service type was known. Now the object reference has to be narrowed to the particular service type. If this fails, the service is not available.

ORBACUS allows you to define your own initial services, as described in the next section. However, these are the recommended names for the services included with ORBACUS:

```
NameService
PropertyService
EventService
```

6.5.2 Providing IORs of Initial Services

When starting a program that makes use of an initial service, the object references of the objects implementing these services have to be registered with the ORB. ORBACUS supports the `-ORBservice` command-line option for adding an initial service:

`-ORBservice` **`name IOR`**

The `-ORBconfig` option is an alternative method for defining a list of initial services, and is often preferable when a number of services must be defined. See “Configuring the ORB and BOA” on page 45 for more information on the `-ORBservice` and `-ORBconfig` options.

In addition to using command-line parameters, a program can also add to the list of initial services using the ORBACUS-specific ORB operation `add_initial_reference`:

```
// IDL
module CORBA
{
   interface ORB
   {
      void add_initial_reference(in ObjectId identifier,
                                 in Object obj);
   };
};
```

For example, in C++:

```
// C++
CORBA_ORB_var orb = ... // Get a reference to the ORB somehow
CORBA_Object_var obj = ... // Get a name service reference somehow
orb -> add_initial_reference("NameService", obj);
```

Or in Java:

```
1 // Java
2 org.omg.CORBA.ORB orb = ... // Get a reference to the ORB somehow
3 org.omg.CORBA.Object obj = ...// Get a name service reference somehow
4 ((com.ooc.CORBA.ORB)orb).add_initial_reference("NameService", obj);
```

3 Get a reference to the naming service, for example by reading a stringified object reference and converting it with `string_to_object`, or by using `get_inet_object`, or by any other means.

4 Add the reference to the ORB's list of initial references. In Java, it's necessary to cast the ORB to `com.ooc.CORBA.ORB`, since `add_initial_reference` is an ORBACUS-specific extension and thus is not supported with `org.omg.CORBA.ORB`.

CHAPTER 7 Reference Counting

7.1 What is Reference Counting?

Reference counting is a commonly-used technique to manage CORBA servant and proxy objects. In general, a reference count is an integer value associated with an object. The counter is initialized to 1, and will be incremented and decremented during the life of the object. When the counter reaches zero, the object is destroyed.

Unlike some distributed object technologies, most notably Microsoft's Distributed Component Object Model (DCOM), CORBA reference counting mechanisms typically are not distributed. In other words, the reference count of a proxy is independent of the reference count of its corresponding servant. Therefore, if the reference count of a proxy reaches zero, the proxy object is destroyed, but the servant is unaffected. Similarly, the reference counts of any proxy objects for a servant are not affected when that servant's reference count reaches zero and the servant is subsequently destroyed.

7.2 Reference Counting in Java

ORBACUS for Java does not need to use reference counting because the standard Java garbage collector performs this activity automatically. However, there is one issue that should be mentioned regarding garbage collection of servant objects.

In Java, the garbage collector does not reclaim an object until there are no more references to that object held by the program. When you use the ORB's `connect` method to connect a servant to the object adapter, the ORB will keep a reference to your servant. Therefore, in order for your servant to be eligible for garbage collection, you must eliminate all references to the servant in your server code, and you must use the ORB's `disconnect` method to ensure that the ORB no longer holds a reference to the servant. Although use of `connect` is optional, because the ORB will automatically connect objects when necessary, use of `disconnect` is always required.

7.3 *Reference Counting in C++*

ORBACUS for C++ implements servants and proxies as reference-counted objects. The reference-counting semantics used by ORBACUS for C++ are outlined in Table 7.1.

`new Servant_impl`	Reference count of new servant is initialized to 1
`ORB::string_to_object`	Reference count of proxy is initialized to 1
`ORB::get_inet_object`	Like `string_to_object`, reference count of proxy is initialized to 1
`ORB::connect(servant)`	Reference count of servant is incremented by 1, since a reference to the servant is added to the object adapter.[a]
`ORB::disconnect(servant)`	Reference count of servant is decremented by 1, since the object adapter's reference to the servant is removed.[b]
`_duplicate(obj)`	Reference count of servant or proxy is incremented by 1
`CORBA_release(obj)`	Reference count of servant or proxy is decremented by 1

Table 7.1: C++ Reference Counting Semantics

a. The reference count is only incremented by 1 after the first (implicit or explicit) call to `connect`. Subsequent calls to `connect` do not affect the reference count.

b. If the servant is already disconnected, calling `disconnect` again does not change the reference count.

7.3.1 Marshalling Issues

When a server returns the object reference of a servant to a client, either as a return value or as an `out` or `inout` parameter, the marshalling code automatically decrements the servant's reference count by 1. Therefore, you will need to use `_duplicate` if you wish to preserve the existing reference count of your servant, as shown in the following example.

```
 1 // IDL
 2
 3 interface A
 4 {
 5 };
 6
 7 interface B
 8 {
 9     A getA();
10 };
```

3-10 Interfaces `A` and `B` are defined.

9 The operation `getA` returns a reference to an object of `A`.

Here is our implementation:

```
 1 // C++
 2
 3 class A_impl : public virtual A_skel
 4 {
 5 };
 6
 7 class B_impl : public virtual B_skel
 8 {
 9     A_var a_;
10     CORBA_ORB_var orb_;
11
12 public:
13
14     void B_impl(CORBA_ORB_ptr orb)
15         : orb_(CORBA_ORB::_duplicate(orb))
16     {
17         a_ = new A_impl;
18         orb_ -> connect(a_);
19     }
20
21     virtual A_ptr getA()
22     {
23         return A::_duplicate(a_);
24     }
25 };
```

3-5 Servant class `A_impl` is defined.

7-25 Servant class `B_impl` is defined.

14-19 The `B_impl` constructor saves a reference to the ORB, instantiates `A_impl` and connects it to the object adapter. It is not strictly necessary to invoke `connect`, because the object will be connected automatically when the object's reference is returned to a client.

21-24 Upon entry to `getA`, the reference count of `a_` is 2 (the initial value is 1 upon construction, and is incremented to 2 when connected). To maintain this value, `getA` duplicates `a_`, which increments the reference count to 3. The marshalling code that returns the reference will decrement the reference count back to 2.

For more information on using object references as `in`, `inout`, `out` and return values, see "Object References" on page 112.

7.3.2 Releasing Proxies and Servants

The reference count of a servant is incremented by 1 when the servant is (implicitly or explicitly) connected to the object adapter (see "Connecting Servants using C++" on page 71). Therefore, **you must disconnect a servant from the object adapter prior to releasing it** with `CORBA_release` in order to ensure that its reference count reaches zero. See "Factory Objects using C++" on page 74 for an example that properly manages the reference count of a servant.

It is important to remember to never use `delete` to destroy proxies or servants. Use only `CORBA_release`. For example, the following code calling `delete` on a proxy obtained with `string_to_object` is wrong:

```
1 const char* s = ... // Obtain a stringified reference somehow
2 CORBA_Object_ptr p = orb -> string_to_object(s);
3 delete p; // Wrong!
```

3 This line is wrong. Instead of `delete`, `CORBA_release` must be used.

This is the correct version:

```
1 const char* s = ... // Obtain a stringified reference somehow
2 CORBA_Object_ptr p = orb -> string_to_object(s);
3 CORBA_release(p);
```

3 OK, `CORBA_release` is used.

You should use self-managed types whenever possible:

```
1 const char* s = ... // Obtain a stringified reference somehow
2 CORBA_Object_var p = orb -> string_to_object(s);
```

2 No `CORBA_release` is necessary, since the `_var` will automatically call `CORBA_release` upon destruction.

You should also avoid allocating servants on the stack. If you do so, the servant will be destroyed if the stack unwinds, without any calls to `CORBA_release`. The following code demonstrates the problem:

```
1 // C++
2
3 void f()
4 {
5    I_impl impl; // Wrong!
6 }
```

5 Upon return from `f`, `impl` is destroyed without the proper call to `CORBA_release`.

7.3.3 Global Object References

You should never have global `_var` type object references, because you can never tell exactly when and in which order they will be destroyed. For example, it is possible that a `_var` reference could be destroyed *after* the ORB was destroyed. Here's an example.

```
1 I_var impl; // Don't do this!
2
3 int
4 main(int argc, char* argv[], char*[])
5 {
6    CORBA_ORB_var orb = CORBA_ORB_init(argc, argv);
7    impl = new I_impl;
8    return 0;
9 }
```

1 A global object reference `_var` type is created.

6 The ORB is initialized.

7 The `I_var` object reference is initialized with a new servant.

8 Upon return, the ORB is destroyed (since `orb` is destroyed, causing `CORBA_release` to be called for the ORB). However, `impl` is still alive, and therefore the servant is not

destroyed, meaning that there is still a servant, but no ORB anymore. This will most likely result in a crash.

The ORB must be the last object to be destroyed! In addition to the technical justification for avoiding global object references, it is generally a bad programming style to have global object references.

7.3.4 Cyclic Object Dependencies

Consider the following code:

```
 1 class X_impl : virtual public X_skel
 2 {
 3    Y_var y_;
 4
 5 public:
 6
 7    void setY(Y_ptr y) { y_ = Y::_duplicate(y); }
 8 };
 9
10 class Y_impl : public Y_skel
11 {
12    X_var x_;
13
14 public:
15
16    void setX(X_ptr x) { x_ = X::_duplicate(x); }
17 };
18
19 void f()
20 {
21    X_var x = new X_impl;
22    Y_var y = new Y_impl;
23    x -> setY(y);
24    y -> setX(x);
25 }
```

1-8 A servant class `X_impl` is defined, which has a `Y_var` data member that can be set with `setY`.

10-17 Ditto, but a servant class `Y_impl` with a data member `X_var` is defined.

19-25 The function `f` creates new `X` and `Y` servants. It stores the reference of the `X` servant in the `Y` servant and vice versa.

Here the X_impl has a reference to the Y_impl and the Y_impl has a reference to the X_impl, what is known as a “cyclic object dependency.” This means that when f returns, even though x and y get destroyed, the objects they are referring to are *not* destroyed since the reference count never becomes zero. Why? Let’s take a deeper look into what happens in the example program:

```
X_var x = new X_impl
```

The initial reference count of the X_impl after the new is 1.

```
Y_var y = new Y_impl
```

Same as above, the initial reference count of the Y_impl is 1.

```
x -> setY(y)
```

After setY, the reference count of the Y_impl is 2.

```
y -> setX(x)
```

After setX, the reference count of the X_impl is 2.

```
return
```

x and y get destroyed and therefore call CORBA_release on their contents, so the reference count of the X_impl and the Y_impl is 1. This means that after the return of f the X_impl and the Y_impl will live forever.

This problem can be solved by adding a releaseInternal function[1] to at least one of the two interface implementations. For example:

```
class X_impl : public X_skel
{
   Y_var y_;

public:

   void setY(Y_ptr y) { y_ = Y::_duplicate(y); }
};

class Y_impl : public Y_skel // Implements interface Y
{
   X_var x_;

public:
```

1. Of course you are free to choose whatever name you like.

```
15
16    void setX(X_ptr x) { x_ = X::_duplicate(x); }
17    void releaseInternal() { x_ = X::_nil(); }
18 };
19
20 void f()
21 {
22    X_var x = new X_impl;
23    Y_var y = new Y_impl;
24    x -> setY(y);
25    y -> setX(x);
26    y -> releaseInternal();
27 }
```

1-8 Same as before

10-18 The `releaseInternal` operation has been added.

26 `releaseInternal` is called before `f` returns.

Now both the `X_impl` and the `Y_impl` get destroyed at the return of `f`:

`X_var x = new X_impl`

The initial reference count of the `X_impl` after the `new` is 1.

`Y_var y = new Y_impl`

Same as above, the initial reference count of the `Y_impl` is 1.

`x -> setY(y)`

After `setY`, the reference count of the `Y_impl` is 2.

`y -> setX(x)`

After `setX`, the reference count of the `X_impl` is 2.

`y -> releaseInternal()`

The `releaseInternal` function sets the `x_` value of the `Y_impl` to `X::_nil`. Assignment to a `_var` object reference causes `CORBA_release` to be called on its contents. So now the reference count of the `X_impl` is 1.

`return`

`x` and `y` are destroyed and therefore call `CORBA_release` on their contents. That means that the reference count of the `X_impl` becomes zero, resulting in `X_impl` being destroyed. This of course also eliminates `X_impl`'s `y_` data member, causing

CORBA_release to be called on the Y_impl. So the Y_impl's reference count also becomes zero and the Y_impl is also destroyed.

CHAPTER 8

C++ Mapping Notes

ORBACUS implements the IDL-to-C++ mapping as described in [2]. The standard IDL-to-C++ mapping is not a topic of this manual. Please refer to [2] for the exact specifications.

8.1 Reserved Names

All names starting with `OB`, `_OB_` or `_ob_` are reserved by ORBACUS for internal use and must not be used as identifiers.[1]

8.2 Mapping of Modules

Generally, IDL modules are mapped to C++ namespaces. However, since most C++ compilers currently do not support namespaces, the IDL-to-C++ mapping defines two alternatives. The first one maps modules to C++ classes, implying that nested classes are needed for interfaces or other modules defined within a module. The second alternative is to map modules to name prefixes, e.g., the name of an interface `I` in a module `M` is mapped to `M_I`.

ORBACUS uses the name prefix mapping alternative for the following reasons:

- As mentioned earlier, C++ namespaces are not widely available yet. ORBACUS was designed to be portable among a variety of C++ compilers. Therefore using namespaces was not possible.

1. Who wants to use such ugly names anyway?

- Although nested classes are available with most C++ compilers, this mapping alternative has the disadvantage that modules cannot be “reopened” (since classes cannot be reopened). That is, it is not possible to define in one IDL file one part of a module and in another IDL file another part of the same module.

8.3 Extensions

ORBACUS provides several extensions to the standard IDL-to-C++ mapping. If you are concerned about source code compatibility with CORBA-compliant ORBs from other vendors, you should not use these extensions. However, if you plan to use your source code exclusively with ORBACUS these extensions will reduce programming overhead.

8.3.1 Extensions to the String Type

The ORBACUS `CORBA_String_var` type provides the `operator+=` for appending to the string. The argument to `operator+=` can be of type `const char*`, `char` and `unsigned char` as well as `short`, `unsigned short`, `int`, `unsigned int`, `long` and `unsigned long`. For example:

```
1 CORBA_String_var s;
2 s += "abc";
3 s += ’x’;
4 s += ’y’;
5 s += ’z’;
6 s += 12345;
```

1 `s` is empty.

2 `s` is "abc".

3 `s` is "abcx".

4 `s` is "abcxy".

5 `s` is "abcxyz".

6 `s` is "abcxyz12345".

8.3.2 Extensions to _var Types

All `_var` types have the following additional member functions:

- `in`: This function converts the `_var` type to a type suitable for `in` parameters.
- `inout`: This function converts the `_var` type to a type suitable for `inout` parameters.

- `out`: This function converts the `_var` type to a type suitable for `out` parameters. As a side effect, this function ensures that the value held by the `_var` is released or freed, by either calling `CORBA_string_free` (in case of a string), `CORBA_release` (in case of an object reference) or `delete` (in case of types like sequences, variable-length structs etc.).
- `_retn`: This function converts the `_var` type to a type suitable for function return values. The `_retn` function also removes the value that is held by the `_var` type without destroying it, i.e., without calling `delete`, `CORBA_string_free` or `CORBA_release` on its value. For example consider a function `f` that returns its three `in` string arguments as a single string:

  ```
  char*
  f(const char* s1, const char* s2, const char* s3)
  {
     CORBA_String_var s = s1;
     s += s2;
     s += s3;
     return s._retn();
  }
  ```

Please note that these functions are not covered by the CORBA 2.0 version of the IDL-to-C++ mapping, but it is likely that they will become a part of the standard for the next major mapping revision.

8.3.3 Extensions to Sequence Types

All unbounded non-array sequences (for example unbounded string, struct and object reference sequences) have an additional `insert`, `append` and `remove` member function. For a sequence `s` and a value `v`, the `s.insert(v)` and `s.append(v)` behave as follows:

```
s.length(s.length() + 1);
... // Somehow shift sequence contents one to the right
s[0] = v;
```

and

```
s.length(s.length() + 1)
s[s.length() - 1] = v;
```

respectively.

Please note that ORBACUS's sequence implementation does not really shift the contents of the sequence. It is rather implemented as a “double ended queue” (like the Standard Template Library's “dequeue”), and therefore needs no value shifting. That is, the `insert` function is as efficient as the `append` function.

8.4 *C++ Mapping Tips & Tricks*

Unfortunately, the official CORBA IDL-to-C++ mapping is a little complicated.[1] The traps & pitfalls justify devoting a section of the ORBACUS manual to how to avoid the most common mistakes.

Note that compared to the IDL-to-C++ mapping, the IDL-to-Java mapping is nice, clean and easy to understand, so it's not really necessary to have a "Java Mapping Tips & Tricks". The official mapping specification [3] is completely sufficient.

8.4.1 CORBA Strings

When using CORBA strings, always remember the following rules.

CORBA-Specific String Functions

Use the CORBA-specific string functions `CORBA_string_alloc`, `CORBA_string_free` and `CORBA_string_dup` if you're dealing with CORBA strings. Never use `new`, `delete`, `malloc`, `free`, `strdup` or similar functions.

For example, the following code is incorrect:

```
1 char* s1 = strdup("Hello!"); // Wrong!
2
3 // Allocate a string for 10 characters + trailing ’\0’ ...
4 String_var s2 = malloc(11); // Wrong!
```

1 Error, `CORBA_string_dup` must be used instead of `strdup`.

4 No! `CORBA_string_alloc` must be used!

This is the correct version:

```
1 char* s1 = CORBA_string_dup("Hello!");
2
3 // Allocate a string for 10 characters + trailing ’\0’ ...
4 CORBA_String_var s2 = CORBA_string_alloc(10);
```

1 OK, `CORBA_string_dup` is fine.

1. Note that OOC did not invent this mapping. We just had to implement it exactly as specified to be CORBA compliant.

4 OK. Note that `CORBA_string_alloc` (unlike `malloc`) adds an additional character for the trailing “\0” automatically.

This code is wrong, too:

```
1 free(s2); // Wrong!
2
```

1 No! Use `CORBA_string_free`!

And again, the corrected version:

```
1 CORBA_string_free(s1);
2
```

1 This is OK. Note that there is no need to free `s2` explicitly since `CORBA_String_var` types release the string they manage automatically when the `CORBA_String_var` type is destroyed.

Initialization and Assignment from char and const char**

Initialization of a `CORBA_String_var` type or assignment to a `CORBA_String_var` type from a `char*` type value *consumes* that value. That means that if the `CORBA_String_var` is destroyed, the value from which the `CORBA_String_var` was initialized or that was assigned to the `CORBA_String_var` will *also be destroyed*.

Initialization of a `CORBA_String_var` type or assignment to a `CORBA_String_var` type from a `const char*` type value *duplicates* that value. This means that if the `CORBA_String_var` is destroyed, the value from which the `CORBA_String_var` was initialized or that was assigned to the `CORBA_String_var` is *not destroyed*.

Note that for compatibility reasons with C the type of string literals in C++ is `char*`, *not* `const char*`. So the following code is wrong:

```
1 CORBA_String_var s = "Hello!"; // Wrong!
2
```

1 Error, since “Hello!” is `char*`, not `const char*`.

The following code is OK:

```
1 CORBA_String_var s1 = CORBA_string_dup("Hello!");
2 CORBA_String_var s2 = (const char*)"Hello!";
```

1 OK, `s1` consumes the value returned by `CORBA_string_dup`.

2 OK, s2 will implicitly duplicate “Hello!”.

Initialization and Assignment from CORBA_String_var

Initialization of a CORBA_String_var type or assignment to a CORBA_String_var type from another CORBA_String_var type value automatically duplicates that value. This means that it is not necessary to use explicit calls to CORBA_string_dup. The following examples are correct:

```
1 CORBA_String_var s1 = CORBA_string_dup("ABC");
2 CORBA_String_var s2 = s1;
3 CORBA_String_var s3 = CORBA_string_dup(s1);
```

2 OK, s2 will implicitly duplicate “ABC”.

3 Also OK, explicit duplication.

Note that string elements of a structure, elements of a string array and elements of a string sequence behave exactly like the CORBA_String_var type[1], i.e., you can deliberately assign between these types or use one of these types to initialize any other of these types. There is no need to call CORBA_string_dup explicitly.

Strings as Parameters and Return Values

If a function is called returning a string value via an out or inout parameter or as a return value, the callee must *duplicate* and the caller must *release* this value. The duplication can be done using CORBA_string_dup and the release by either explicitly calling CORBA_string_free or by assigning the value to a CORBA_String_var. For example:

```
1 // IDL
2 interface I
3 {
4    string op(out string os, inout string ios);
5 };
```

4 An operation op is defined with an out string argument, an inout string argument and a string return value.

The following implementation of I’s op operation is wrong:

1. In code generated by the ORBACUS IDL-to-C++ translator, array and structure string elements *are* actually of type CORBA_String_var. String sequence elements are not of type CORBA_String_var (for technical reasons), but the type used for string sequence elements behaves exactly like the CORBA_String_var type.

```
 1 // C++
 2 class I_impl : virtual public I_skel
 3 {
 4 public:
 5     virtual char* op(char*& os, char*& ios)
 6     {
 7         // Wrong, ios is not freed
 8         ios = "abc"; // Wrong!
 9         os = "def"; // Wrong!
10         return "ghi"; // Wrong!
11     }
12 };
```

7 Forgot to free the `inout` string parameter `ios`.

8,9,10 Wrong. Strings must be duplicated.

Here is the correct version:

```
 1 // C++
 2 class I_impl : virtual public I_skel
 3 {
 4 public:
 5     virtual char* op(char*& os, char*& ios)
 6     {
 7         CORBA_string_free(ios);
 8         ios = CORBA_string_dup("abc");
 9         os = CORBA_string_dup("def");
10         return CORBA_string_dup("ghi");
11     }
12 };
```

7 Now `ios` is freed.

8-10 All String values are now duplicated.

Here is an example showing how to use string `out`, `inout` or return values on the calling side if `CORBA_string_free` is used:

```
 1 // C++
 2 I_ptr i = ... // Get a reference to an I somehow
 3
 4 char* out;
 5 char* inOut = CORBA_string_dup("This is my inout arg");
 6 char* result;
 7
 8 result = i -> op(out, inOut);
 9
10 CORBA_string_free(out);
11 CORBA_string_free(inOut);
12 CORBA_string_free(result);
```

4-6 The parameters are defined. A value must be assigned to the `inout` parameter. Of course values to `in` parameters must also be assigned, but our example does not have any `in` parameters.

8 `op` is called.

10-12 All `out` and `inout` parameters, as well as the return value, must be freed.

Here is the same example, but with self-managed `CORBA_String_var` types instead of explicitly calls to `CORBA_string_free`:

```
1 // C++
2 I_ptr i = ... // Get a reference to an I somehow
3
4 CORBA_String_var out;
5 CORBA_String_var inOut = CORBA_string_dup("This is my inout arg");
6 CORBA_String_var result;
7
8 result = i -> op(out, ios);
```

4-6 `CORBA_String_var` is used instead of `char*`.

8 After the call to `op`, no explicit calls to `CORBA_string_free` are necessary, since the `CORBA_String_var` type destroys its contents automatically.

Since method two in this example is much less error prone, you should always use the self-managed type `CORBA_String_var` in such a case.

8.4.2 Object References

If you use CORBA object references, i.e., `_ptr` and `_var` types for specific interfaces, keep the following in mind.

Object References as Parameters and Return Values

If a function returning an object reference via an `out` or `inout` parameter or as a return value is called, the callee must *duplicate* and the caller must *release* the reference. As described above, an object reference to an object of type `I` (i.e., an object with the interface `I`) is duplicated with `I::_duplicate` and released with `CORBA_release`. This is quite similar to strings as parameters and return values. For example:

```
 1  // IDL
 2  interface I
 3  {
 4  };
 5
 6  interface A
 7  {
 8      I op(out I oref, inout I ioref);
 9  };
```

2-4 An interface `I` is defined.

6-9 An interface `A` is defined, having an operation `op`, which returns an `I` and has an `I` `in` and `inout` parameter.

This implementation of the `op` operation is wrong:

```
 1  // C++
 2  class A_impl : virtual public A_skel
 3  {
 4      I_var myref;
 5
 6  public:
 7
 8      A_impl()
 9      {
10          myref = ... // Initialize myref somehow
11      }
12
13      virtual I_ptr op(I_ptr& oref, I_ptr& ioref)
14      {
15          // Wrong, ioref is not released
16          ioref = myref; // Wrong!
17          oref = myref; // Ditto!
18          return myref; // Ditto!
19      }
20  };
```

15 Forgot to free the `inout` object reference parameter `ioref`.

16-18 Wrong. Object references must be duplicated.

This version is correct:

```
 1 // C++
 2 class A_impl : virtual public A_skel
 3 {
 4    I_var myref;
 5
 6 public:
 7
 8    A_impl()
 9    {
10       myref = ... // Initialize myref somehow
11    }
12
13    virtual I_ptr op(I_ptr& oref, I_ptr& ioref)
14    {
15       CORBA_release(ioref);
16       ioref = I::_duplicate(myref);
17       oref = I::_duplicate(myref);
18       return I::_duplicate(myref);
19    }
20 };
```

15 Now `ioref` is released.

16-18 All object references are now duplicated.

The first example on how to use object reference `out`, `inout` or return values on the calling side uses explicit calls to `CORBA_release`:

```
 1 // C++
 2 A_ptr a = ... // Get a reference to an A somehow
 3
 4 I_ptr out;
 5 I_ptr inOut = ... // Get a reference to an I somehow
 6 I_ptr result;
 7
 8 result = a -> op(out, inOut);
 9
10 CORBA_release(out);
11 CORBA_release(inOut);
12 CORBA_release(result);
```

4-6 The parameters are defined. A value must be assigned to the `inout` parameter.

8 op is called.

10-12 All out and inout parameters, as well as the return value, must be released.

The second example uses self-managed I_var types:

```
1 // C++
2 A_ptr a = ... // Get a reference to an A somehow
3
4 I_var out;
5 I_var inOut = ... // Get a reference to an I somehow
6 I_var result;
7
8 result = i -> op(out, ios);
```

4-6 I_var is used instead of I_ptr.

8 After the call to op, no explicit calls to CORBA_release are necessary, since the I_var type destroys its contents automatically.

We recommend that you use method two with the self-managed types, since this method is much less error prone.

Differences between String_var and Object Reference _var Types

There is a slight but important difference between String_var and object reference _var types regarding their initialization or assignment from in parameters. Consider the following IDL code:

```
1 // IDL
2 interface Y
3 {
4 };
5
6 interface X
7 {
8    void init(in string s1, in string s2, in Y y1, in Y y2);
9 };
```

Here the init function is used to initialize an X with two strings and two Y object references. The following code shows the difference between _var type assignments from strings and from object references:

```
1 // C++
2 class X_impl : virtual public X_skel
```

```
 3 {
 4    CORBA_String_var s1_;
 5    CORBA_String_var s2_;
 6    Y_var y1_;
 7    Y_var y2_;
 8
 9 public:
10
11    void init(const char* s1, const char* s2, Y_ptr y1, Y_ptr y2)
12    {
13       s1_ = s1;
14       s2_ = CORBA_string_dup(s2);
15       y1_ = y1; // Wrong!
16       y2_ = Y::_duplicate(y2);
17    }
18 }
```

13 OK, `CORBA_String_var` automatically duplicates `const char*`.

14 Explicit duplication is also OK, as the `CORBA_String_var` consumes the duplicated string returned from `CORBA_string_dup`, which returns a string of type `char*`.

15 This is wrong, `Y_var` consumes the value of type `Y_ptr`. Therefore `Y::_duplicate` must be used.

16 This is correct now, since `Y::_duplicate` was used.

The reason for this behavior is that there is no such thing as a constant object reference for `in` parameters. Therefore it is not possible for the object reference `_var` type to distinguish between assignments from regular object references and `in` object references.

CHAPTER 9 Concurrency Models

9.1 Introduction

9.1.1 What is a Concurrency Model?

A concurrency model describes how an Object Request Broker (ORB) handles communication and request execution. There are two main categories of concurrency models, single-threaded concurrency models and multi-threaded concurrency models.

Single-threaded concurrency models describe how an ORB behaves while a request is sent or received in a single-threaded environment. For example, one model is to simply let the ORB block on sending and receiving messages. Another model is to let the ORB do some work while sending and receiving messages, for example to receive user input through a keyboard or a GUI, or to simply transfer buffered messages.

Multi-threaded concurrency models describe how the ORB makes use of multiple threads, for example to send and receive messages “in the background.” Multi-threaded concurrency models also describe how several threads can be active in the user code and the strategy the ORB employs to create these threads.

9.1.2 Why different Concurrency Models?

There is no “one size fits all” approach with respect to concurrency models. Each concurrency model provides a unique set of properties, each having advantages and disadvantages. For example, applications using callbacks must have a concurrency model that allows nested method invocations to avoid deadlocks. Other applications must be optimized for speed, in which case a concurrency model with the least overhead will be chosen.

Some ORBs are highly specialized, providing only the most frequently used concurrency models for a specific domain. ORBACUS takes a different approach by supporting several concurrency models.

9.1.3 ORBacus Concurrency Models Overview

ORBACUS allows different concurrency models to be established for the client and server activities of an application. The client-side concurrency models are *Blocking*, *Reactive* and *Threaded*. The server-side concurrency models are *Blocking*, *Reactive*, *Threaded*, *Thread-per-Client*, *Thread-per-Request* and *Thread Pool*.

9.2 Single-Threaded Concurrency Models

9.2.1 Blocking Clients and Servers

The blocking concurrency model is the simplest one. For the client, “blocking” means that the ORB blocks while sending requests to or receiving replies from a server.

A special case are oneway requests,[1] which do not block the ORB. If the ORB determines that sending the oneway request would cause blocking, it puts the oneway request into a request buffer. Whenever the client tries to send another request to the same server, this buffer’s contents are sent first.

Blocking servers block the ORB while receiving a request or sending a reply. Additionally, since the ORB blocks on a connection after accepting it with a call like `accept`, the ORB cannot accept any new connections. Therefore a blocking server can only serve one client at a time. This is shown in Figure 9.1.

Because of its simplicity, the blocking concurrency models are the fastest models available. There is no overhead, neither for calls to operations like `select`[2] (because the ORB

1. A oneway request is a request for which no reply is received. Therefore a oneway request cannot return any results and there is no guarantee that a oneway request was properly executed by a server.
2. `select` is used for synchronous I/O multiplexing. For more information, see the `select` Unix manual page.

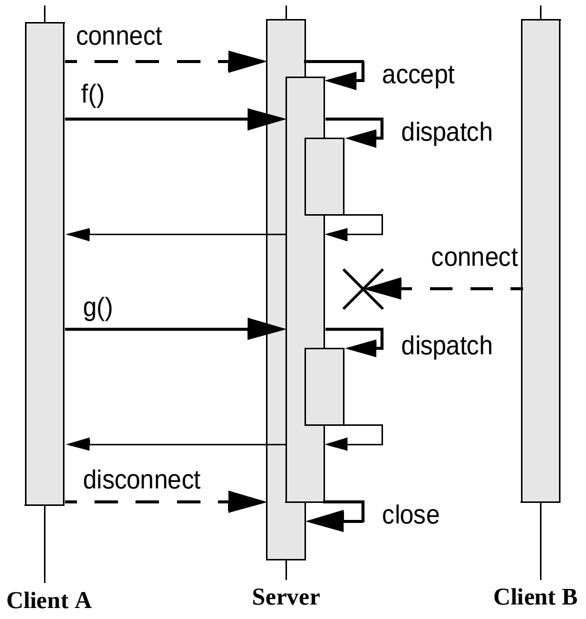


Figure 9.1: Blocking Server

is allowed to block on a single connection), nor for any thread creation or context switches.

9.2.2 Reactive Clients and Servers

Reactive servers use calls to operations like `select` in order to simultaneously accept incoming connection requests, to receive requests from multiple clients and to send back replies. This means that a reactive server can handle more than one client at a time. This is shown in Figure 9.2. Reactive servers are the most common server types for single-threaded client/server applications.

Reactive clients also use operations like `select` to avoid blocking. This means that while a request to a server is sent or a reply from that server is received, the client can simultaneously send buffered requests to other servers or receive and buffer replies. This is very useful for oneway operations or the Dynamic Invocation Interface (DII) operation `send_deferred` in combination with `get_response` or `poll_response`.[1]

However, the main advantage of a reactive client becomes apparent if it is used together with a reactive server in mixed client/server applications. A mixed client/server applica-

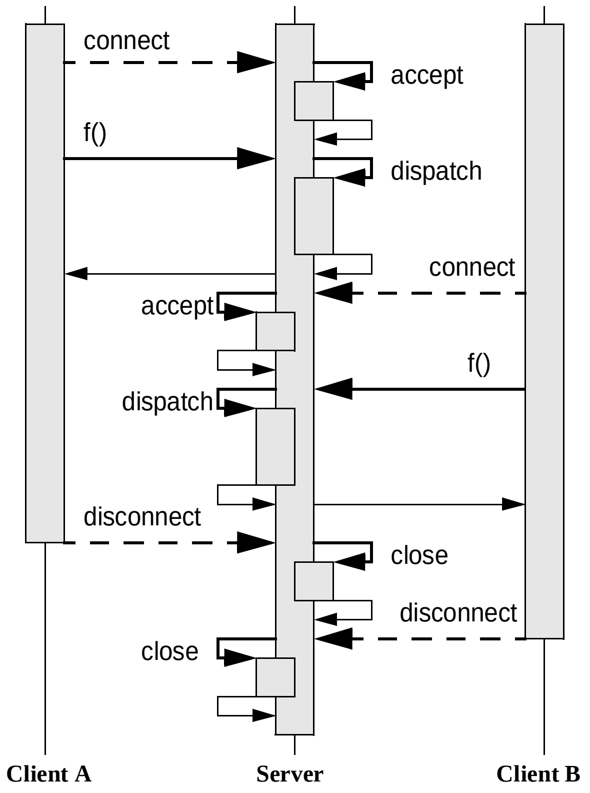


Figure 9.2: Reactive Server

tion is a program that is both a client and server at the same time. Without the reactive concurrency model it is not possible to use nested method calls in single-threaded applications, which are absolutely necessary for most kinds of callbacks.

Consider two programs A and B, both mixed client/server applications. First A tries to call a method `f` on B. Before this method returns, B calls back A by invoking method `g`. This scenario is quite common, and for example is used in the popular Model-View-Controller pattern [7].

1. For more information on `send_deferred`, `get_response` and `poll_response`, see the chapter “The Dynamic Invocation Interface” in [2].

For blocking client/servers this scenario is shown in Figure 9.3. As you can see, the call-

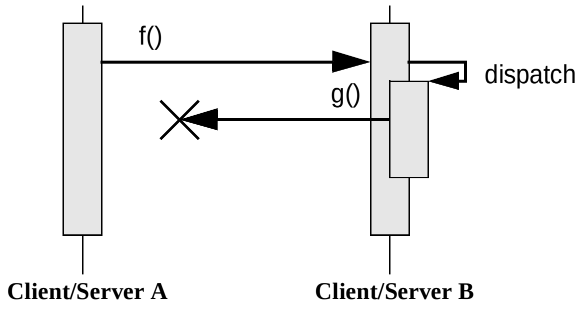


Figure 9.3: Blocking Client/Server

back `g` from B to A does not succeed, because A blocks while waiting for a reply for `f` from B. In contrast, if the reactive concurrency model for the client and the server is used, A can dispatch incoming requests while waiting for B's reply for `f`. This is shown in Figure 9.4.

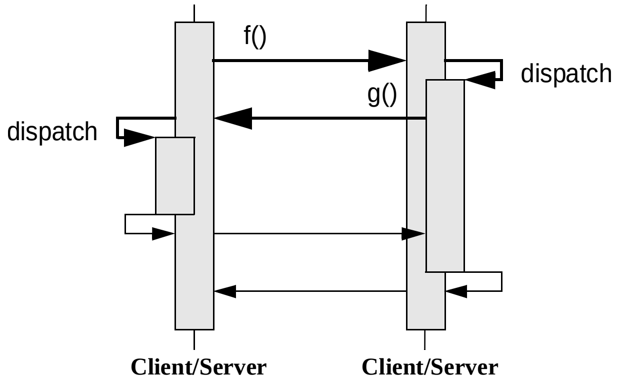


Figure 9.4: Reactive Client/Server

The reactive concurrency models are also very fast. There is no overhead for thread creation or context switching. Only an additional call to an operation like `select` is needed before operations such as `send`, `recv` or `accept` can be used by the ORB.[1]

9.3 *Multi-Threaded Concurrency Models*

9.3.1 Threaded Clients and Servers

A threaded client uses two separate threads for each connection to a server, one for sending requests and another for receiving replies. In contrast to a blocking server, this model has the advantage that oneway requests can be sent “in the background”, i.e., without blocking the user thread execution. The separate receiver thread allows messages to be received and buffered for later retrieval by the user thread with DII operations such as `get_response` or `poll_response`.

Like a threaded client, a threaded server uses separate threads for receiving requests from clients and sending replies. Additionally, there is a separate thread dedicated to accepting incoming connection requests, so that a threaded server can serve more than one client at a time.

ORBACUS’s threaded server concurrency model allows only one active thread in the user code. This means that even though many requests can be received simultaneously, the execution of these requests is serialized. This is shown in Figure 9.5. (For simplicity, the

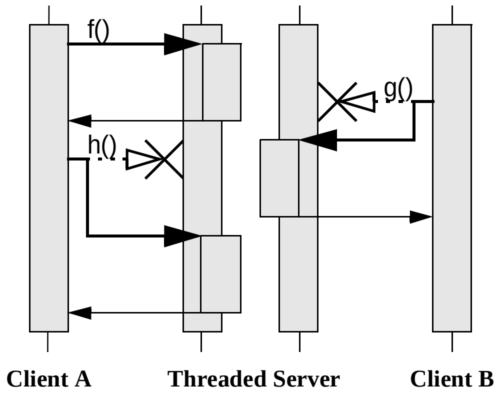


Figure 9.5: Threaded Server

“dispatch” arrows and the corresponding return arrows are omitted in this and all follow-

1. Instead of directly using operations like `select`, ORBACUS uses a *Reactor* to provide for flexible integration with existing event loops and to allow the installation of user supplied event handlers. See Chapter 10 for more information.

ing diagrams.) In the example, the threaded server has two clients connected to it and thus two receiver threads (sender threads not shown). First A calls `f` on the server. If, before `f` returns, B tries to call another operation `g`, this request is delayed until `f` returns. The same is true for A's call to `h`, which must wait until `g` returns.

Allowing only one active thread in user code has the advantage of the user code not having to take care of any kind of thread synchronization. This means that the user code can be written as if for a single threaded system, but without losing the advantage of the ORB optimizing its operation by using multiple threads internally.

The threaded concurrency model is still fast. No calls to operations like `select` are required. Time consuming thread creation is only necessary when a new client is connecting, but not for each request. However, thread context switching makes this approach slower than the blocking concurrency model, at least on a single-processor computer.

9.3.2 Thread-per-Client Server

The thread-per-client server concurrency model is very similar to the threaded server concurrency model, except that the ORB allows one active thread-per-client in the user code. This is shown in Figure 9.6. A's call to `f` and B's call to `g` are carried out simultaneously,

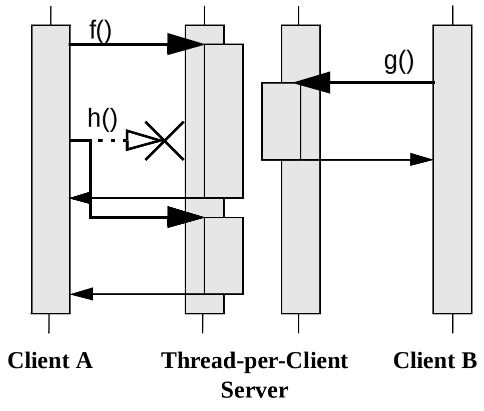


Figure 9.6: Thread-per-Client Server

each in its own thread. However, if A tries to call another operation `h` (for example by sending requests from different threads in a multi-threaded client or by using the DII operation `send_deferred` in a single-threaded client) as long as `f` has not finished yet, the execution of `h` is delayed until `f` returns.

The thread-per-client model is still efficient. Like with the threaded concurrency model, no threads need to be created, except when new connections are accepted.

9.3.3 Thread-per-Request Server

If the thread-per-request server concurrency model is chosen, the ORB creates a new thread for each request. This is shown in Figure 9.7. (For simplicity there are no separate

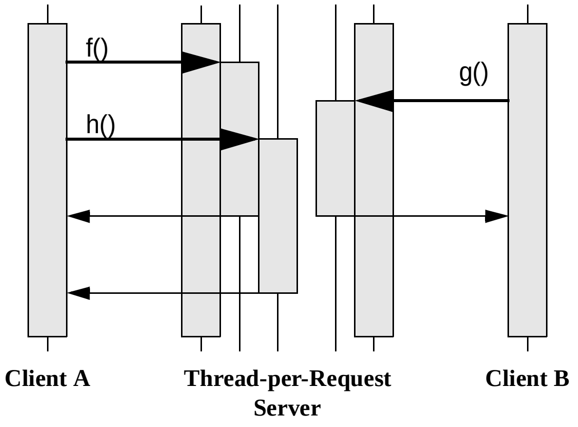


Figure 9.7: Thread-per-Request Server

arrows for dispatch and thread creation in the diagram.) With the thread-per-request model, requests are never delayed. When they come in, a new thread is created and the request is executed in the user code using this thread. On return, the thread is destroyed.

Besides using a reactive client together with a reactive server, the thread-per-request server in combination with a threaded client is the only other model that allows nested method calls with an unlimited nesting level. The thread pool model also allows nested method calls, but the nesting level is limited by the number of threads in the pool.

The thread-per-request concurrency model is inefficient. The main problem results from the overhead involved in creating new threads, namely one for each request.

9.3.4 Thread Pool Server

The thread pool model uses threads from a pool to carry out requests, so that threads have to be created only once and can then be reused for other requests. Figure 9.8 shows an

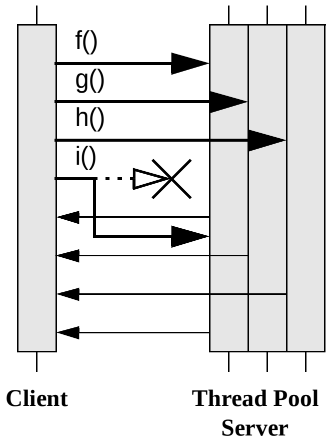


Figure 9.8: Thread Pool Server

example with one client and a thread pool server with three threads in the pool. (Sender and receiver threads are not shown.) The first three operation calls `f`, `g` and `h` can be carried out immediately, since there are three threads in the pool. However, the fourth request `i` is delayed until at least one of the other requests returns.

Since there is no time-consuming thread creation, the thread pool concurrency model performs better than the thread-per-request model. The thread pool is a good trade-off if on the one hand frequent thread creation and destruction result in unacceptable performance, but on the other hand delaying the execution of concurrent method calls is also not desired.

9.4 Performance Comparisons

9.4.1 Sample Application

In order to measure the performance overhead introduced by a given concurrency model, it is important to keep all other overhead not directly related to the concurrency model minimal. Therefore the sample application for performance measurements only consists of a single interface with a single operation with no parameters and return values:

```
// IDL
interface I
{
    void f()
}
```

This ensures that any additional overhead for parameter marshalling or request dispatching is minimal.

All tests have been performed with ORBACUS for C++ version 3.1.1 on a Linux 2.0.35 based machine, libc 5.4.33, PII 400 MHz, 128 MB memory, egcs 1.0.3a C++ compiler, with optimization (compiled with `-O2 -DNDEBUG`), shared libraries, and no debug code.

9.4.2 Regular Method Invocations

The first test scenario is a server that is used by a single client. Table 9.1 shows the time

	Blocking	**Reactive**	**Threaded**
Blocking	0.20 ms	0.25 ms	0.28 ms
Reactive	0.25 ms	0.29 ms	0.33 ms
Threaded	0.26 ms	0.31 ms	0.37 ms
Thread-per-Client	0.25 ms	0.30 ms	0.36 ms
Thread-per-Request	0.63 ms	0.68 ms	0.71 ms
Thread Pool	0.31 ms	0.39 ms	0.42 ms

Table 9.1: Regular Method Invocations

needed for a single call to `f`. In this and all following tables, the different columns correspond to the client side concurrency models and the different rows to the server side concurrency models.

The clear winners are the blocking concurrency models, which are fastest. Second fastest are the reactive concurrency models, followed by the different threaded concurrency models.

Note that Table 9.1 shows the performance results for a thread safe version of ORBACUS. In case no threads are used at all, i.e., if no multi-threaded concurrency model is chosen and if multiple threads are not used in application code, then it’s also possible to use a non-thread-safe version of ORBACUS. Table 9.2 shows that such a version is much faster

	Blocking	**Reactive**
Blocking	0.16 ms	0.20 ms
Reactive	0.20 ms	0.23 ms

Table 9.2: Non-Thread-Safe Version

than a thread-safe one, because there is no additional overhead for any thread synchronization.

9.4.3 Nested Method Invocations

As already pointed out, nested methods invocations are only possible with the following concurrency model combinations:

- reactive client / reactive server
- threaded client / thread-per-request server
- threaded client / thread pool server

Table 9.3 shows the performance results for a nesting level of 100. That is, in the test

	Reactive	**Threaded**
Reactive	2.78 ms	n/a
Thread-per-Request	n/a	3.39 ms
Thread Pool	n/a	3.23 ms

Table 9.3: Nested Method Invocations

applications there are two mixed client/servers, each of them implementing the IDL code of the test application. The first client/server calls `f` on the second, and *before* f returns, the second client/server calls `f` on the first client/server, then the first client/server f on the second again and so on. This is repeated until each client/server called `f` on the other client/server 50 times, which corresponds to a total nesting level of 100.

Again, the clear winner is a single-threaded concurrency model, namely the reactive concurrency model. Here the difference between single-threaded and multi-threaded concurrency models is very significant, because there is a huge overhead for creating threads and thread context switches in the multi-threaded concurrency models.

The maximum nesting level for the reactive concurrency model is usually much higher than for the thread-per-request and thread pool concurrency models. The reason is that the maximum nesting level for thread-per-request and thread pool is determined by the maximum number of threads allowed per process, whereas the reactive concurrency model is only limited by the maximum stack size per process.

9.5 *Selecting Concurrency Models*

Concurrency models can be selected either by command-line parameters (see Chapter 4), or with the operations `ORB::conc_model` and `BOA::conc_model`. The default concurrency models are shown in Table 9.4.

	Client	**Server**
Java	Blocking	Threaded
C++	Blocking	Reactive

Table 9.4: Default Concurrency Models

For example, here is how to establish the concurrency models in C++:

```
// C++
CORBA_ORB_var orb = ... // Get a reference to the ORB somehow
CORBA_BOA_var boa = ... // Get a reference to the BOA somehow
orb -> conc_model(CORBA_ORB::ConcModelThreaded)
boa -> conc_model(CORBA_BOA::ConcModelThreadPerRequest)
```

Other possible parameters for `ORB::conc_model` are:

```
ConcModelBlocking
ConcModelReactive
ConcModelThreaded
```

And for `BOA::conc_model`:

```
ConcModelBlocking
ConcModelReactive
```

```
ConcModelThreaded
ConcModelThreadPerClient
ConcModelThreadPerRequest
ConcModelThreadPool
```

In Java, the example looks like this:

```
// Java
org.omg.CORBA.ORB orb = ... // Get a reference to the ORB somehow
org.omg.CORBA.BOA boa = ... // Get a reference to the BOA somehow
((com.ooc.CORBA.ORB)orb).conc_model(
    com.ooc.CORBA.ORB.ConcModel.ConcModelThreaded)
((com.ooc.CORBA.BOA)boa).conc_model(
    com.ooc.CORBA.BOA.ConcModel.ConcModelThreadPerRequest)
```

The casts to `com.ooc.CORBA.ORB` and `com.ooc.CORBA.BOA` are necessary because the `conc_model` operations are ORBACUS-specific and are not available in the classes `org.omg.CORBA.ORB` and `org.omg.CORBA.BOA`, respectively.

In case the thread pool concurrency model has been selected, it's also necessary to specify the number of threads in the thread pool. This can be done with the operation `BOA::conc_model_thread_pool`:

```
// C++
CORBA_BOA_var boa = ... // Get a reference to the BOA somehow
boa -> conc_model_thread_pool(10);
```

This allocates 10 threads for the thread pool. Here is the same example in Java:

```
// Java
org.omg.CORBA.BOA boa = ... // Get a reference to the BOA somehow
((com.ooc.CORBA.BOA)boa).conc_model_thread_pool(10);
```

CHAPTER 10

The Reactor

10.1 What is a Reactor?

In “reactive” mode (see “Reactive Clients and Servers” on page 119), ORBACUS uses a so-called “Reactor” for event dispatching [6]. Simply speaking, the Reactor is an instance in ORBACUS (a singleton) where special objects — so-called event handlers — can register if they are interested in specific events. These events can be network events, such as an event signaling that data are ready to be read from a network connection.

Again, this chapter only applies to ORBACUS when used with reactive concurrency models. If you use ORBACUS with any other concurrency model, for example “blocking” or any of the multi-threaded models, the following examples are not applicable. Also, since ORBACUS for Java currently doesn’t support the reactive model at all, the following only applies to ORBACUS for C++.

10.2 Available Reactors

Currently there are three Reactors supported by ORBACUS:

- The standard “select” Reactor which relies on the Berkeley Sockets `select` function.
- A special Reactor for use with the X11 Window System. This Reactor handles X11 events (which for example can trigger X11 callbacks) and CORBA network events simultaneously.

- A special Reactor for use with Microsoft Windows 95 or Windows NT. This Reactor handles Windows messages and CORBA network events simultaneously.

The “default” Reactor is the “select” Reactor. If one of the other Reactors is to be used, it must be initialized explicitly.

10.2.1 The X11 Reactor

An application that wants to use the X11 Reactor simply has to call the function `OBX11Init` *before* the ORB is initialized with `CORBA_ORB_init`. For example:

```
 1 #include <X11/Intrinsic.h>
 2
 3 #include <OB/CORBA.h>
 4 #include <OB/X11.h>
 5
 6 int
 7 main(int argc, char* argv[], char*[])
 8 {
 9    XtAppContext appContext;
10    Widget topLevel = XtAppInitialize(&appContext,
11                                      "MyApplication",
12                                      0, 0,
13                                      &argc, argv,
14                                      0, 0, 0);
15
16    OBX11Init(appContext);
17
18    CORBA_ORB_var orb = CORBA_ORB_init(argc, argv);
19    CORBA_BOA_var boa = orb -> BOA_init(argc, argv);
20
21    // More application code ...
22
23    boa -> impl_is_ready();
24
25    return 0;
26 }
```

1-4 Include header files.

6-7 Define the `main` function.

9-14 Initialize X11 application.

16 Use the X11 application context to initialize the X11 Reactor.

18-19 Initialize ORB and BOA as usual.

23 Enter the CORBA event loop. This loop will now also dispatch X11 events. Alternatively, the standard X11 event loop may be called, which will then also dispatch CORBA events.

10.2.2 The Windows Reactor

For the Windows Reactor, the function `OBWindowsInit` must be called, also *before* the ORB is initialized. For example:

```
 1 #include <Windows.h>
 2
 3 #include <OB/CORBA.h>
 4 #include <OB/Windows.h>
 5
 6 int WINAPI
 7 WinMain(HINSTANCE hInstance, HINSTANCE hPrevInstance,
 8         LPSTR lpszArgs, int nWinMode)
 9 {
10     OBWindowsInit(hInstance);
11
12     int dummy = 0;
13     CORBA_ORB_var orb = CORBA_ORB_init(dummy, 0);
14     CORBA_BOA_var boa = orb -> BOA_init(dummy, 0);
15
16     // More application code ...
17
18     boa -> impl_is_ready();
19
20     return 0;
21 }
```

1-4 Include header files.

6-8 Define the `WinMain` function.

10 Use the Windows application instance to initialize the Windows Reactor.

12-14 Initialize ORB and BOA as usual.

18 Enter the CORBA event loop, which now also dispatches Windows events. The standard Windows event loop may also be called, which will then also dispatch CORBA events.

10.3 Writing a Custom Event Handler

ORBACUS in reactive mode includes support for customized event handlers. This means that while your application is running, it can react to events like keyboard events. In order to implement your own ORBACUS event handler, you must derive a class from `OBEventHandler` and overload the `handleEvent` and `handleStop` member functions. The constructor of the derived class must ensure that objects of this class are registered with the Reactor. This is an example for an event handler that listens to keyboard events:

```
#include <OB/Reactor.h>

class MyEventHandler : public OBEventHandler
{
public:

   MyEventHandler();
   virtual ~MyEventHandler();

   virtual void handleEvent(CORBA_ULong);
   virtual void handleStop();
};

MyEventHandler::MyEventHandler()
{
   OBReactor* Reactor = OBReactor::instance();
   Reactor -> registerHandler(this, OBEventRead, 0);
}

MyEventHandler::~MyEventHandler()
{
   OBReactor* Reactor = OBReactor::instance();
   Reactor -> unregisterHandler(this);
}

void
MyEventHandler::handleEvent(OBMask mask)
{
   assert(mask == OBEventRead);

   char c;
   cin.read(&c, 1);

   // Handle character input here ...
}
```

```
36
37 void
38 MyEventHandler::handleStop()
39 {
40 }
```

1 The header file for the reactor is included. This file also contains the definition of `OBEventHandler`.

3-12 An event handler `MyEventHandler` is defined, which has a constructor, a destructor, a `handleEvent` and a `handleStop` operation.

14-18 The constructor registers the event handler with the Reactor singleton. Only “read” events are requested.

20-24 The destructor unregisters the event handler with the Reactor singleton.

26-35 The ORBACUS Reactor calls the `handleEvent` function each time a read event from standard input is pending.

37-40 `handleStop` is not used by this event handler.

10.4 *Using Timers*

Often an application may wish to perform tasks on a regular timed basis. The reactor provides an API for the integration of timed tasks into an ORBACUS application.

In order to have a timed task a class must be created that inherits from the class `OBTimer`. The class `OBTimer` provides a pure-virtual method `notify` that is called when the timer expires.

For the timer to be notified it must first be enabled. To do this the `activate` method is called. This method takes two parameters. A timeval, and a boolean flag. The boolean flag indicates whether the timeval is a relative or absolute - true indicates a relative value. The timeval contains two members, `tv_sec` and `tv_usec`. Note that the timer is only as accurate as the underlying operating system, so microsecond accuracy is not necessarily offered.

The `activate` method causes the timer to be notified once. If a recurring timer is desired the `activate` method should be invoked before the `notify` method is completed.

The `stop` method is provided to cancel the next notification.

```
#include <OB/Timer.h>
class CustomTimer : public OBTimer
```

```
 3 {
 4    void register()
 5    {
 6       struct timeval tv;
 7       tv.tv_sec = 10;
 8       tv.tv_usec = 0;
 9       //
10       // Call notify() method in 10 seconds
11       //
12       activate(tv, true);
13
14    }
15
16 public:
17    CustomTimer()
18    {
19       register();
20    }
21
22    virtual void notify()
23    {
24       cout << "Notify called" << endl;
25       register();
26    }
27 };
```

1 The file `OB/Timer.h` must be included to use the timer classes.

2 A class `CustomTimer` is defined that inherits from `OBTimer`.

4-12 The private method `register` causes the timer to be notified every 10 seconds.

17-20 The constructor calls the `register` method.

22-26 The `notify` method is called every 10 seconds. A string is displayed, and the timer is re-registered.

CHAPTER 11

The Open Communications Interface

11.1 What is the Open Communications Interface?

The Open Communications Interface (OCI) defines common interfaces for pluggable protocols. It supports connection-oriented, reliable “byte-stream” protocols. That is, protocols which allow the transmission of a continuous stream of bytes (octets) from the sender to the receiver.

TCP/IP is one possible candidate for an OCI plug-in. Since ORBACUS uses GIOP, such a plug-in then implements the IIOP protocol. Other candidates are SCCP (Signaling Connection Control Part, part of SS.7) or SAAL (Signaling ATM Adaptation Layer).

Non-reliable or non-connection-oriented protocols can also be used if the protocol plug-in itself takes care of reliability and connection management. For example, UDP/IP can be used if the protocol plug-in provides for packet ordering and packet repetition in case of a packet loss.

11.2 Interface Summary

11.2.1 Buffer

An interface for a buffer. A buffer can be viewed as an object holding an array of octets and a position counter, which determines how many octets have already been sent or received.

11.2.2 Transport

The Transport interface allows the sending and receiving of octet streams in the form of Buffer objects. There are blocking and non-blocking send/receive operations available, as well as operations that handle time-outs and detection of connection loss.

11.2.3 Acceptor and Connector

Acceptors and Connectors are Factories [10] for Transport objects. A Connector is used to connect clients to servers. An Acceptor is used by a server to accept client connection requests.

Acceptors and Connectors also provide operations to manage protocol-specific IOR profiles. This includes operations for comparing profiles, adding profiles to IORs or extracting object keys from profiles.

11.2.4 Connector Factory

A Connector Factory is used by clients to create Connectors. No special Acceptor Factory is necessary, since an Acceptor is created just once on server start-up and then accepts incoming connection requests until it is destroyed on server shutdown. Connectors, however, need to be created by clients whenever a new connection to a server has to be established.

11.2.5 The Registries

The ORB provides a Connector Factory Registry and the Object Adapter provides an Acceptor Registry. These registries allow the plugging-in of new protocols. Transport, Connector, Connector Factory and Acceptor must be written by the plug-in implementors. The Connector Factory must then be registered with the ORB's Connector Factory Registry and the Acceptor must be registered with the Object Adapter's Acceptor Registry.

11.2.6 The Info Objects

Info objects provide information on Transports, Acceptors and Connectors. A Transport Info provides information on a Transport, an Acceptor Info on an Acceptor and a Connector Info on a Connector. To get information for a concrete protocol, these info objects must be `narrow`'d to an info object for this protocol, for example, in the case of an IIOP plug-in, a `OCI::TransportInfo` must be `narrow`'d to `OCI::IIOP::TransportInfo`.

11.2.7 Class Diagram

Figure 11.1 shows the classes and interfaces of the OCI (except for the Buffer and Info

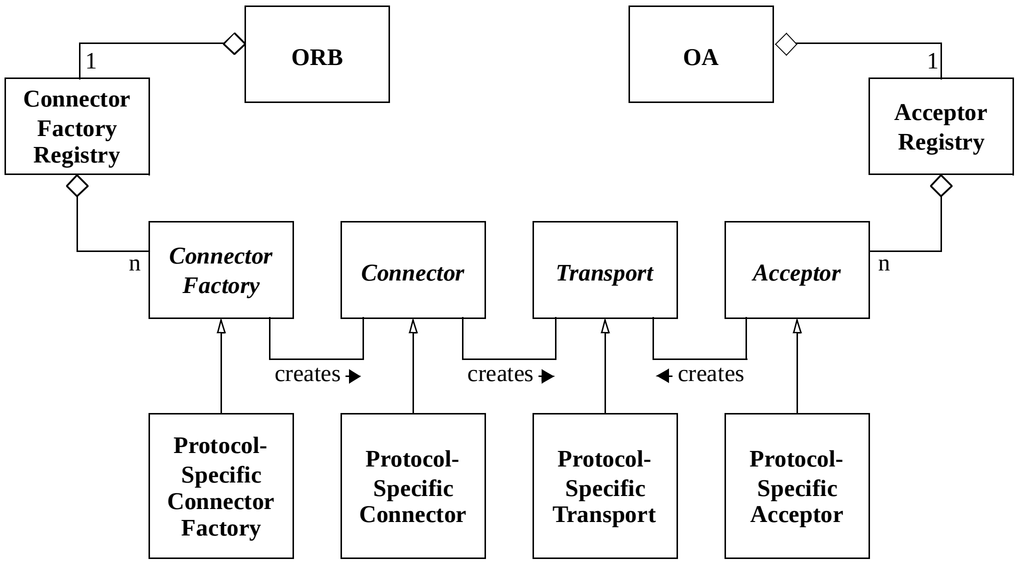

1
ORB
OA
1
Connector Factory Registry
Acceptor Registry
n
Connector Factory
Connector
Transport
Acceptor
n
creates ▶
creates ▶
◀ creates
Protocol-Specific Connector Factory
Protocol-Specific Connector
Protocol-Specific Transport
Protocol-Specific Acceptor

Figure 11.1: OCI Class Diagram

interfaces). ORBACUS provides abstract base classes for the interfaces Connector Factory, Connector, Transport and Acceptor. The protocol plug-in must inherit from these classes in order to provide concrete implementations for a specific protocol. ORBACUS also provides concrete classes for the interfaces Buffer, Connector Factory Registry and Acceptor Registry. Instances of Connector Factory Registry and Acceptor Registry are provided by the ORB and Object Adapter, respectively. Concrete implementations of the Connector Factory must be registered with the ORB's Connector Factory Registry, and concrete implementations of the Acceptor must be registered with the Acceptor Registry.

11.3 OCI Reference

This chapter does not contain a complete reference of the OCI. It only explains OCI basics and, in the remainder of this chapter, how it is used from the application programmer's point of view for the most common tasks. For more information on how to use the OCI to write your own protocol plug-ins, and for a complete reference, please refer to Appendix B.

11.4 *OCI for the Application Programmer*

The following information only applies to the standard ORBACUS IIOP plug-in. For other plug-ins, like the ORBACUS SSL plug-in, please refer to the plug-in's documentation.

11.4.1 A "Converter" Class for Java

As you will see in the following examples, the OCI info objects return port numbers as IDL `unsigned short` values and IP addresses as an array of 4 IDL `unsigned octet` values. This works fine for C++, but in Java this causes a problem, because there are no unsigned types in Java. The Java mapping simply maps unsigned types to signed types. Consider for example the IP address 126.127.128.129. In Java, the OCI will return this as 126.127.-128.-127, because 128 and 129, if bit-wise mapped to the Java `byte` type, are -128 and -127.

To avoid this problem, we will use a helper class which converts port numbers and IP addresses to Java `int` types. This helper class looks as follows:

```
// Java

final class Converter
{
   static int port(short s)
   {
      if(s < 0)
         return 0xffff + (int)s + 1;
      else
         return (int)s;
   }

   static int[] addr(byte[] bArray)
   {
      int[] iArray = new int[4];
      for(int i = 0 ; i < 4 ; i++)
         if(bArray[i] < 0)
            iArray[i] = 0xff + (int)bArray[i] + 1;
         else
            iArray[i] = (int)bArray[i];

22         return iArray;
23      }
24  };
```

5-11 Converts `short` port numbers to `int`.

13-23 Converts `byte[]` IP addresses to `int[]`.

The converter class is used throughout the examples in the sections below.

11.4.2 Getting Hostnames and Port Numbers

The following code fragments show how it is possible to find out on what hostnames and port numbers a server is listening. First the C++ version:

```
 1  // C++
 2
 3  OCI_AccRegistry_var registry = boa -> get_acc_registry();
 4  OCI_AcceptorSeq_var acceptors = registry -> get_acceptors();
 5
 6  for(CORBA_ULong i = 0 ; i < acceptors -> length() ; i++)
 7  {
 8     OCI_AcceptorInfo_var info = acceptors[i] -> get_info();
 9     OCI_IIOP_AcceptorInfo_var iiopInfo =
10        OCI_IIOP_AcceptorInfo::_narrow(info);
11
12     if(!CORBA_is_nil(iiopInfo))
13     {
14        CORBA_String_var host = iiopInfo -> host();
15        CORBA_UShort port = iiopInfo -> port();
16
17        cout << "host: " << host << endl;
18        cout << "port: " << port << endl;
19     }
20  }
```

3 The Acceptor Registry is requested from the object adapter.

4 From the Acceptor Registry, the list of registered acceptors is requested.

6 The `for` loop iterates over all acceptors.

8-10 The info object for the acceptor is requested and narrowed to an IIOP acceptor info object.

12 The `if` block is only entered in case the info object really belongs to an IIOP plug-in.

14-18 The hostname and port number are requested from the IIOP acceptor info object and printed on standard output.

The Java version is basically equivalent to the C++ code and looks as follows:

```
 1 // Java
 2
 3 com.ooc.OCI.AccRegistry registry =
 4    ((com.ooc.CORBA.BOA)boa).get_acc_registry();
 5 com.ooc.OCI.Acceptor[] acceptors = registry.get_acceptors();
 6
 7 for(int i = 0 ; i < acceptors.length ; i++)
 8 {
 9    com.ooc.OCI.AcceptorInfo info = acceptors[i].get_info();
10    com.ooc.OCI.IIOP.AcceptorInfo iiopInfo =
11       com.ooc.OCI.IIOP.AcceptorInfoHelper.narrow(info);
12
13    if(iiopInfo != null)
14    {
15       String host = iiopInfo.host();
16       short port = Converter.port(iiopInfo.port());
17
18       System.out.println("host: " + host);
19       System.out.println("port: " + port);
20    }
21 }
```

3 The acceptor registry is requested from the BOA. Since the standard BOA `org.omg.CORBA.BOA` does not provide a method for this, there must be a cast to `com.ooc.CORBA.BOA`.

5-15 This is equivalent to the C++ version.

16 The converter class is used to get a port number in `int` format.

18-19 Like in the C++ version, the hostname and port number are printed on standard output.

11.4.3 Finding out a Client’s IP Address

To find out the IP address of a client within a server method, the following code can be used in a servant class method implementation:

```
 1 // C++
 2
 3 CORBA_Object_var baseCurrent =
 4     orb -> resolve_initial_references("OCICurrent");
 5 OCI_Current_var current = OCI_Current::_narrow(baseCurrent);
 6
 7 OCI_TransportInfo_var info = current -> get_oci_transport_info();
 8 OCI_IIOP_TransportInfo_var iiopInfo =
 9     OCI_IIOP_TransportInfo::_narrow(info);
10
11 if(!CORBA_is_nil(iiopInfo))
12 {
13     OCI_IIOP_InetAddr remoteAddr = iiopInfo -> remote_addr();
14     CORBA_UShort remotePort = iiopInfo -> remote_port();
15
16     cout << "Call from: "
17          << remoteAddr[0] << '.' << remoteAddr[1] << '.'
18          << remoteAddr[2] << '.' << remoteAddr[3]
19          << ":" << remotePort << endl;
20 }
```

3-5 The OCI current object is requested and `narrow`'d to the correct `OCI::Current` type.

7-9 The info object for the transport is requested and `narrow`'d to an IIOP transport info object.

11 The remainder of the example code is only executed if this was really an IIOP transport info object.

13-19 The address and the port of the client calling this operation are obtained and printed on standard output.

The Java version looks as follows:

```
org.omg.CORBA.Object baseCurrent =
    orb.resolve_initial_references("OCICurrent");
com.ooc.OCI.Current current =
    com.ooc.OCI.CurrentHelper.narrow(baseCurrent);

com.ooc.OCI.TransportInfo info = current.get_oci_transport_info();
com.ooc.OCI.IIOP.TransportInfo iiopInfo =
    com.ooc.OCI.IIOP.TransportInfoHelper.narrow(baseInfo);

if(iiopInfo != null)
{
    int[] remoteAddr = Converter.addr(iiopInfo.remote_addr());
    int remotePort = Converter.port(iiopInfo.remote_port());

   System.out.println("Call from: " +
16                    remoteAddr[0] + "." +
17                    remoteAddr[1] + "." +
18                    remoteAddr[2] + "." +
19                    remoteAddr[3] + ":" + remotePort);
20 }
```

1-10 This code is equivalent to the C++ version.

12-13 Again, the port number must be converted from `short` to `int`.

15-19 This is also equivalent to the C++ version.

11.4.4 Finding out a Server's IP Address

To find out the server's IP address and port that an object will attempt to connect to, the following code can be used:

```
1  // C++
2
3  CORBA_Object_var obj = ... // Get an object reference somehow
4
5  OCI_ConnectorInfo_var info = obj -> get_oci_connector_info();
6  OCI_IIOP_ConnectorInfo_var iiopInfo =
7     OCI_IIOP_ConnectorInfo::_narrow(info);
8
9  if(!CORBA_is_nil(iiopInfo))
10 {
11    OCI_IIOP_InetAddr_var remoteAddr = iiopInfo -> remoteAddr();
12    CORBA_UShort remotePort = iiopInfo -> remote_port();
13
14    cout << "Will connect to: "
15        << remoteAddr[0] << '.' << remoteAddr[2] << '.'
16        << remoteAddr[2] << '.' << remoteAddr[3]
17        << ":" << remotePort << endl;
18 }
```

5-7 Get the OCI connector info and narrow to an IIOP connector info

9 The `if` block is only executed if this really was an IIOP connector info.

11-17 The address and port are obtained and displayed on standard output.

The Java version looks as follows:

```
1  // Java
2
```

```
 3 org.omg.CORBA.Object obj = ... // Get an object reference somehow
 4
 5 org.omg.CORBA.portable.ObjectImpl objImpl =
 6    (org.omg.CORBA.portable.ObjectImpl)obj;
 7 com.ooc.CORBA.Delegate objDelegate =
 8    (com.ooc.CORBA.Delegate)objImpl._get_delegate();
 9
10 com.ooc.OCI.ConnectorInfo info =
11    objDelegate.get_oci_connector_info();
12 com.ooc.OCI.IIOP.ConnectorInfo iiopInfo =
13    com.ooc.OCI.IIOP.ConnectorInfoHelper.narrow(info);
14
15 if(iiopInfo != null)
16 {
17    int[] remoteAddr = Converter.addr(iiopInfo.remote_addr());
18    int remotePort = Converter.port(iiopInfo.remote_port());
19
20   System.out.println("Will connect to: " +
21                     remoteAddr[0] + "." +
22                     remoteAddr[1] + "." +
23                     remoteAddr[2] + "." +
24                     remoteAddr[3] + ":" + remotePort);
25 }
```

5-8 We need to retrieve the ORBACUS-specific `Delegate` object so that we can get the connector info.

10-13 Get the OCI connector info and narrow to an IIOP connector info.

15 The `if` block is only entered if this really was an IIOP connector info.

17-24 The address and port are obtained and displayed on standard output.

CHAPTER 12

Using Policies

12.1 Overview

The ORB and its services may allow the application developer to configure the semantics of its operations. This configuration is accomplished in a structured manner through interfaces derived from the interface `CORBA::Policy`. For instance, the ORBACUS SSL plug-in [13] allows the configuration of the cipher suites used for peer communications through the interface `SSL::CipherSuitePolicy`.

The configuration of these policy objects is accomplished at three levels:

- **ORB Level**: These policies override the system defaults. The ORB has an initial reference `ORBPolicyManager`. A `PolicyManager` has a set of operations through which the current set of overriding policies can be obtained, and new policies can be applied.
- **Thread Level**: A standard `PolicyCurrent` is defined with operations that allow the querying and retrieval of policies that affect the current thread. These policies override the policies set at the ORB level.
- **Object Level**: The object interface contains operations to retrieve and set policies for itself. Policies applied at the object level override those applied at the thread level, or the ORB level.

At present ORBACUS does not support thread level policies.

For more information on Policies, the `PolicyManager` interface and the `CORBA::Object` policy operations see [11] and [12].

12.2 *Supported Policies*

The following is a brief description of the policies that are currently supported. For a detailed description, please refer to Appendix A.

SSL::ConnectPolicy

This policy determines whether the ORB is permitted to establish an insecure communications channel between peers. The default for this policy is `true` if the SSL plug-in is not installed. If the SSL plug-in is installed, the default is `false`. For more information on this policy, see [13].

OB::ConnectionReusePolicy

This policy determines whether the ORB is permitted to reuse a communications channel between peers. If this policy is `false` then each object will have a new communications channel to its peer. The default for this policy is `true`.

OB::ProtocolPolicy

This policy is used to force the selection of a particular protocol. If this policy is set, then the protocol with the identified tag will be used, if possible. If it is not possible to use this protocol, a `CORBA::NO_RESOURCES` exception will be raised.

OB::ReconnectPolicy

If an object possesses this policy and the `value` flag of this policy is `true`, then upon a communications failure a reconnection will automatically be attempted. If this reconnection attempt fails a `CORBA::COMM_FAILURE` exception is raised.

OB::TimeoutPolicy

If an object has this policy and no response is available for a request after `value` milliseconds, a `CORBA::NO_RESPONSE` exception is raised.

12.3 *Examples*

The following examples demonstrate how to set `OB::ConnectionReusePolicy` at both the ORB level and the object level in C++ and Java. Setting a policy at the ORB level means that the ORB will honor this policy for all newly created objects. Existing objects maintain their current set of policies. Setting a policy at the object level overrides any ORB level policies applied to that object.

Setting the connection reuse policy to `false` at the ORB level means that the ORB will create a new connection from the client to the server for each new proxy object instead of reusing existing ones. Setting the connection reuse policy to `false` at the object level means that the client does not reuse connections to the server only for a particular proxy object.

If the connection reuse policy is set to `true` at some later point, communications channels that were previously created with a connection reuse policy set to `false` will not be reused. That is, the connection reuse policy is sticky, in the sense that the reuse policy that was in effect at the time that a communications channel is created stays with it. Setting the reuse policy at the object level means that for a client the ORB will not reuse the communications channel that is associated with the proxy object.

12.3.1 Connection Reuse Policy at ORB Level

Our first example shows how the connection reuse policy can be set at the ORB level. First in C++:

```
 1 // C++
 2 CORBA_Any boolAny;
 3 boolAny <<= CORBA_Any::from_boolean(CORBA_FALSE);
 4 CORBA_PolicyList policies;
 5 policies.length(1);
 6 policies[0] = orb -> create_policy(OB_CONNECTION_REUSE, boolAny);
 7 CORBA_Object_var pmObj =
 8     orb -> resolve_initial_references("ORBPolicyManager");
 9 CORBA_PolicyManager_var pm = CORBA_PolicyManager::_narrow(pmObj);
10 pm -> add_policy_overrides(policies);
```

2-3 Create an any and insert the value `CORBA_FALSE`.

4-5 Create a sequence containing one policy object.

6 Ask the ORB to create a connection reuse policy. Pass the any that contains the value for this policy.

7-9 Obtain the ORB level policy manager object.

10 Add the policies to the ORB level policy manager.

And here is the same example in Java:

```
 1 // Java
 2 org.omg.CORBA.Any boolAny = orb.create_any();
 3 boolAny.insert_boolean(false);
 4 org.omg.CORBA.Policy[] policies = new org.omg.CORBA.Policy[1];
 5 policies[0] =
 6     orb.create_policy(com.ooc.OB.CONNECTION_REUSE.value, boolAny);
 7 org.omg.CORBA.PolicyManager pm =
 8     org.omg.CORBA.PolicyManagerHelper.narrow(
 9         orb.resolve_initial_references("ORBPolicyManager"));
10 pm.add_policy_overrides(policies);
```

1-10 This is equivalent to the C++ version.

12.3.2 Connection Reuse Policy at Object Level

And now the same example, but at the object level. C++ first:

```
1 // C++
2 CORBA_Any boolAny;
3 boolAny <<= CORBA_Any::from_boolean(CORBA_FALSE);
4 CORBA_PolicyList policies(1);
5 policies.length(1);
6 policies[0] = orb -> create_policy(OB_CONNECTION_REUSE, boolAny);
7 CORBA_Object_var newObj =
8     obj -> _set_policy_overrides(policies, CORBA_ADD_OVERRIDES);
```

2-6 This is the same as in the example for the ORB level.

7-8 Set these policies on the object by using the `set_policy_overrides` method. This method returns a new object that has the set of policies applied.

And here is the same example in Java:

```
1 // Java
2 org.omg.CORBA.Any boolAny = orb.create_any();
3 boolAny.insert_boolean(false);
4 org.omg.CORBA.Policy[] policies = new org.omg.CORBA.Policy[1];
5 policies[0] =
6     orb.create_policy(com.ooc.OB.CONNECTION_REUSE.value, boolAny);
7 org.omg.CORBA.Object newObj =
8     obj._set_policy_overrides(policies,
9         org.omg.CORBA.SetOverrideType.ADD_OVERRIDE);
```

1-9 This is equivalent to the C++ version.

CHAPTER 13

ORBacus Basic Services

This chapter describes the standard services included with the ORBACUS distribution:

- The Naming Service
- The Property Service
- The Event Service

These services are implemented compliant to [4] and available in C++ and Java versions.

Other services, such as the Trading Service “ORBACUS Trader”, are *not* included in the standard ORBACUS distribution. For more information on other services available from Object-Oriented Concepts, please see our Web site.

This chapter does not provide a complete description of the naming, property and event services. It only provides an overview, suitable to get you started. For more information, please refer to the service specifications.

13.1 Configuring and Using a Basic Service

This section describes the steps necessary to start a service, publish its IOR, and connect to the service from a client. We will use the Naming Service as an example, but the steps outlined below are applicable to all of the services.

13.1.1 Starting the Service

To start the C++ version of the Naming Service, type the following:

```
nameserv -i -OAport 10000 > nameserv.ref
```

The Java version can be started like this:

```
java com.ooc.CosNaming.Server -i -OAport 10000 > nameserv.ref
```

Notice that we have specified a unique port number for the service, in order to ensure that the object reference of the service remains valid across executions of the service (see “Lifetime of Object References” on page 83).

The `-i` argument causes the service to dump its IOR to standard output, which we have redirected to the file `nameserv.ref`.

13.1.2 Connecting to the Service

Chapter 6 describes different strategies for locating objects, and these strategies can also be used to locate services. For example, it’s possible to read the stringified IOR from the file `nameserv.ref`, convert it to an object using `string_to_object` and then narrow this object reference to the `CosNaming::NamingContext` interface.

A more common way is to use `resolve_initial_references` as shown in “Resolving an Initial Service” on page 90. The references for the initial services can be defined using the `-ORBservice` option. Here’s a Unix example which uses “Bourne” shell command substitution (`‘command‘`) to obtain an IOR from a file:

```
java MyClient -ORBservice NameService ‘cat nameserv.ref‘
```

On non-Unix operating systems, however, it can be inconvenient to handle IORs on the command line, therefore it’s often easier to use the `-ORBconfig` option:

```
java MyClient -ORBconfig orb.cfg
```

The configuration file `orb.cfg` could be written as follows:

```
# ORB configuration file
ooc.service.NameService=iiop://myhost:10000/DefaultNamingContext
```

Notice that we are using the ORBACUS-specific `iiop://` notation for specifying the IOR of the Naming Service, but we also could have pasted the contents of `nameserv.ref`. See “Using the iiop:// Notation” on page 89 for more information.

The IOR contains the name of the host where the naming service was started ("myhost"), the port number that we specified when starting the service, and the name assigned to the service's primary object: `DefaultNamingContext`.

13.1.3 Object Names for the Basic Services

Each of the Basic Services has a named primary object, which allows you to use the `iiop://` notation or the ORB operation `get_inet_object` to obtain a reference to the service (see "Connecting to Named Objects" on page 88). The name and interface type of each service's primary object is shown in Table 13.1.

	Object Name	**Interface Type**
Naming Service	`DefaultNamingContext`	`CosNaming::NamingContext`
Event Service	`DefaultEventChannel`	`CosEventChannelAdmin::EventChannel`
Typed Event Service	`DefaultTypedEventChannel`	`CosTypedEventChannelAdmin::TypedEventChannel`
Property Service	`DefaultPropertySetDefFactory`	`CosPropertyService::PropertySetDefFactory`
Interface Repository[a]	`DefaultRepository`	`CORBA::Repository`

Table 13.1: Primary Object Names and Interface Types

a. The Interface Repository is not a CORBA Service and therefore not described in this chapter. However, the object name of the Interface Repository is shown here for completeness.

The examples below illustrate how to connect to the Naming Service using `get_inet_object`. Here's the C++ version:

```
// C++
CORBA_ORB_var orb = ... // Get a reference to the ORB somehow
CORBA_Object_var obj =
    orb -> get_inet_object("myhost", 10000, "DefaultNamingContext");
CosNaming_NamingContext_var ctx =
    CosNaming_NamingContext::_narrow(obj);
```

And in Java:

```
// Java
org.omg.CORBA.ORB orb = ... // Get a reference to the ORB somehow
org.omg.CORBA.Object obj =
   ((com.ooc.CORBA.ORB)orb).get_inet_object("myhost", 10000,
                                             "DefaultNamingContext");
org.omg.CosNaming.NamingContext ctx =
   org.omg.CosNaming.NamingContextHelper.narrow(obj);
```

For these examples to work, the Naming Service must have been started on the host “myhost” using the port number 10000.

13.2 *The Naming Service*

A CORBA object is often represented by an object reference in the form of a “stringified” IOR, a lengthy string that is difficult to read and cumbersome to use. It is much more natural to think of an object in terms of its name, which is a core feature of the CORBA Naming Service. In the Naming Service, objects are registered with a unique name, which can later be used to resolve its associated object reference.

13.2.1 Properties

The ORBACUS Naming Service supports the following properties:

`ooc.naming.database=FILE`	Enables persistence for the server. All of the bindings created by the server will be saved to the specified file. If you are starting the server for the first time using this database, you must also use the `-s` command-line option.
`ooc.naming.timeout=MINS`	Specifies the timeout in minutes after which a persistent server automatically compacts its database. The default timeout is five minutes.

13.2.2 Command-line Options

The ORBACUS Naming Service supports the following command-line options:

`-h` `--help`	Display the command-line options supported by the server.

`-v` `--version`	Display the version of the server.
`-i` `--ior`	Print the interoperable object reference (IOR) of the server to standard output.
`-s` `--start`	Use this option only when starting a persistent server using a new database.

`-d FILE`
`--database FILE`
	Equivalent to the `ooc.naming.database` property.

`-t MINS`
`--timeout MINS`
	Equivalent to the `ooc.naming.timeout` property.

13.2.3 Creating Bindings

Object references registered with the Naming Service are maintained in a hierarchical structure similar to a filesystem. A file in a filesystem is analogous to an object binding in the Naming Service. The equivalent for a folder in a filesystem is a naming context in Naming Service terms. The pieces of information stored in a Naming Service are called *bindings*. A binding consists of an object's name and its type, as defined in the `CosNaming` module:

```
// IDL
typedef string Istring;

struct NameComponent
{
   Istring id;
   Istring kind;
};

typedef sequence<NameComponent> Name;

enum BindingType
{
   nobject,
   ncontext
};

struct Binding
{
   Name binding_name;
   BindingType binding_type;
};
```

As you can see, each name consists of one or more components, like a file is fully specified by its path in a filesystem. Each name component consists of two strings, `id` and `kind`, which could be likened to a file's name and its extension. Generally, the filesystem analogy works very well when describing the Naming Service structures.

A new Naming Service entry, i.e., a binding, is created with the following operations:

```
// IDL
void bind(in Name n, in Object obj)
   raises(NotFound, CannotProceed, InvalidName, AlreadyBound);

void bind_context(in Name n, in NamingContext nc)
   raises(notFound, CannotProceed, InvalidName);

NamingContext new_context();

NamingContext bind_new_context(in Name n)
   raise(NotFound, AlreadyBound, CannotProceed, InvalidName);
```

`bind` registers a new object with the Naming Service, whereas a new context is registered with `bind_context`. For each operation, an object reference and a `Name` are expected as parameters. If no exception was thrown, the `bind` operation was successful. New naming context objects are created with `new_context` or `bind_new_context`.

Use the `unbind` operation to delete a particular binding:

```
// IDL
void unbind(in Name n)
   raises(NotFound, CannotProceed, InvalidName);
```

13.2.4 Name Resolution

Besides registering objects, an equally important task of the Naming Service is name resolution. A name is passed to the `resolve` operation and an object reference is returned if the name exists.

```
// IDL
Object resolve(in Name n)
   raises(NotFound, CannotProceed, InvalidName);
```

The `resolve` operation is only useful when a particular name is known in advance. Sometimes it is necessary to ask for a list of all bindings registered with a particular naming context. The `list` operation returns a list of bindings.

```
// IDL
typedef sequence<Binding> BindingList;

void list(in unsigned long how_many,
   out BindingList bl, out BindingIterator bi);
```

If the number of bindings is especially large, the `BindingIterator` interface is provided so that you don't have to query for all available bindings at once. Simply get a certain number of bindings specified with `how_many`, and get the rest, if any, using the `BindingIterator`.

```
// IDL
interface BindingIterator
{
   boolean next_one(out Binding b);

   boolean next_n(in unsigned long how_many,
      out BindingList bl);

   void destroy();
};
```

Make sure that you destroy the iterator object when it is no longer needed.

13.2.5 Persistence

The ORBACUS Naming Service can optionally be used in a persistent mode in which all bindings managed by the service are saved in a file. If you do not run the service in its persistent mode, all of the bindings will be lost when the service terminates.

It is also important to note that **when using the service in its persistent mode, you should always start the service on the same port** (see "Configuring the ORB and BOA" on page 45 for more information).

13.2.6 A Simple Example

ORBACUS includes simple C++ and Java examples that demonstrate how to use the CORBA Naming Service. These examples are located in the folder `naming/demo`. We will concentrate on the Java example, but the C++ example works similarly. The example expects a Naming Service server to be already running and that the server's initial reference can be resolved by the ORB. Because of its volume we have split the code into several parts for the discussion below.

Initialization

The first code fragment deals with initializing the ORB and the BOA.

```
 1 // Java
 2
 3 try
 4 {
 5     ORB orb = ORB.init(args, new java.util.Properties());
 6 }
 7 catch(SystemException ex)
 8 {
 9     // The ORB initialization failed
10 }
11
12 org.omg.CORBA.Object obj = null;
13 try
14 {
15     obj = orb.resolve_initial_references("NameService");
16 }
17 catch(org.omg.CORBA.ORBPackage.InvalidName ex)
18 {
19     // There is no Naming Service available
20 }
21
22 if(obj == null)
23 {
24     // Something is wrong with the Naming Service reference
25 }
26
27 NamingContext nc = NamingContextHelper.narrow(obj);
28
29 if(nc == null)
30 {
31     // This is not a Naming Service reference at all
32 }
33
34 BOA boa = orb.BOA_init(args, new java.util.Properties());
```

3-10 Usually the application is initialized in the `main` method. In order to initialize the ORB, its `init` operation is called.

12-20 In the next step we try to connect to the Naming Service by supplying “NameService” to `resolve_initial_references`. If `InvalidName` is thrown, there is no Naming Service available because the ORB doesn’t know anything about this service.

22-32 If calling `resolve_initial_references` was successful, the object reference is checked and narrowed in order to verify that it’s a Naming Service instance. If the `narrow` operation returns a null reference, the object returned is not a Naming Service instance but something else. This is considered to be an error because we explicitly asked for a Naming Service instance.

34 Finally the BOA is initialized.

Binding

In the next step some sample bindings are created and bound to the Naming Service.

```
// Java

Named a = new Named_impl();
Named a1 = new Named_impl();
Named a2 = new Named_impl();
Named a3 = new Named_impl();
Named b = new Named_impl();
Named c = new Named_impl();

try
{
   NameComponent[] nc1Name = new NameComponent[1];
   nc1Name[0] = new NameComponent();
   nc1Name[0].id = "nc1";
   nc1Name[0].kind = "";
   NamingContext nc1 = nc.bind_new_context(nc1Name);

   NameComponent[] nc2Name = new NameComponent[2];
   nc2Name[0] = new NameComponent();
   nc2Name[0].id = "nc1";
   nc2Name[0].kind = "";
   nc2Name[1] = new NameComponent();
   nc2Name[1].id = "nc2";
   nc2Name[1].kind = "";
   NamingContext nc2 = nc.bind_new_context(nc2Name);

   NameComponent[] aName = new NameComponent[1];
   aName[0] = new NameComponent();
   aName[0].id = "a";
   aName[0].kind = "";
   nc.bind(aName, a);

33     NameComponent[] a1Name = new NameComponent[1];
34     a1Name[0] = new NameComponent();
35     a1Name[0].id = "a1";
36     a1Name[0].kind = "";
37     nc.bind(a1Name, a1);
38 
39     NameComponent[] a2Name = new NameComponent[1];
40     a2Name[0] = new NameComponent();
41     a2Name[0].id = "a2";
42     a2Name[0].kind = "";
43     nc.bind(a2Name, a2);
44 
45     NameComponent[] a3Name = new NameComponent[1];
46     a3Name[0] = new NameComponent();
47     a3Name[0].id = "a3";
48     a3Name[0].kind = "";
49     nc.bind(a3Name, a3);
50 
51     NameComponent[] bName = new NameComponent[2];
52     bName[0] = new NameComponent();
53     bName[0].id = "nc1";
54     bName[0].kind = "";
55     bName[1] = new NameComponent();
56     bName[1].id = "b";
57     bName[1].kind = "";
58     nc.bind(bName, b);
59 
60     NameComponent[] cName = new NameComponent[3];
61     cName[0] = new NameComponent();
62     cName[0].id = "nc1";
63     cName[0].kind = "";
64     cName[1] = new NameComponent();
65     cName[1].id = "nc2";
66     cName[1].kind = "";
67     cName[2] = new NameComponent();
68     cName[2].id = "c";
69     cName[2].kind = "";
70     nc.bind(cName, c);
71 
72     boa.impl_is_ready(null);
73 }
```

3-8 Several sample objects are created that will later be bound to our Naming Service. These objects implement an interface called `Named`. In this example, the details of this interface are not important. `Named` might even be an interface without any operations defined in it.

10-70 Create and bind some new contexts and bind the sample objects to these contexts. Each binding name consists of several name components `NameComponent` that are similar to the path components of a file located somewhere in a filesystem. Objects are bound with the Naming Service's `bind` operation; for contexts, the corresponding operation `bind_context` is used. In addition to the object's IOR, both calls expect a unique binding name. If a name already exists, an `AlreadyBound` exception is thrown. There are also other exceptions you might encounter at this stage, e.g., `IllegalName` if an empty string was provided as part of a `NameComponent`.

72 Everything is prepared now, so we can listen for requests by calling `impl_is_ready` on the BOA.

Unbinding

Some cleanup work should be done before exiting the program. Every binding is properly unbound here.

```
// Java

nc.unbind(cName);
nc.unbind(bName);
nc.unbind(aName);
nc.unbind(nc2Name);
nc.unbind(nc1Name);
```

Exceptions

The final code fragment deals with exception handling.

```
// Java

catch(NotFound ex)
{
   System.err.print("Got a ‘NotFound’ exception (");
   switch(ex.why.value())
   {
      case NotFoundReason._missing_nod:
      System.err.print("missing node");
      break;

      case NotFoundReason._not_context:
      System.err.print("not context");
      break;

16       case NotFoundReason._not_object:
17       System.err.print("not object");
18       break;
19    }
20
21    System.err.println(")");
22    ex.printStackTrace();
23    return 1;
24 }
25 catch(CannotProceed ex)
26 {
27    System.err.println("Got a ‘CannotProceed’ exception");
28    ex.printStackTrace();
29    return 1;
30 }
31 catch(InvalidName ex)
32 {
33    System.err.println("Got an ‘InvalidName’ exception");
34    ex.printStackTrace();
35    return 1;
36 }
37 catch(AlreadyBound ex)
38 {
39    System.err.println("Got an ‘AlreadyBound’ exception");
40    ex.printStackTrace();
41    return 1;
42 }
```

3-42 Catch exceptions. Don’t ever forget to do this. It can be useful to call `printStackTrace` on the exception object in order to get detailed information about the program flow causing the exception.

Now you should have a look at the complete example as it is provided in the folder `demo/naming` as a part of the ORBACUS distribution.

13.3 The Property Service

The CORBA Property Service[1] is another important CORBA service. With it, you can annotate an object with extra attributes (called *properties*) that were not defined by the

1. Note that the Property Service has nothing to do with the properties used for configuration purposes, as described in “Properties” on page 45.

object's IDL interface. Properties can represent any value because they make use of the powerful CORBA `Any` data type.

13.3.1 Command-line Options

The ORBACUS Property Service supports the following command-line options:

`-h` `--help`	Display the command-line options supported by the server.
`-v` `--version`	Display the version of the server.
`-i` `--ior`	Print the interoperable object reference (IOR) of the server to standard output.

13.3.2 Creating Properties

A property handled by the CORBA Property Service consists of two components, namely the property's name and its value. The name is simply a CORBA string and the associated value is represented by a CORBA `Any`:

```
// IDL
typedef string PropertyName;

struct Property
{
   PropertyName property_name;
   any property_value;
};
```

New properties are created using a factory object implementing the `PropertySet` interface. A new property is created using the `define_property` operation:

```
// IDL
void define_property(in PropertyName, in any property_value)
   raises(InvalidPropertyName, ConflictingProperty,
   UnsupportedTypeCode, UnsupportedProperty,
   ReadOnlyProperty);
```

As a property consists of a name-value pair, both the name and the value are the parameters to this operation.

13.3.3 Querying for Properties

As soon as a property is defined, the `PropertySet` can be queried for the property's value with the `get_property_value` operation:

```
// IDL
any get_property_value(in PropertyName property_name)
   raises(PropertyNotFound, InvalidPropertyName);
```

For a particular property name this call either returns the `Any` associated with this name or throws an exception if a property with the name does not exist.

You can not only query for a particular property value, but also for a list of all the properties defined within a `PropertySet`. The `get_all_properties` operation serves this purpose:

```
// IDL
void get_all_properties(in unsigned long how_many,
   out Properties nproperties, out PropertiesIterator rest);
```

This operation works similar to the `list` call offered by the Naming Service. In both cases the maximum number of items to be returned at once is specified. An iterator implementing the `PropertiesIterator` interface gives access to the remaining items, if any.

```
// IDL
interface PropertiesIterator
{
   void reset();

   boolean next_one(out Property aproperty);

   boolean next_n(in unsigned long how_many,
      out Properties nproperties);

   void destroy();
};
```

If you are only interested in a list of property names you can get this list by calling `get_all_property_names`:

```
// IDL
void get_all_property_names(in unsigned long how_many,
   out PropertyNames property_names,
   out PropertyNamesIterator rest);
```

As with `get_all_properties` a list of names as well as an iterator is returned. This iterator implements the `PropertyNamesIterator` interface:

```
// IDL
interface PropertyNamesIterator
{
   void reset();

   boolean next_one(out PropertyName property_name);

   boolean next_n(in unsigned long how_many,
      out PropertyNames property_names);

   void destroy();
};
```

The iterators should always be destroyed when they are no longer needed.

Sometimes it is useful to know of how many properties a `PropertySet` consists of. This information is provided by `get_number_of_properties`:

```
// IDL

unsigned long get_number_of_properties();
```

Note that you have to be careful if you intend to use the return value of `get_number_of_properties` as the input value for the `how_many` parameter of `get_all_properties` in order to get a complete property list. You always have to check the `PropertiesIterator` for properties that were not returned as part of the `Properties` sequence returned by `get_all_properties`, otherwise you might miss a property that was defined by another process between your calls to `get_number_of_properties` and `get_all_properties`.

13.3.4 Deleting Properties

If a property has become obsolete it can be deleted from the `PropertySet` with `delete_property`:

```
// IDL
void delete_property(in PropertyName property_name)
   raises(PropertyNotFound, InvalidProperty, FixedProperty);
```

As you might have guessed by this operation's signature, there are properties that cannot be deleted at all. This kind of property is called a `FixedProperty`. The Property Service defines several other special property types, such as read-only properties. Please refer to the OMG's Property Service [4] specification for details.

13.3.5 A Simple Example

The Property Service test suite, which is part of the ORBACUS distribution, provides a good example of how to create properties and query for their values. The code below is based on excerpts of this test suite, which is located in the directory `property/test`. We will concentrate on an example in Java here. As with the previous examples, the Java code is very similar to what is necessary in C++. The example demonstrates how to create properties and how to get a list of all the properties defined within a `PropertySet`.

```
// Java

org.omg.CORBA.Object obj = null;

try
{
    obj = orb.resolve_initial_references("PropertyService");
}
catch(org.omg.CORBA.ORBPackage.InvalidName ex)
{
    // An error occurred, Property Service is not available
}

if(obj == null)
{
    // The object reference is invalid
}

PropertySetFactory factory = PropertySetFactoryHelper.narrow(obj);
if(factory == null)
{
    // This object does not implement the Property Service
}

PropertySet set = factory.create_propertyset();

Any anyLong = orb.create_any();
Any AnyInt = orb.create_any();
Any anyShort = orb.create_any();
anyLong.insert_long(12345L);
anyInt.insert_int(6789);
anyShort.insert_short(0);

try
{
```

```
36     set.define_property("LongProperty", anyLong);
37     set.define_property("IntProperty", anyInt);
38     set.define_property("ShortProperty", anyShort);
39 }
40 catch(ReadOnlyProperty ex)
41 {
42     // An error occurred
43 }
44 catch(ConflictingProperty ex)
45 {
46     // An error occurred
47 }
48 catch(UnsupportedProperty ex)
49 {
50     // An error occurred
51 }
52 catch(UnsupportedTypeCode ex)
53 {
54     // An error occurred
55 }
56 catch(InvalidPropertyName ex)
57 {
58     // An error occurred
59 }
60
61 PropertiesHolder ph = new PropertiesHolder();
62 PropertiesIteratorHolder ih = new PropertiesIteratorHolder();
63 set.get_all_properties(0, ph, ih);
64
65 PropertyHolder h = new PropertyHolder();
66 while(ih.value.next_one(h))
67 {
68     // The next property is now stored in h.value
69 }
70
71 ih.value.destroy();
```

5-23 Get a Property Service reference and check for errors.

25 The `PropertySetFactory` object is used to create a `PropertySet` instance.

27-32 Each property consists of a name and a value in the form of a CORBA `Any`.

34-59 Three properties are defined. The first has the name "LongProperty" and stores a `long` value. The second one is called "IntProperty" and stores an `int`. The remaining property represents a `short` value. If for some reason a property cannot be created, an exception is thrown.

61-69 Now we try to get a list of all the properties that were previously defined. With `get_all_properties` the `PropertySet` returns its properties. As we have set the `how_many` parameter to 0, we have to use the `PropertiesIterator` for each item. Usually you provide a positive integer for `how_many`.

71 The iterator has fulfilled its duty and can now be destroyed.

13.4 The Event Service

Sometimes applications have to exchange information without explicitly knowing about each other. Often a server isn't even aware of the nature and number of clients that are interested in the data the server has to offer. A special mechanism is required that provides decoupled data-transfer between servers and clients. This issue is addressed by the CORBA Event Service [4].

13.4.1 Properties

The ORBACUS C++ Event Service supports the following properties:

`ooc.event.response_timeout=μs`	Specifies the initial amount of time in microseconds that the service will wait for a response. The default value is `100000`.
`ooc.event.response_increment=μs`	After each consecutive expiration of the response timeout, the timeout value will be increased by the specified number of microseconds. The default value is `100000`.
`ooc.event.retry_timeout=μs`	Specifies the initial amount of time in microseconds that the service will wait before trying again after an error has occurred. The default value is `500000`.
`ooc.event.retry_increment=μs`	After each consecutive expiration of the retry timeout, the timeout value will be increased by the specified number of microseconds. The default value is `100000`.
`ooc.event.max_events`	The maximum number of events in each event queue. If this limit is reached and another event is received, the oldest event is discarded. The default value is `10`.

`ooc.event.max_retries`	The maximum number of times to retry before giving up and disconnecting the proxy. The default value is `10`.

13.4.2 Command-line Options

The ORBACUS Event Service supports the following command-line options:

`-h` `--help`	Display the command-line options supported by the server.
`-v` `--version`	Display the version of the server.
`-i` `--ior`	Print the interoperable object reference (IOR) of the server to standard output.

The C++ implementation of the Event Service supports both typed and untyped event channels, therefore the following additional command-line options are provided to allow you to select which kind of channel the server should create:

`-t` `--typed-service`	Run a typed event service.
`-u` `--untyped-service`	Run an untyped event service. This is the default behavior.

13.4.3 Diagnostics

The C++ Event Service uses the ORBACUS `OBMessageViewer` class to generate diagnostic messages. You can activate these messages by setting the `ooc.orb.trace_level` property to `2`. Note that you must have compiled the ORBACUS distribution with the `OB_TRACE` preprocessor macro defined in order to enable diagnostic messages. This macro is defined by default.

13.4.4 The Event Channel

The Event Service distributes data in the form of events. The term *event* in this context refers to a piece of information that is contributed by an event source. An event channel instance accepts this information and distributes it to a list of objects that previously have connected to the channel and are listening for events.

The Event Service specification defines two distinct kinds of event channels: untyped and typed. Whereas an untyped event channel forwards every event to each of the registered clients in the form of a CORBA `Any`, a typed event channel works more selectively by supporting strongly-typed events which allow for data filtering. We will only discuss the untyped event channel here. For information on typed event channels, and more details on the Event Service in general, please refer to the official Event Service specification [4].

13.4.5 Event Suppliers and Consumers

Applications participating in generating and accepting events are called *suppliers* and *consumers*, respectively. To be more precise, there are two kinds of suppliers, namely *push suppliers* and *pull suppliers*. The situation is similar with event consumers, in that there are *push consumers* and *pull consumers*.

What's the difference between pushing events and pulling events? Let's have a look at the consumer side first. There are consumers that have to be immediately informed when any new events become available on the event channel. These consumers usually act as push consumers. They implement the `PushConsumer` interface which ensures that the event channel actively forwards events to them using the `push` operation:.

```
// IDL
interface PushConsumer
{
    void push(in any data)
        raises(Disconnected);

     void disconnect_push_consumer();
};
```

The push consumer has a more or less passive role, only waiting for something to happen. This is different than pull consumers, which (optionally) implement the `PullConsumer` interface. A pull consumer has a more active role and (usually periodically) polls the event channel for new events. As these events may occur more frequently than they are polled for by the pull consumer, some events might get lost. The buffering policy implemented by the event channel determines whether events are buffered and what happens in case of an event queue overflow. A client is typically implemented as a pull consumer when it is not concerned about the possibility of lost events, e.g., if the client is only interested in the most recent events.

Like consumers, suppliers can also use push or pull behavior. Push suppliers are probably the more common type, in which the supplier directly forwards data to the event channel and thus plays the active role in the link to the channel. Pull suppliers, on the other hand, are polled by the event channel and supply an event in response, if a new event is available. Polling is done by the `try_pull` operation if it is to be non-blocking or by the blocking `pull` call:

```
// IDL
interface PullSupplier
{
   any pull()
      raises(Disconnected);

   any try_pull(out boolean has_event)
      raises(Disconnected);

    void disconnect_pull_supplier();
};
```

13.4.6 Event Channel Policies

The untyped event channel implementation included in the ORBACUS distribution features a simple event queue policy. Events are buffered in the form of a FIFO stack, i.e., a certain number of events are stored and, in case of a buffer overflow, the oldest events are discarded.

13.4.7 A Simple Example

In the Event Service example that comes with ORBACUS, two supplier and two consumer clients demonstrate how to use an untyped event channel to propagate information. The pieces of information transferred by this example are strings containing the current date and time. After starting the Event Service server, you can start these clients in any order. The demo applications obtain the initial Event Service reference as already demonstrated, i.e., by calling `resolve_initial_references`. When started, each supplier will provide information about the current date and time and each client displays the event data in its console window.

This is the push supplier's main loop:

```
// Java

while(consumer_ != null)
{
```

```
5      java.util.Date date = new java.util.Date();
6      String s = "PushSupplier says: " + date.toString();
7
8      Any any = orb_.create_any();
9      any.insert_string(s);
10
11     try
12     {
13        consumer_.push(any);
14     }
15     catch(Disconnected ex)
16     {
17        // Supplier was disconnected from event channel
18     }
19
20     Thread.yield();
21     try
22     {
23        Thread.sleep(1000);
24     }
25     catch(InterruptedException ex)
26     {
27     }
28  }
```

5-9 The current date and time is inserted into the `Any`.

11-18 The event data, in this example date and time, are pushed to the event channel. From the push supplier's view the event channel is just a consumer implementing the `PushConsumer` interface.

20-27 After sleeping for one second, the steps above are repeated.

The example's pull supplier works similarly to the push supplier, except that the event channel explicitly polls the supplier for new events. This is done by either `pull` or `try_pull`. The pull supplier doesn't see anything from the event channel but an object implementing the `PullConsumer` interface. The following example shows the basic layout of a pull supplier:

```
// Java

public Any
pull()
{
   ORB orb = ORB.init();
```

```
 7
 8     java.util.Date date = new java.util.Date();
 9     String s = "PullSupplier says: " + date.toString();
10
11     Any any = orb.create_any();
12     any.insert_string(s);
13
14     return any;
15 }
16
17 public Any
18 try_pull(BooleanHolder has_event)
19 {
20     has_event.value = true;
21
22     return pull();
23 }
```

8-12 Date and time are inserted into the `Any`.

17-23 In this example new event data can be provided at any time, so `try_pull` always sets `has_event` to `true` in order to signal that an event is available. It then returns the actual event data.

After examining the most important aspects of the event suppliers' code, we are now going to analyze the consumers' code. The push consumer with its `push` operation is shown first:

```
// Java

public void
push(Any any)
{
    try
    {
        String s = any.extract_string();
        System.out.println(s);
    }
    catch(MARSHAL ex)
    {
       // Ignore unknown event data
    }
}
```

6-14 The push consumer's push operation is called with the event wrapped in a CORBA Any. In this code fragment it is assumed that the Any contains a string with date and time information. In case the Any contains another data type a MARSHAL exception is thrown.This exception can be ignored here because other events aren't of interest. After extracting the string it is displayed in the console window.

In contrast to the push consumer, the pull consumer has to actively query the event channel for new events. This is how the pull consumer loop looks:

```
// Java

while(supplier_ != null)
{
   Any any = null;

   try
   {
      any = supplier_.pull();
   }
   catch(Disconnected ex)
   {
      // Supplier was diconnected from event channel
   }

   try
   {
      String s = any.extract_string();
      System.out.println(s);
   }
   catch(MARSHAL ex)
   {
      // Ignore unknown event data
   }

   Thread.yield();

   try
   {
      Thread.sleep(1000);
   }
   catch(InterruptedException ex)
   {
   }
}
```

5 A CORBA `Any` is prepared for later use.

7-14 Using `pull`, the consumer polls the event channel for new events. The event channel acts as a pull supplier in this case. The `pull` operation blocks until a new event is available.

16-24 The consumer expects a string wrapped in a CORBA `Any`. The string value is extracted and displayed. If an exception is raised the `Any` contained some other data type which is simply ignored.

26-34 After sleeping for one second the event channel is polled for the next event.

In all of these examples the event channel acts either as a consumer (if the clients are suppliers) or a supplier (if the clients are consumers) of events. Actually each client is not directly connected to the event channel but to a proxy that receives or sends events on behalf of the channel. For more information on the Event Service and for the complete definitions of the IDL interfaces, please refer to the official Event Service specification.

CHAPTER 14

Exceptions and Error Messages

14.1 CORBA System Exceptions

The CORBA specification defines the standard system exceptions shown in Table 14.1.

`UNKNOWN`	Unknown exception type
`BAD_PARAM`	An invalid parameter was passed
`NO_MEMORY`	Failure to allocate dynamic memory
`IMP_LIMIT`	Implementation limit was violated
`COMM_FAILURE`	Communication failure
`INV_OBJREF`	Invalid object reference
`NO_PERMISSION`	The attempted operation was not permitted
`INTERNAL`	Internal error in ORB
`MARSHAL`	Error marshalling a parameter or result
`INITIALIZE`	Failure when initializing ORB
`NO_IMPLEMENT`	Operation implementation unavailable

Table 14.1: Standard CORBA System Exceptions

UNKNOWN	Unknown exception type
BAD_TYPECODE	Bad typecode
BAD_OPERATION	Invalid operation
NO_RESOURCES	Insufficient resources for a request
NO_RESPONSE	Response to a request is not yet available
PERSIST_STORE	Persistent storage failure
BAD_INV_ORDER	Routine invocation out of order
TRANSIENT	Transient failure, request can be reissued
FREE_MEM	Cannot free memory
INV_IDENT	Invalid identifier syntax
INV_FLAG	Invalid flag was specified
INTF_REPOS	Error accessing interface repository
BAD_CONTEXT	Error processing context object
OBJ_ADAPTER	Failure detected by object adapter
DATA_CONVERSION	Error in data conversion
OBJECT_NOT_EXIST	Non-existent object, references should be discarded
INV_POLICY	Invalid Policy

Table 14.1: Standard CORBA System Exceptions

Table 14.2 shows the minor codes for the `COMM_FAILURE` exception, and Table 14.3 the

`OBMinorRecv`	`recv()` failed
`OBMinorSend`	`send()` failed
`OBMinorRecvZero`	`recv()` returned zero
`OBMinorSendZero`	`send()` returned zero
`OBMinorSocket`	`socket()` failed
`OBMinorSetsockopt`	`setsockopt()` failed
`OBMinorGetsockopt`	`getsockopt()` failed
`OBMinorBind`	`bind()` failed
`OBMinorListen`	`bind()` failed
`OBMinorConnect`	`connect()` failed
`OBMinorAccept`	`accept()` failed
`OBMinorSelect`	`select()` failed
`OBMinorGethostname`	`gethostname()` failed
`OBMinorGethostbyname`	`gethostbyname()`
`OBMinorWSAStartup`	`WSAStartup()` failed
`OBMinorWSACleanup`	`WSACleanup()` failed
`OBMinorNoGIOP`	Not a GIOP message
`OBMinorUnknownMessage`	Unknown GIOP message
`OBMinorWrongMessage`	Wrong GIOP message
`OBMinorCloseConnection`	Got a close connection message
`OBMinorMessageError`	Got a message error message

Table 14.2: Minor Exception Codes for COMM_FAILURE

minor codes for the `INTF_REPOS` exception. No other minor codes are currently defined by ORBACUS.

`OBMinorNoIntfRepos`	Interface repository is not available
`OBMinorIdExists`	Repository id already exists
`OBMinorNameExists`	Name already exists
`OBMinorRepositoryDestroy`	`destroy()` invoked on `Repository` object
`OBMinorPrimitiveDefDestroy`	`destroy()` invoked on `PrimitiveDef` object
`OBMinorAttrExists`	Attribute is already defined in a base interface
`OBMinorOperExists`	Operation is already defined in a base interface
`OBMinorLookupAmbiguous`	Search name for `lookup()` is ambiguous
`OBMinorAttrAmbiguous`	Attribute name collisions in base interfaces
`OBMinorOperAmbiguous`	Operation name collisions in base interfaces

Table 14.3: Minor Exception Codes for INTF_REPOS

14.2 *Non-Compliant Application Asserts*

If the ORBACUS library was compiled without the preprocessor definition `-DNDEBUG` defined, ORBACUS tries to detect common programming mistakes that lead to non–compliant CORBA applications. If such a mistake is found an error messages like this will appear:

```
Non-compliant application error detected:
Application used wrong memory allocation function
```

After detecting such an error, the ORBACUS library dumps a core (Unix only) and prints the file and line number where the error was detected. You can use the core dump in order to track down the problem with a debugger.

The following error messages can appear:

Application requested a feature that has not yet been implemented

This is not an application error. This error message appears if an application attempts to use a feature that has not yet been implemented in ORBACUS. In this case the only thing that can be done is to wait for the next ORBACUS version that has this particular feature implemented.

Application used wrong memory allocation function

If this message appears, an incorrect memory allocation function has been used. A common mistake that leads to this error is to use `malloc`, `strdup` and `free` (or the `new` and `delete` operator) instead of `CORBA_string_alloc` and `CORBA_string_dup` and `CORBA_string_free` for string memory management.

Memory that was already deallocated was deallocated again

This message indicates multiple memory deallocations. For example, if `CORBA_string_free` is called twice on the same string, this message will be displayed.

Object was deleted without an object reference count of zero

This message appears if an object was deleted by calling `delete` on its object reference. Never use the `delete` operator for that. Use `CORBA_release` instead.

Object was already deleted (object reference count was already zero)

This message appears if the number of `release` operations on an object reference is higher than the number of `_duplicate` operations.

Sequence length was greater than maximum sequence length

This message indicates that the application tried to set the length of a bounded sequence to a value greater than its maximum length.

Index for sequence operator[]() or remove() function was out of range

This message appears if the argument to the sequence member functions `operator[]` or `remove` exceeds the sequence length.

Null pointer was used to initialize T_var type

This message indicates an attempt to initialize a `_var` type with a null pointer.

operator->() was used on null pointer or nil object reference

This message indicates an attempt to use `operator->` on an uninitialized `_var` type.

Application tried to dereference a null pointer

Some CORBA _var types have built-in conversion operators to a C++ reference type, i.e., some _var types for type T have a conversion operator to T&. This message appears if an application uses this conversion operator on an uninitialized _var type.

Null pointer was passed as string parameter or return value

According to the IDL–to–C++ mapping specification, no null pointers may be passed as string parameters or return values. This message appears if an application tries to do so.

Self assignment caused a dangling pointer

This message appears if the content of a _var type is assigned to itself. For example, the following code will lead to this error message:

```
1 // Somehow get a pointer to a variable struct
2 AVariableStruct_var var = ...
3 AVariableStruct* ptr = var;
4 var = ptr;
```

3,4 This will result in a dangling pointer, because var will free its own content on assignment.

Replacement of Any content by its own value caused a dangling pointer

This message appears if there is an attempt to replace the content of an Any by its own value. For example:

```
1 char* s = CORBA_string_dup("Hello, world!");
2 CORBA_Any any;
3 any <<= s;
4 any <<= s;
```

3,4 Inserting s into any twice will result in a dangling pointer, because any will free its own value (which is s) on assignment.

Invalid union discriminator type used

This message appears if the discriminator type argument to CORBA_ORB::create_union_tc denotes a type invalid for union discriminators. Valid types have a CORBA_TCKind that is one of CORBA_tk_short, CORBA_tk_ushort, CORBA_tk_long, CORBA_tk_ulong, CORBA_tk_char, CORBA_tk_boolean or CORBA_tk_enum.

Union discriminator mismatch

This message either indicates an attempt to set a union discriminator to an invalid value with the `_d` modifier function or the use of a wrong accessor function, i.e., an accessor function that does not correspond to the type of the union's actual value.

Uninitialized union used

If this message appears, an unitialized union (i.e., a union that was created with the default constructor and that was not set to any legal value) was used.

Dynamic implementation object cannot be used as static implementation object

This message appears if an attempt is made to use a DSI object implementation as a regular (i.e., static) implementation object.

APPENDIX A ORBacus Policy Reference

A.1 Module SSL

Constants

CONNECT_POLICY

```
const CORBA::PolicyType CONNECT_POLICY = 1;
```

This policy type identifies the connection policy.

Enums

ConnectPolicyType

```
enum ConnectPolicyType
{
   ConnectSecure,
   ConnectInsecure
};
```

This enumeration is used to specify whether connection attempts should be secure or insecure.

A.2 Interface SSL::ConnectPolicy

interface **ConnectPolicy**
inherits from CORBA::Policy

The connection policy. This policy is used to specify whether secure or insecure connections are used.

Attributes

value

```
readonly attribute ConnectPolicyType value;
```

If an object has a `ConnectPolicy` set with `value` set to `ConnectSecure`, then only secure connections will be used for that object.

A.3 Module OB

Constants

PROTOCOL_POLICY
```
const CORBA::PolicyType PROTOCOL_POLICY = 2;
```

This policy type identifies the protocol policy.

CONNECTION_REUSE_POLICY
```
const CORBA::PolicyType CONNECTION_REUSE_POLICY = 3;
```

This policy type identifies the connection reuse policy.

RECONNECT_POLICY
```
const CORBA::PolicyType RECONNECT_POLICY = 4;
```

This policy type identifies the reconnect policy.

TIMEOUT_POLICY
```
const CORBA::PolicyType TIMEOUT_POLICY = 5;
```

This policy type identifies the timeout policy.

A.4 Interface OB::ProtocolPolicy

interface **ProtocolPolicy**
inherits from CORBA::Policy

The protocol policy. This policy is used to force the selection of a specific protocol.

Attributes

value

```
readonly attribute IOP::ProfileId value;
```

If a `ProtocolPolicy` is set, then the protocol with the identified tag will be used, if possible. If it is not possible to use this protocol, a `CORBA::NO_RESOURCES` exception will be raised.

A.5 Interface OB::ConnectionReusePolicy

interface **ConnectionReusePolicy**
inherits from CORBA::Policy

The connection reuse policy. This policy determines whether connections may be reused or are private to specific objects.

Attributes

value

```
readonly attribute boolean value;
```

If an object has a `ConnectionReusePolicy` set with `value` set to `FALSE`, then other objects will not be permitted to also use any connection made on behalf of this object.

A.6 Interface OB::ReconnectPolicy

interface **ReconnectPolicy**
inherits from CORBA::Policy

The reconnect policy. This policy determines if an object will automatically try to reconnect to a server upon a communication failure.

Attributes

value
```
readonly attribute boolean value;
```

If an object has a `ReconnectPolicy` set with `value` set to `TRUE`, then upon a `CORBA::COMM_FAILURE` a reconnection will automatically be attempted.

A.7 Interface OB::TimeoutPolicy

interface **TimeoutPolicy**
inherits from CORBA::Policy

The timeout policy. This policy can be used to specify communication timeouts.

Attributes

value
```
readonly attribute unsigned long value;
```

If an object has a `TimeoutPolicy` set and no response to a request is available after `value` milliseconds, a `CORBA::NO_RESOURCE` exception is raised.

APPENDIX B

Open Communications Interface Reference

B.1 Module OCI

The Open Communications Interface (OCI). The definitions in this module provide a uniform interface to network protocols. This allows for easy plug-in of new protocols or other communication mechanisms into ORBs that implement the OCI. Furthermore, protocol implementations need only to be written once and can then be reused with all OCI compliant ORBs. For more information, please see the OCI documentation.

Aliases

BufferSeq
```
typedef sequence<Buffer> BufferSeq;
```

Alias for a sequence of buffers.

IOR
```
typedef IOP::IOR IOR;
```

Alias for an IOR.

ProfileId
```
typedef IOP::ProfileId ProfileId;
```

Alias for a profile id.

ProfileIdSeq
```
typedef sequence<ProfileId> ProfileIdSeq;
```

Alias for a sequence of profile ids.

ObjectKey
```
typedef sequence<octet> ObjectKey;
```

Alias for an object key, which is a sequence of octets.

Handle
```
typedef long Handle;
```

Alias for a system-specific handle type.

CloseCBSeq
```
typedef sequence<CloseCB> CloseCBSeq;
```

Alias for a sequence of close callback objects.

ConnectCBSeq
```
typedef sequence<ConnectCB> ConnectCBSeq;
```

Alias for a sequence of connect callback objects.

AcceptorSeq
```
typedef sequence<Acceptor> AcceptorSeq;
```

Alias for a sequence of Acceptors.

AcceptCBSeq
```
typedef sequence<AcceptCB> AcceptCBSeq;
```

Alias for a sequence of accept callback objects.

ConFactorySeq
```
typedef sequence<ConFactory> ConFactorySeq;
```

Alias for a sequence of Connector factories.

B.2 Interface OCI::Buffer

interface **Buffer**

An interface for a buffer. A buffer can be viewed as an object holding an array of octets and a position counter, which determines how many octets have already been sent or received. The IDL interface definition for Buffer is incomplete and must be extended by the specific language mappings. For example, the C++ mapping defines the following additional functions:

- `Octet* data()`: Returns a C++ pointer to the first element of the array of octets, which represents the buffer's contents.
- `Octet* rest()`: Similar to `data()`, this operation returns a C++ pointer, but to the n-th element of the array of octets with n being the value of the position counter.

Attributes

length
```
readonly attribute unsigned long length;
```

The buffer length.

pos
```
attribute unsigned long pos;
```

The position counter. Note that the buffer's length and the position counter don't depend on each other. There are no restrictions on the values permitted for the counter. This implies that it's even legal to set the counter to values beyond the buffer's length.

Operations

advance
```
void advance(in unsigned long delta);
```

Increment the position counter.

Parameters:
`delta` - The value to add to the position counter.

rest_length
```
unsigned long rest_length();
```

Returns the rest length of the buffer. The rest length is the length minus the position counter's value. If the value of the position counter exceeds the buffer's length, the return value is undefined.

Returns:
The rest length.

is_full

```
boolean is_full();
```

Checks if the buffer is full. The buffer is considered full if its length is equal to the position counter's value.

Returns:
`TRUE` if the buffer is full, `FALSE` otherwise.

B.3 Interface OCI::Transport

interface **Transport**

The interface for a Transport object, which provides operations for sending and receiving octet streams. In addition, it is possible to register callbacks with the Transport object, which are invoked whenever data can be sent or received without blocking.

See Also:
Connector
Acceptor

Attributes

tag
```
readonly attribute ProfileId tag;
```

The profile id tag.

handle
```
readonly attribute Handle handle;
```

The "handle" for this Transport. The handle may *only* be used to determine whether the Transport object is ready to send or to receive data, e.g., with `select()` on Unix-based operating systems. All other uses (e.g., calls to `read()`, `write()`, `close()`) are strictly non-compliant. A handle value of -1 indicates that the protocol plug-in does not support "selectable" Transports.

fragmentation
```
readonly attribute unsigned long fragmentation;
```

The Transport's maximum packet size. The `send` and `receive` operations must not be used to send packets larger than this size within a single call. A value of 0 means that there is no upper limit for the packet size.

Operations

close
```
void close();
```

Closes the Transport. `send` and `receive` must not be called after `close` has been called.

shutdown

```
void shutdown();
```

Shuts down the Transport. After calling `shutdown`, all calls to the `send` and `receive` operations result in an appropriate `CORBA::COMM_FAILURE` exception being raised.

receive

```
void receive(in Buffer buf,
             in boolean block);
```

Receives a buffer's contents.

Parameters:

`buf` - The buffer to fill.
`block` - If set to `TRUE`, the operation blocks until the buffer is full. If set to `FALSE`, the operation fills as much of the buffer as possible without blocking.

receive_detect

```
boolean receive_detect(in Buffer buf,
                       in boolean block);
```

Similar to `receive` but it signals a connection loss by returning `FALSE` instead of raising `CORBA::COMM_FAILURE`.

Parameters:

`buf` - The buffer to fill.
`block` - If set to `TRUE`, the operation blocks until the buffer is full. If set to `FALSE`, the operation fills as much of the buffer as possible without blocking.

Returns:

`FALSE` if a connection loss is detected, `TRUE` otherwise.

receive_timeout

```
void receive_timeout(in Buffer buf,
                     in unsigned long timeout);
```

Similar to `receive` but it is possible to specify a timeout. On return the caller can test whether there was a timeout by checking if the buffer has been filled completely.

Parameters:

`buf` - The buffer to fill.

`timeout` - The timeout value in milliseconds. A zero timeout is equivalent to calling `receive(buf, FALSE)`.

send

```
void send(in Buffer buf,
          in boolean block);
```

Sends a buffer's contents.

Parameters:

`buf` - The buffer to send.
`block` - If set to `TRUE`, the operation blocks until the buffer has completely been sent. If set to `FALSE`, the operation sends as much of the buffer's data as possible without blocking.

send_detect

```
boolean send_detect(in Buffer buf,
                    in boolean block);
```

Similar to `send` but it signals a connection loss by returning `FALSE` instead of raising `CORBA::COMM_FAILURE`.

Parameters:

`buf` - The buffer to fill.
`block` - If set to `TRUE`, the operation blocks until the entire buffer has been sent. If set to `FALSE`, the operation sends as much of the buffer's data as possible without blocking.

Returns:

`FALSE` if a connection loss is detected, `TRUE` otherwise.

send_timeout

```
void send_timeout(in Buffer buf,
                  in unsigned long timeout);
```

Similar to `send` but it is possible to specify a timeout. On return the caller can test whether there was a timeout by checking if the buffer has been sent completely.

Parameters:

`buf` - The buffer to send.
`timeout` - The timeout value in milliseconds. A zero timeout is equivalent to calling `send(buf, FALSE)`.

get_info

```
TransportInfo get_info();
```

Returns the information object associated with the Transport.

Returns:
The Transport information object.

B.4 Interface OCI::TransportInfo

interface **TransportInfo**

Information on an OCI Transport object. Objects of this type must be narrowed to a Transport information object for a concrete protocol implementation, for example to `OCI::IIOP::TransportInfo` in case the plug-in implements IIOP.

See Also:
Transport

Attributes

tag
```
readonly attribute ProfileId tag;
```

The profile id tag.

connector_info
```
readonly attribute ConnectorInfo connector_info;
```

The ConnectorInfo object for the Connector that created the Transport object that this TransportInfo object belongs to. If the Transport for this TransportInfo was not created by a Connector, this attribute is set to the nil object reference.

acceptor_info
```
readonly attribute AcceptorInfo acceptor_info;
```

The AcceptorInfo object for the Acceptor that created the Transport object that this TransportInfo object belongs to. If the Transport for this TransportInfo was not created by an Acceptor, this attribute is set to the nil object reference.

Operations

add_close_cb
```
void add_close_cb(in CloseCB cb);
```

Add a callback that is called before a connection is closed. If the callback has already been registered, this method has no effect.

Parameters:

`cb` - The callback to add.

remove_close_cb

```
void remove_close_cb(in CloseCB cb);
```

Remove a close callback. If the callback was not registered, this method has no effect.

Parameters:

`cb` - The callback to remove.

B.5 Interface OCI::CloseCB

interface **CloseCB**

An interface for a close callback object.

See Also:
TransportInfo

Operations

close_cb

```
void close_cb(in TransportInfo transport_info);
```

Called before a connection is closed.

Parameters:
`transport_info` - The TransportInfo for the new closeion.

B.6 Interface OCI::Connector

interface **Connector**

An interface for Connector objects. A Connector is used by CORBA clients to initiate a connection to a server. It also provides operations for the management of IOR profiles.

See Also:
ConFactory
Transport

Attributes

tag
```
readonly attribute ProfileId tag;
```

The profile id tag.

Operations

connect
```
Transport connect();
```

Used by CORBA clients to establish a connection to a CORBA server. It returns a Transport object, which can be used for sending and receiving octet streams to and from the server.

Returns:
The new Transport object.

is_usable
```
ObjectKey is_usable(in IOR ior);
```

Checks whether this Connector can be used for a specific IOR. That is, the IOR must contain at least one profile that matches this Connector.

Parameters:
`ior` - The IOR to check for.

Returns:
The object key of the matching profile if the Connector can be used for the given IOR, or an

empty object key otherwise.

is_usable_with_policies

```
ObjectKey is_usable_with_policies(in IOR ior,
                                  in CORBA::PolicyList policies);
```

Checks whether this Connector can be used for a specific IOR with a given set of polcies. That is, the IOR must contain at least one profile that matches this Connector and the Connector must also satisfy the provided list of policies for the given IOR.

Parameters:

`ior` - The IOR to check for.

`policies` - The policies that must be satisfied.

Returns:

The object key of the matching profile if the Connector can be used for the given IOR and policies, or an empty object key otherwise.

get_info

```
ConnectorInfo get_info();
```

Returns the information object associated with the Connector.

Returns:

The Connector information object.

B.7 Interface OCI::ConnectorInfo

interface **ConnectorInfo**

Information on a OCI Connector object. Objects of this type must be narrowed to a Connector information object for a concrete protocol implementation, for example to `OCI::IIOP::ConnectorInfo` in case the plug-in implements IIOP.

See Also:
Connector

Attributes

tag
```
readonly attribute ProfileId tag;
```

The profile id tag.

Operations

add_connect_cb
```
void add_connect_cb(in ConnectCB cb);
```

Add a callback that is called whenever a new connection is established. If the callback has already been registered, this method has no effect.

Parameters:
`cb` - The callback to add.

remove_connect_cb
```
void remove_connect_cb(in ConnectCB cb);
```

Remove a connect callback. If the callback was not registered, this method has no effect.

Parameters:
`cb` - The callback to remove.

B.8 Interface OCI::ConnectCB

interface **ConnectCB**

An interface for a connect callback object.

See Also:
ConnectorInfo

Operations

connect_cb

```
void connect_cb(in TransportInfo transport_info);
```

Called after a new connection has been established. If the application wishes to reject the connection `CORBA::NO_PERMISSION` may be raised.

Parameters:
`transport_info` - The TransportInfo for the new connection.

B.9 Interface OCI::Acceptor

interface **Acceptor**

An interface for an Acceptor object, which is used by CORBA servers to accept client connection requests. It also provides operations for the management of IOR profiles.

See Also:
AccRegistry
Transport

Attributes

tag
```
readonly attribute ProfileId tag;
```

The profile id tag.

handle
```
readonly attribute Handle handle;
```

The "handle" for this Acceptor. Like with the handle for Transports, the handle may *only* be used with operations like `select()`. A handle value of -1 indicates that the protocol plug-in does not support "selectable" Transports.

Operations

close
```
void close();
```

Closes the Transport. `accept` or `listen` must not be called after `close` has been called.

shutdown
```
void shutdown();
```

Shuts down the Transport. After calling `shutdown`, calls to `accept` or `listen` result in an appropriate `CORBA::COMM_FAILURE` exception being raised.

listen
```
void listen();
```

Sets the acceptor up to listen for incoming connections. Until this method is called on the acceptor, new connection requests should result in a connection request failure.

accept
```
Transport accept();
```

Used by CORBA servers to accept client connection requests. It returns a Transport object, which can be used for sending and receiving octet streams to and from the client.

Returns:
The new Transport object.

add_profile
```
void add_profile(in ObjectKey key,
                 inout IOR ior);
```

Adds a new profile that matches this Acceptor to an IOR.

Parameters:
`key` - The object key to use for the new profile.
`ior` - The IOR.

is_local
```
ObjectKey is_local(in IOR ior);
```

Checks whether an IOR is for a local object, taking only profiles into account matching this Acceptor.

Parameters:
`ior` - The IOR to check for.

Returns:
If the IOR is for a local object, the object key for that local object, or an empty object key otherwise.

get_info
```
AcceptorInfo get_info();
```

Returns the information object associated with the Acceptor.

Returns:

The Acceptor information object.

B.10 Interface OCI::AcceptorInfo

interface **AcceptorInfo**

Information on an OCI Acceptor object. Objects of this type must be narrowed to an Acceptor information object for a concrete protocol implementation, for example to `OCI::IIOP::AcceptorInfo` in case the plug-in implements IIOP.

See Also:
Acceptor

Attributes

tag
```
readonly attribute ProfileId tag;
```

The profile id tag.

Operations

add_accept_cb
```
void add_accept_cb(in AcceptCB cb);
```

Add a callback that is called whenever a new connection is accepted. If the callback has already been registered, this method has no effect.

Parameters:
`cb` - The callback to add.

remove_accept_cb
```
void remove_accept_cb(in AcceptCB cb);
```

Remove an accept callback. If the callback was not registered, this method has no effect.

Parameters:
`cb` - The callback to remove.

B.11 Interface OCI::AcceptCB

interface **AcceptCB**

An interface for an accept callback object.

See Also:
AcceptorInfo

Operations

accept_cb

```
void accept_cb(in TransportInfo transport_info);
```

Called after a new connection has been accepted. If the application wishes to reject the connection `CORBA::NO_PERMISSION` may be raised.

Parameters:
`transport_info` - The TransportInfo for the new connection.

B.12 Interface OCI::ConFactory

interface **ConFactory**

A factory for Connector objects.

See Also:
Connector
ConFactoryRegistry

Attributes

tag
```
readonly attribute ProfileId tag;
```

The profile id tag.

Operations

create
```
Connector create(in IOR ior);
```

Creates a new Connector for a given IOR. All connection specific data is taken from an IOR profile that matches this Connector factory. If more than one profile matches, then which of these profiles is used is implementation specific.

Parameters:
`ior` - The IOR from which the profile and connection data are extracted.

Returns:
The new Connector. A nil object reference is returned if the IOR does not contain a profile which matches this Connector factory.

create_with_policies
```
Connector create_with_policies(in IOR ior,
                               in CORBA::PolicyList policies);
```

Creates a new Connector for a given IOR, satisfing a list of policies. Like `create`, all connection specific data is taken from an IOR profile that matches this Connector factory, and if more than one profile matches, then which of these profiles is used is implementation specific.

Parameters:

`ior` - The IOR from which the profile and connection data are extracted.

`policies` - The policies that must be satisfied.

Returns:

The new Connector. A nil object reference is returned if the IOR does not contain a profile which matches this Connector factory or if the policies cannot be satisfied.

consider_with_policies

```
boolean consider_with_policies(in IOR ior,
                               in CORBA::PolicyList policies);
```

Determines whether this Connector factory can create a Connector for a given IOR and a given list of policies.

Parameters:

`ior` - The IOR to consider.

`policies` - The policies that must be satisfied.

Returns:

`TRUE` if a Connector can be created for the IOR and the policies can be satisfied, `FALSE` otherwise.

equivalent

```
boolean equivalent(in IOR ior1,
                   in IOR ior2);
```

Checks whether two IORs are equivalent, taking only profiles into account matching this Connector factory.

Parameters:

`ior1` - The first IOR to check for equivalence.

`ior2` - The second IOR to check for equivalence.

Returns:

`TRUE` if the IORs are equivalent, `FALSE` otherwise.

hash

```
unsigned long hash(in IOR ior,
                   in unsigned long maximum);
```

Calculates a hash value for an IOR.

Parameters:

`ior` - The IOR to calculate a hash value for.
`maximum` - The maximum value of the hash value.

Returns:

The hash value.

get_info

```
ConFactoryInfo get_info();
```

Returns the information object associated with the Connector factory.

Returns:

The Connnector factory information object.

B.13 Interface OCI::ConFactoryInfo

interface **ConFactoryInfo**

Information on an OCI ConFactory object.

See Also:
ConFactory

Attributes

tag
```
readonly attribute ProfileId tag;
```

The profile id tag.

Operations

add_connect_cb
```
void add_connect_cb(in ConnectCB cb);
```

Add a callback that is called whenever a new connection is established. If the callback has already been registered, this method has no effect.

Parameters:
`cb` - The callback to add.

remove_connect_cb
```
void remove_connect_cb(in ConnectCB cb);
```

Remove a connect callback. If the callback was not registered, this method has no effect.

Parameters:
`cb` - The callback to remove.

B.14 Interface OCI::ConFactoryRegistry

interface **ConFactoryRegistry**

A registry for Connector factories.

See Also:
Connector
ConFactory

Operations

add_factory
```
void add_factory(in ConFactory factory);
```

Adds a Connector factory to the registry.

Parameters:
`factory` - The Connector factory to add.

get_factory
```
ConFactory get_factory(in IOR ior);
```

Returns a suitable Connector factory for an IOR.

Parameters:
`ior` - The IOR to for which a Connector factory is requested.

Returns:
The Connector factory. A nil object reference is returned if no Connector factory is registered which is able to create a Connector for the given IOR.

get_factory_with_policies
```
ConFactory get_factory_with_policies(in IOR ior,
                                     in CORBA::PolicyList policies);
```

Returns a suitable Connector factory for an IOR. The Connector factory returned must satisfy a list of policies.

Parameters:
`ior` - The IOR for which a Connector factory is requested.

`policies` - The list of policies which have to be satisfied.

Returns:
The Connector factory. A nil object reference is returned if no Connector factory is registered which is able to create a Connector for the given IOR with the given list of policies.

get_factories
```
ConFactorySeq get_factories();
```

Returns a sequence of all registered Connector factories.

Returns:
A sequence with all registered Connector factories.

equivalent
```
boolean equivalent(in IOR ior1,
                   in IOR ior2);
```

Checks whether two IORs are equivalent. It calls the `equivalent` operation of all registered Connector factories. Two IORs are considered equivalent, if all these calls return `TRUE`.

Parameters:
`ior1` - The first IOR to check for equivalence.
`ior2` - The second IOR to check for equivalence.

Returns:
`TRUE` if the IORs are equivalent, `FALSE` otherwise.

hash
```
unsigned long hash(in IOR ior,
                   in unsigned long maximum);
```

Calculates an hash value for an IOR. This hash value is based on the return values of the `hash` operations of all registered Connector factories.

Parameters:
`ior` - The IOR to calculate an hash value for.
`maximum` - The maximum hash value that is allowed.

Returns:
The hash value.

B.15 Interface OCI::AccRegistry

interface **AccRegistry**

A registry for Acceptors.

See Also:
Acceptor

Operations

add_acceptor
```
void add_acceptor(in Acceptor Acceptor);
```

Adds an Acceptor to the registry.

Parameters:
`Acceptor` - The Acceptor to add.

get_acceptors
```
AcceptorSeq get_acceptors();
```

Returns a sequence of all registered Acceptors.

Returns:
A sequence of all registered Acceptors.

add_profiles
```
void add_profiles(in ObjectKey key,
                  inout IOR ior);
```

Adds new profiles to an IOR. For each registered Acceptor a new profile is added by calling the Acceptor’s `add_profile` operation.

Parameters:
`key` - The object key to use for the new profiles.
`ior` - The IOR.

is_local
```
ObjectKey is_local(in IOR ior);
```

Checks whether an IOR is for a local object. It calls the `is_local` operation of all registered Acceptors. An IOR is considered local, if at least one of these calls returns a non-empty object key.

Parameters:

`ior` - The IOR to check for.

Returns:

If the IOR is for a local object, the object key for that local object, or an empty object key otherwise.

B.16 Interface OCI::Current

interface **Current**
inherits from CORBA::Current

Interface to access Transport and Acceptor information objects related to the current request.

Operations

get_oci_transport_info
```
TransportInfo get_oci_transport_info();
```

This method returns the Transport information object for the Transport used to invoke the current request.

Returns:
The Transport information object.

get_oci_acceptor_info
```
AcceptorInfo get_oci_acceptor_info();
```

This method returns the Acceptor information object for the Acceptor which created the Transport used to invoke the current request.

Returns:
The Acceptor information object.

B.17 Module OCI::IIOP

This module contains interfaces to gather information on the IIOP OCI plug-in.

Aliases

InetAddr
```
typedef octet InetAddr[4];
```

Alias for an array of four octets. This alias will be used for address information from the various information classes. The address will always be in network byte order.

B.18 Interface OCI::IIOP::TransportInfo

interface **TransportInfo**
inherits from OCI::TransportInfo

Information on an IIOP OCI Transport object.

See Also:
Transport
TransportInfo

Attributes

addr
```
readonly attribute InetAddr addr;
```

The local 32 bit IP address.

port
```
readonly attribute unsigned short port;
```

The local port.

remote_addr
```
readonly attribute InetAddr remote_addr;
```

The remote 32 bit IP address.

remote_port
```
readonly attribute unsigned short remote_port;
```

The remote port.

B.19 Interface OCI::IIOP::ConnectorInfo

interface **ConnectorInfo**
inherits from OCI::ConnectorInfo

Information on an IIOP OCI Connector object.

See Also:
Connector
ConnectorInfo

Attributes

remote_addr
```
readonly attribute InetAddr remote_addr;
```

The remote 32 bit IP address to which this connector connects.

remote_port
```
readonly attribute unsigned short remote_port;
```

The remote port to which this connector connects.

B.20 Interface OCI::IIOP::AcceptorInfo

interface **AcceptorInfo**
inherits from OCI::AcceptorInfo

Information on an IIOP OCI Acceptor object.

See Also:
Acceptor
AcceptorInfo

Attributes

host
```
readonly attribute string host;
```

Hostname used for creation of IIOP object references.

addr
```
readonly attribute InetAddr addr;
```

The local 32 bit IP address on which this acceptor accepts.

port
```
readonly attribute unsigned short port;
```

The local port on which this acceptor accepts.

B.21 Interface OCI::IIOP::ConFactoryInfo

interface **ConFactoryInfo**
inherits from OCI::ConFactoryInfo

Information on an IIOP OCI Connector Factory object.

See Also:
ConFactory
ConFactoryInfo

APPENDIX C

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References

[1] *The* ORBACUS *Home Page*, `http://www.ooc.com/ob/`, Object-Oriented Concepts, Inc.

[2] *The Common Object Request Broker: Architecture and Specification*, Revision 2.0, OMG Document 97–02–25

[3] *IDL/Java Language Mapping*, OMG document 97-03-01

[4] *CORBAservices: Common Object Services Specification*, OMG document 97-12-02

[5] Marc Laukien and Robert Resendes, *Introduction to CORBA Distributed Objects*, C/C++ Users Journal, April 1998

[6] D. C. Schmidt, *Reactor: An Object Behavioral Pattern for Concurrent Event Demultiplexing and Event Handler Dispatching*, in Pattern Languages of Program Design, Addison-Wesley, 1995

[7] Frank Buschman, Regine Meunier, Hans Rohnert, Peter Sommerlad, and Michael Stal, *A System of Patterns*, John Wiley & Sons, Inc.

[8] *The* JTHREADS/C++ *Home Page*, `http://www.ooc.com/jtc/`, Object-Oriented Concepts, Inc.

[9] JTHREADS/C++ *User's Manual*, Object-Oriented Concepts, Inc.

[10] Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides, *Design Patterns*, Addison-Wesley, 1994

[11] *CORBA Messaging*, OMG document 98-03-11

[12] *The Common Object Request Broker: Architecture and Specification*, Revision 2.2, OMG document 98-02-33

[13] *ORBacus SSL User's Manual*, Object Oriented Concepts, Inc.