Writing an Ice Application with C++

This page shows how to create an Ice application with C++.

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Compiling a Slice Definition for C++

The first step in creating our C++ application is to compile our Slice definition to generate C++ proxies and skeletons. Under Unix, you can compile the definition as follows:

\$ slice2cpp Printer.ice



Whenever we show Unix commands, we assume a Bourne or Bash shell. The commands for Windows are essentially identical and therefore not shown.

The slice2cpp compiler produces two C++ source files from this definition, Printer.h and Printer.cpp.

- Printer.h
 - The Printer.h header file contains C++ type definitions that correspond to the Slice definitions for our Printer interface. This header file must be included in both the client and the server source code.
- Printer.cpp

The Printer.cpp file contains the source code for our Printer interface. The generated source contains type-specific run-time support for both clients and servers. For example, it contains code that marshals parameter data (the string passed to the printString operation) on the client side and unmarshals that data on the server side.

The Printer.cpp file must be compiled and linked into both client and server.

Writing and Compiling a Server in C++

The source code for the server takes only a few lines and is shown in full here:

C++

```
#include <Ice/Ice.h>
#include <Printer.h>
using namespace std;
using namespace Demo;
class PrinterI : public Printer {
    virtual void printString(const string& s, const Ice::Current&);
};
void
PrinterI::
printString(const string& s, const Ice::Current&)
{
    cout << s << endl;
}
int
main(int argc, char* argv[])
    int status = 0;
    Ice::CommunicatorPtr ic;
    try {
        ic = Ice::initialize(argc, argv);
        Ice::ObjectAdapterPtr adapter =
           ic->createObjectAdapterWithEndpoints("SimplePrinterAdapter", "default -p 10000");
        Ice::ObjectPtr object = new PrinterI;
        adapter->add(object, ic->stringToIdentity("SimplePrinter"));
        adapter->activate();
        ic->waitForShutdown();
    } catch (const Ice::Exception& e) {
        cerr << e << endl;
        status = 1;
    } catch (const char* msg) {
        cerr << msg << endl;
        status = 1;
    if (ic) {
        try {
            ic->destroy();
        } catch (const Ice::Exception& e) {
            cerr << e << endl;
            status = 1;
    }
    return status;
}
```

There appears to be a lot of code here for something as simple as a server that just prints a string. Do not be concerned by this: most of the preceding code is boiler plate that never changes. For this very simple server, the code is dominated by this boiler plate.

Every Ice source file starts with an include directive for Ice.h, which contains the definitions for the Ice run time. We also include Printer.h, which was generated by the Slice compiler and contains the C++ definitions for our printer interface, and we import the contents of the std and Demo namespaces for brevity in the code that follows:

#include <Ice/Ice.h> #include <Printer.h> using namespace std; using namespace Demo;

Our server implements a single printer servant, of type PrinterI. Looking at the generated code in Printer.h, we find the following (tidied up a little to get rid of irrelevant detail):

```
namespace Demo {
   class Printer : virtual public Ice::Object {
    public:
        virtual void printString(const std::string&, const Ice::Current& = Ice::Current()) = 0;
    };
};
```

The Printer skeleton class definition is generated by the Slice compiler. (Note that the printstring method is pure virtual so the skeleton class cannot be instantiated.) Our servant class inherits from the skeleton class to provide an implementation of the pure virtual printstring method. (By convention, we use an I-suffix to indicate that the class implements an interface.)

```
C++

class PrinterI : public Printer {
  public:
     virtual void printString(const string& s, const Ice::Current&);
};
```

 $The \ implementation \ of \ the \ \texttt{printString} \ method \ is \ trivial: \ it \ simply \ writes \ its \ string \ argument \ to \ \texttt{stdout:}$

```
void
PrinterI::
printString(const string& s, const Ice::Current&)
{
    cout << s << endl;
}</pre>
```

Note that printString has a second parameter of type Ice::Current. As you can see from the definition of Printer::printString, the Slice compiler generates a default argument for this parameter, so we can leave it unused in our implementation. (We will examine the purpose of the Ice::Current parameter later.)

What follows is the server main program. Note the general structure of the code:

C++

```
main(int argc, char* argv[])
{
    int status = 0;
    Ice::CommunicatorPtr ic;
    try {
        // Server implementation here...
    } catch (const Ice::Exception& e) {
        cerr << e << endl;
        status = 1;
    } catch (const char* msg) {
        cerr << msg << endl;</pre>
        status = 1;
    if (ic) {
        try {
            ic->destroy();
        } catch (const Ice::Exception& e) {
            cerr << e << endl;
            status = 1;
    return status;
}
```

The body of main contains the declaration of two variables, status and ic. The status variable contains the exit status of the program and the ic variable, of type Ice::CommunicatorPtr, contains the main handle to the Ice run time.

Following these declarations is a try block in which we place all the server code, followed by two catch handlers. The first handler catches all exceptions that may be thrown by the Ice run time; the intent is that, if the code encounters an unexpected Ice run-time exception anywhere, the stack is unwound all the way back to main, which prints the exception and then returns failure to the operating system. The second handler catches string constants; the intent is that, if we encounter a fatal error condition somewhere in our code, we can simply throw a string literal with an error message. Again, this unwinds the stack all the way back to main, which prints the error message and then returns failure to the operating system.

Following the try block, we see a bit of cleanup code that calls the destroy method on the communicator (provided that the communicator was initialized). The cleanup call is outside the first try block for a reason: we must ensure that the Ice run time is finalized whether the code terminates normally or terminates due to an exception.



Failure to call destroy on the communicator before the program exits results in undefined behavior.

The body of the first try block contains the actual server code:

ic = Ice::initialize(argc, argv); Ice::ObjectAdapterPtr adapter = ic->createObjectAdapterWithEndpoints("SimplePrinterAdapter", "default -p 10000"); Ice::ObjectPtr object = new PrinterI; adapter->add(object, ic->stringToIdentity("SimplePrinter")); adapter->activate(); ic->waitForShutdown();

The code goes through the following steps:

1. We initialize the lce run time by calling Ice::initialize. (We pass argc and argv to this call because the server may have command-line arguments that are of interest to the run time; for this example, the server does not require any command-line arguments.) The call to in itialize returns a smart pointer to an Ice::Communicator object, which is the main object in the Ice run time.

- 2. We create an object adapter by calling <code>createObjectAdapterWithEndpoints</code> on the <code>Communicator</code> instance. The arguments we pass are "SimplePrinterAdapter" (which is the name of the adapter) and "default -p 10000", which instructs the adapter to listen for incoming requests using the default protocol (TCP/IP) at port number 10000.
- 3. At this point, the server-side run time is initialized and we create a servant for our Printer interface by instantiating a PrinterI object.
- 4. We inform the object adapter of the presence of a new servant by calling add on the adapter; the arguments to add are the servant we have just instantiated, plus an identifier. In this case, the string "SimplePrinter" is the name of the servant. (If we had multiple printers, each would have a different name or, more correctly, a different object identity.)
- 5. Next, we activate the adapter by calling its activate method. (The adapter is initially created in a holding state; this is useful if we have many servants that share the same adapter and do not want requests to be processed until after all the servants have been instantiated.) The server starts to process incoming requests from clients as soon as the adapter is activated.
- 6. Finally, we call waitforShutdown. This call suspends the calling thread until the server implementation terminates, either by making a call to shut down the run time, or in response to a signal. (For now, we will simply interrupt the server on the command line when we no longer need it.)

Note that, even though there is quite a bit of code here, that code is essentially the same for all servers. You can put that code into a helper class and, thereafter, will not have to bother with it again. (Ice provides such a helper class, called Ice::Application.) As far as actual application code is concerned, the server contains only a few lines: six lines for the definition of the PrinterI class, plus three lines to instantiate a PrinterI object and register it with the object adapter.

Assuming that we have the server code in a file called Server.cpp, we can compile it as follows:

```
$ c++ -I. -I$ICE_HOME/include -c Printer.cpp Server.cpp
```

This compiles both our application code and the code that was generated by the Slice compiler. We assume that the ICE_HOME environment variable is set to the top-level directory containing the Ice run time. (For example, if you have installed Ice in /opt/Ice, set ICE_HOME to that path.) Depending on your platform, you may have to add additional include directives or other options to the compiler; please see the demo programs that ship with Ice for the details.

Finally, we need to link the server into an executable:

```
$ c++ -o server Printer.o Server.o -L$ICE_HOME/lib -lIce -lIceUtil
```

Again, depending on the platform, the actual list of libraries you need to link against may be longer. The demo programs that ship with Ice contain all the detail. The important point to note here is that the Ice run time is shipped in two libraries, libice and libiceUtil.

Writing and Compiling a Client in C++

The client code looks very similar to the server. Here it is in full:

C++

```
#include <Ice/Ice.h>
#include <Printer.h>
using namespace std;
using namespace Demo;
int.
main(int argc, char* argv[])
    int status = 0;
    Ice::CommunicatorPtr ic;
    try {
        ic = Ice::initialize(argc, argv);
        Ice::ObjectPrx base = ic->stringToProxy("SimplePrinter:default -p 10000");
        PrinterPrx printer = PrinterPrx::checkedCast(base);
        if (!printer)
            throw "Invalid proxy";
        printer->printString("Hello World!");
    } catch (const Ice::Exception& ex) {
        cerr << ex << endl;
        status = 1;
    } catch (const char* msg) {
        cerr << msg << endl;
```

```
status = 1;
}
if (ic)
   ic->destroy();
return status;
}
```

Note that the overall code layout is the same as for the server: we include the headers for the Ice run time and the header generated by the Slice compiler, and we use the same try block and catch handlers to deal with errors.

The code in the try block does the following:

- 1. As for the server, we initialize the lce run time by calling Ice::initialize.
- 2. The next step is to obtain a proxy for the remote printer. We create a proxy by calling stringToProxy on the communicator, with the string "SimplePrinter:default -p 10000". Note that the string contains the object identity and the port number that were used by the server. (Obviously, hard-coding object identities and port numbers into our applications is a bad idea, but it will do for now; we will see more architecturally sound ways of doing this when we discuss IceGrid.)
- 3. The proxy returned by stringToProxy is of type Ice::ObjectPrx, which is at the root of the inheritance tree for interfaces and classes. But to actually talk to our printer, we need a proxy for a Printer interface, not an Object interface. To do this, we need to do a down-cast by calling PrinterPrx::checkedCast. A checked cast sends a message to the server, effectively asking "is this a proxy for a Printer interface?" If so, the call returns a proxy to a Printer; otherwise, if the proxy denotes an interface of some other type, the call returns a null proxy.
- 4. We test that the down-cast succeeded and, if not, throw an error message that terminates the client.
- 5. We now have a live proxy in our address space and can call the printString method, passing it the time-honored "Hello World!" string. The server prints that string on its terminal.

Compiling and linking the client looks much the same as for the server:

```
$ c++ -I. -I$ICE_HOME/include -c Printer.cpp Client.cpp
$ c++ -o client Printer.o Client.o -L$ICE_HOME/lib -lIce -lIceUtil
```

Running Client and Server in C++

To run client and server, we first start the server in a separate window:

```
$ ./server
```

At this point, we won't see anything because the server simply waits for a client to connect to it. We run the client in a different window:

```
$ ./client
$
```

The client runs and exits without producing any output; however, in the server window, we see the "Hello World!" that is produced by the printer. To get rid of the server, we interrupt it on the command line for now. (We will see cleaner ways to terminate a server in our discussion of Ice:: Application.)

If anything goes wrong, the client will print an error message. For example, if we run the client without having first started the server, we get:

```
Network.cpp:471: Ice::ConnectFailedException: connect failed: Connection refused
```

Note that, to successfully run client and server, you will have to set some platform-dependent environment variables. For example, under Linux, you need to add the Ice library directory to your LD_LIBRARY_PATH. Please have a look at the demo applications that ship with Ice for the details for your platform.

See Also

- Client-Side Slice-to-C++ Mapping
- Server-Side Slice-to-C++ Mapping
- The Ice::Application Class
- The Current Object
- IceGrid

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