Example of a File System Server in Python

This page presents the source code for a Python server that implements our file system and communicates with the client we wrote earlier.

The server is remarkably free of code that relates to distribution: most of the server code is simply application logic that would be present just the same as a non-distributed version. Again, this is one of the major advantages of Ice: distribution concerns are kept away from application code so that you can concentrate on developing application logic instead of networking infrastructure.

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Implementing a File System Server in Python

We have now seen enough of the server-side Python mapping to implement a server for our file system. (You may find it useful to review these Slice definitions before studying the source code.)

Our server is implemented in a single source file, `Server.py`, containing our server's main program as well as the definitions of our `Directory` and `File` servant subclasses.

Server Main Program in Python

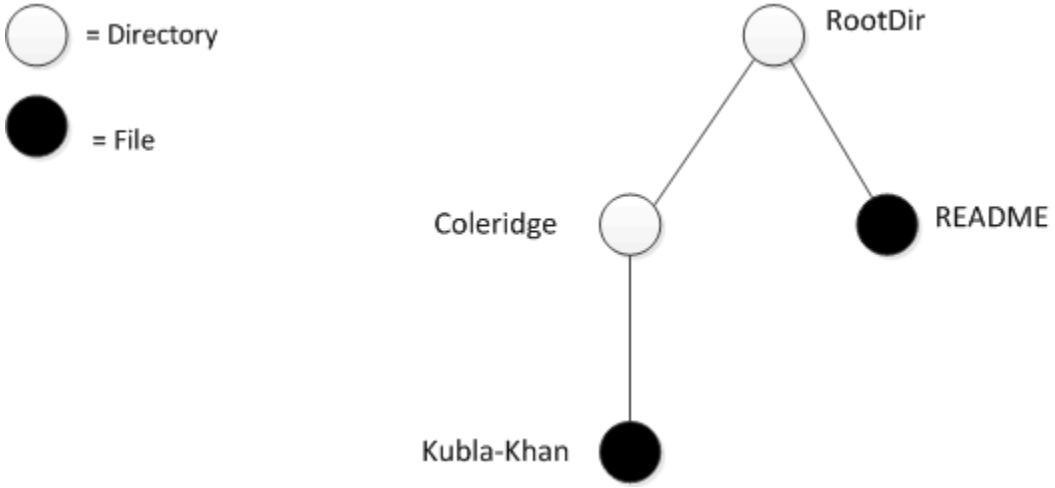
Our server main program uses the `Ice.Application` class. The `run` method installs a signal handler, creates an object adapter, instantiates a few servants for the directories and files in the file system, and then activates the adapter. This leads to a main program as follows:

Python

```
import sys, threading, Ice, Filesystem

# DirectoryI servant class ...
# FileI servant class ...

class Server(Ice.Application):
    def run(self, args):
        # Terminate cleanly on receipt of a signal
        #
        self.shutdownOnInterrupt()

        # Create an object adapter (stored in the _adapter
        # static members)
        #
        adapter = self.communicator().createObjectAdapterWithEndpoints(
                        "SimpleFilesystem", "default -p 10000")
        DirectoryI._adapter = adapter
        FileI._adapter = adapter

        # Create the root directory (with name "/" and no parent)
        #
        root = DirectoryI("/", None)

        # Create a file called "README" in the root directory
        #
        file = FileI("README", root)
        text = [ "This file system contains a collection of poetry." ]
        try:
            file.write(text)
        except Filesystem.GenericError, e:
            print e.reason

        # Create a directory called "Coleridge"
        # in the root directory
        #
        coleridge = DirectoryI("Coleridge", root)

        # Create a file called "Kubla_Khan"
        # in the Coleridge directory
        #
        file = FileI("Kubla_Khan", coleridge)
        text = [ "In Xanadu did Kubla Khan",
                 "A stately pleasure-dome decree:",
                 "Where Alph, the sacred river, ran",
                 "Through caverns measureless to man",
                 "Down to a sunless sea." ]
        try:
            file.write(text)
        except Filesystem.GenericError, e:
            print e.reason

        # All objects are created, allow client requests now
        #
        adapter.activate()

        # Wait until we are done
        #
        self.communicator().waitForShutdown()

        if self.interrupted():
            print self.appName() + ": terminating"

        return 0

app = Server()
sys.exit(app.main(sys.argv))
```

The code defines the `Server` class, which derives from `Ice.Application` and contains the main application logic in its `run` method. Much of this code is boiler plate that we saw previously: we create an object adapter, and, towards the end, activate the object adapter and call `waitForShutdown`.

The interesting part of the code follows the adapter creation: here, the server instantiates a few nodes for our file system to create the structure shown below:



A small file system.

As we will see shortly, the servants for our directories and files are of type `DirectoryI` and `FileI`, respectively. The constructor for either type of servant accepts two parameters, the name of the directory or file to be created and a reference to the servant for the parent directory. (For the root directory, which has no parent, we pass `None`.) Thus, the statement

Python

```
        root = DirectoryI("/", None)
```

creates the root directory, with the name `"/"` and no parent directory.

Here is the code that establishes the structure in the above illustration:

Python

```
        # Create the root directory (with name "/" and no parent)
        #
        root = DirectoryI("/", None)

        # Create a file called "README" in the root directory
        #
        file = FileI("README", root)
        text = [ "This file system contains a collection of poetry." ]
        try:
            file.write(text)
        except Filesystem.GenericError, e:
            print e.reason

        # Create a directory called "Coleridge"
        # in the root directory
        #
        coleridge = DirectoryI("Coleridge", root)

        # Create a file called "Kubla_Khan"
        # in the Coleridge directory
        #
        file = FileI("Kubla_Khan", coleridge)
        text = [ "In Xanadu did Kubla Khan",
                 "A stately pleasure-dome decree:",
                 "Where Alph, the sacred river, ran",
                 "Through caverns measureless to man",
                 "Down to a sunless sea." ]
        try:
            file.write(text)
        except Filesystem.GenericError, e:
            print e.reason
```

We first create the root directory and a file `README` within the root directory. (Note that we pass a reference to the root directory as the parent when we create the new node of type `FileI`.)

The next step is to fill the file with text:

Python

```
        text = [ "This file system contains a collection of poetry." ]
        try:
            file.write(text)
        except Filesystem.GenericError, e:
            print e.reason
```

Recall that Slice sequences map to Python lists. The Slice type `Lines` is simply a list of strings; we add a line of text to our `README` file by initializing the `text` list to contain one element.

Finally, we call the Slice `write` operation on our `FileI` servant by simply writing:

Python

```
            file.write(text)
```

This statement is interesting: the server code invokes an operation on one of its own servants. Because the call happens via a reference to the servant (of type `FileI`) and not via a proxy (of type `FilePrx`), the Ice run time does not know that this call is even taking place — such a direct call into a servant is not mediated by the Ice run time in any way and is dispatched as an ordinary Python method call.

In similar fashion, the remainder of the code creates a subdirectory called `Coleridge` and, within that directory, a file called `Kubla_Khan` to complete the structure in the above illustration.

`FileI` Servant Class in Python

Our `FileI` servant class has the following basic structure:

Python

```
class FileI(Filesystem.File):
    # Constructor and operations here...

    _adapter = None
```

The class has a number of data members:

- `_adapter`
  This class member stores a reference to the single object adapter we use in our server.
- `_name`
  This instance member stores the name of the file incarnated by the servant.
- `_parent`
  This instance member stores the reference to the servant for the file's parent directory.
- `_lines`
  This instance member holds the contents of the file.

The `_name`, `_parent`, and `_lines` data members are initialized by the constructor:

Python

```
    def __init__(self, name, parent):
        self._name = name
        self._parent = parent
        self._lines = []

        assert(self._parent != None)

        # Create an identity
        #
        myID = Ice.Identity()
        myID.name = Ice.generateUUID()

        # Add ourself to the object adapter
        #
        self._adapter.add(self, myID)

        # Create a proxy for the new node and
        # add it as a child to the parent
        #
        thisNode = Filesystem.NodePrx.uncheckedCast(self._adapter.createProxy(myID))
        self._parent.addChild(thisNode)
```

After initializing the instance members, the code verifies that the reference to the parent is not `None` because every file must have a parent directory. The constructor then generates an identity for the file by calling `Ice.generateUUID` and adds itself to the servant map by calling `ObjectAdapter.add`. Finally, the constructor creates a proxy for this file and calls the `addChild` method on its parent directory. `addChild` is a helper function that a child directory or file calls to add itself to the list of descendant nodes of its parent directory. We will see the implementation of this function in `DirectoryI` Methods.

The remaining methods of the `FileI` class implement the Slice operations we defined in the `Node` and `File` Slice interfaces:

Python

```
    # Slice Node::name() operation

    def name(self, current=None):
        return self._name

    # Slice File::read() operation

    def read(self, current=None):
        return self._lines

    # Slice File::write() operation

    def write(self, text, current=None):
        self._lines = text
```

The `name` method is inherited from the generated `Node` class. It simply returns the value of the `_name` instance member.

The `read` and `write` methods are inherited from the generated `File` class and simply return and set the `_lines` instance member.

`DirectoryI` Servant Class in Python

The `DirectoryI` class has the following basic structure:

Python

```
class DirectoryI(Filesystem.Directory):
    # Constructor and operations here...

    _adapter = None
```

`DirectoryI` Data Members in Python

As for the `FileI` class, we have data members to store the object adapter, the name, and the parent directory. (For the root directory, the `_parent` member holds `None`.) In addition, we have a `_contents` data member that stores the list of child directories. These data members are initialized by the constructor:

Python

```
    def __init__(self, name, parent):
        self._name = name
        self._parent = parent
        self._contents = []

        # Create an identity. The
        # parent has the fixed identity "RootDir"
        #
        myID = Ice.Identity()
        if(self._parent):
            myID.name = Ice.generateUUID()
        else:
            myID.name = "RootDir"

        # Add ourself to the object adapter
        #
        self._adapter.add(self, myID)

        # Create a proxy for the new node and
        # add it as a child to the parent
        #
        thisNode = Filesystem.NodePrx.uncheckedCast(self._adapter.createProxy(myID))
        if self._parent:
            self._parent.addChild(thisNode)
```

`DirectoryI` Constructor in Python

The constructor creates an identity for the new directory by calling `Ice.generateUUID`. (For the root directory, we use the fixed identity `"RootDir"`.) The servant adds itself to the servant map by calling `ObjectAdapter.add` and then creates a proxy to itself and passes it to the `addChild` helper function.

`DirectoryI` Methods in Python

`addChild` simply adds the passed reference to the `_contents` list:

Python

```
    def addChild(self, child):
        self._contents.append(child)
```

The remainder of the operations, `name` and `list`, are trivial:

Python

```
    def name(self, current=None):
        return self._name

    def list(self, current=None):
        return self._contents
```

Thread Safety in Python

The server code we have written so far is not quite correct as it stands: if two clients access the same file in parallel, each via a different thread, one thread may read the `_lines` data member while another thread updates it. Obviously, if that happens, we may write or return garbage or, worse, crash the server. However, we can make the `read` and `write` operations thread-safe with a few trivial changes to the `FileI` class:

Python

```
    def __init__(self, name, parent):
        self._name = name
        self._parent = parent
        self._lines = []
        self._mutex = threading.Lock()

        # ...

    def name(self, current=None):
        return self._name

    def read(self, current=None):
        self._mutex.acquire()
        lines = self._lines[:] # Copy the list
        self._mutex.release()
        return lines

    def write(self, text, current=None):
        self._mutex.acquire()
        self._lines = text
        self._mutex.release()
```

We modified the constructor to add the instance member `_mutex`, and then enclosed our `read` and `write` implementations in a critical section. (The `name` method does not require a critical section because the file's name is immutable.)

No changes for thread safety are necessary in the `DirectoryI` class because the `Directory` interface, in its current form, defines no operations that modify the object.

See Also

- Slice for a Simple File System
- Python Mapping for Sequences
- Example of a File System Client in Python
- The Server-Side main Program in Python