

omniidl — The omniORB IDL Compiler

Duncan Grisby
AT&T Laboratories Cambridge

June 2000

1 Introduction

This manual describes `omniidl`, the omniORB IDL compiler. It is intended for developers who wish to write their own IDL compiler back-ends, or to modify existing ones. It also documents the design of the compiler front-end for those poor souls who have to track the IDL specification.

If you just wish to use `omniidl` to create stubs for C++ or Python, you should read the omniORB or omniORBpy manuals instead of this one.

1.1 Requirements

Back-ends for `omniidl` are written in Python, so to use it you must have an up-to-date Python interpreter. You must also understand Python to be able to follow this manual and write back-ends. You can download Python and associated documentation from <http://www.python.org/>.

The front-end scanner and parser are written using flex and bison; the rest of the front-end is written in C++. The code intentionally avoids using any advanced (and useful) features of C++, such as templates, so as to make it as portable as possible.

1.2 Running `omniidl`

On all platforms, there is a command named `omniidl`. On Unix platforms, `omniidl` is a Python script which runs Python via the `#!` mechanism. On Windows NT, there is an executable named `omniidl.exe`.

The `omniidl` command line has the form:

```
omniidl [options] -b<back-end> [back-end options] <file 1> <file 2> ...
```

The supported flags are:

<code>-Dname[=value]</code>	Define <i>name</i> for the preprocessor.
<code>-Uname</code>	Undefine <i>name</i> for the preprocessor.
<code>-I dir</code>	Include <i>dir</i> in the preprocessor search path.
<code>-E</code>	Only run the preprocessor, sending its output to stdout.
<code>-Ycmd</code>	Use <i>cmd</i> as the preprocessor, rather than the normal C preprocessor.
<code>-N</code>	Do not run the preprocessor.
<code>-Wparg[,arg...]</code>	Send arguments to the preprocessor.
<code>-bback-end</code>	Run the specified back-end. For the C++ ORB, use <code>-bcxx</code> .
<code>-wbarg[,arg...]</code>	Send arguments to the back-end.
<code>-nf</code>	Do not warn about unresolved forward declarations.
<code>-k</code>	Keep comments after declarations, to be used by some back-ends.
<code>-K</code>	Keep comments before declarations, to be used by some back-ends.
<code>-Cdir</code>	Change directory to <i>dir</i> before writing output files.
<code>-d</code>	Dump the parsed IDL then exit, without running a back-end.
<code>-pdir</code>	Use <i>dir</i> as a path to find omniidl back-ends.
<code>-V</code>	Print version information then exit.
<code>-u</code>	Print usage information.
<code>-v</code>	Verbose: trace compilation stages.

If you do not specify any back-ends (with the `-b` flag), `omniidl` just runs the compiler front-end, checking that the IDL is valid. If you specify more than one back-end, the back-ends are run in turn on the abstract syntax tree of each file. This permits you to generate stubs for more than one language in a single run. It also permits you to write back-ends which annotate or modify the abstract syntax tree to be used by later back-ends.

For example, the command:

```
omniidl -bdump -bpython foo.idl bar.idl
```

first reads and parses `foo.idl`, and runs the `dump` and `python` back-ends on it in turn. Then it reads and parses `bar.idl` and runs the two back-ends on that.

1.3 Preprocessor interactions

IDL is processed by the C preprocessor before `omniidl` parses it. Unlike the old IDL compiler, which used different C preprocessors on different platforms, `omniidl` always uses the GNU C preprocessor (which it builds with the name `omnicpp`). The `-D`, `-U`, and `-I` options are just sent to the preprocessor. Note that the current directory is not on the include search path by default—use `'-I.'` for that. The `-Y` option can be used to specify a different preprocessor to `omnicpp`. Beware that line directives inserted by other preprocessors are likely to confuse `omniidl`.

1.4 Forward-declared interfaces

If you have an IDL file like:

```
interface I;
interface J {
    attribute I the_I;
};
```

then `omniidl` will normally issue a warning:

```
test.idl:1: Warning: Forward declared interface '::I' was never
fully defined
```

It is illegal to declare such IDL in isolation, but it *is* valid to define interface `I` in a separate file. If you have a lot of IDL with this sort of construct, you will drown under the warning messages. Use the `-nf` option to suppress them.

1.5 Comments

By default, `omniidl` discards comments in the input IDL. However, with the `-k` and `-K` options, it preserves the comments for use by the back-ends.

The two different options relate to how comments are attached to declarations within the IDL. Given IDL like:

```
interface I {
    void op1();
    // A comment
    void op2();
};
```

the `-k` flag will attach the comment to `op1()`; the `-K` flag will attach it to `op2()`.

1.6 Copyright

All parts of `omniidl` are licensed under the GNU General Public License, available in the file `COPYING`.

As a special exception to the terms of the GPL, we do not consider back-ends to be derived works of `omniidl`. This means that you may distribute back-ends you write under any terms you like. The back-ends we distribute are licensed under the GPL, so you must abide by its terms if you distribute or modify our back-ends.

As another exception, we do not consider the output of the back-ends we distribute to be derived works of those back-ends. You may therefore use generated stubs with no restrictions.

2 Back-end interface

There are three elements to the back-end interface: requirements on the back-end modules themselves, a set of output and utility functions, and the interface to the parsed IDL.

2.1 Back-end modules

omniidl back-ends are just normal Python modules. When you specify a back-end with `-bfoo`, omniidl first tries to open the Python module named `omniidl_be.foo`. If that fails, it tries to open the module just named `foo`, using the normal `PYTHONPATH` mechanism. As with any Python module, the module `foo` can either be implemented as a single file named `foo.py`, or as a directory `foo` containing a file named `__init__.py`.

The only requirement on back-end modules is that they contain a function with the signature `run(tree, args)`, where `tree` is an AST object as described in section 2.3.2, and `args` is a list of argument strings passed to the back-end.

Back-ends may also optionally provide a variable named `cpp_args` which contains a list of strings containing arguments to be given to the C preprocessor. For example, the Python back-end contains the line:

```
cpp_args = ["-D__OMNIIDL_PYTHON__"]
```

2.2 Output and utility functions

The purpose of most back-ends is to output source code in some language. It is often the case that much of the output is independent of the specifics of the IDL input. The output for an IDL interface, for example, might be an extensive class definition containing configuration and initialisation code which is largely independent of the specifics of the interface. At various places throughout the class definition, there would be items which *were* dependent on the interface definition.

omniidl supports this with *template* based output functions. Templates are simply strings containing the code to be output, including expressions surrounded by '@' characters. When the templates are output, the keys inside the '@' expressions are replaced with values according to the output arguments. An '@' symbol can be output by putting '@@' in the template.

The output facilities are provided in the `omniidl.output` module by the `Stream` class. The primary method of `Stream` objects is `out()`, which takes arguments of a template string and a set of key/value pairs to be used in @ substitutions. For example, if `st` is a `Stream` object, then the code:

```
template = """\
class @id@ {
public:
    @id@(@type@ a) : a_(a) {}
private:
```

```

    @type@ a_;
}; ""

    st.out(template, id="foo", type="int")

```

would result in output:

```

class foo {
public:
    foo(int a) : a_(a) {}
private:
    int a_;
};

```

When @ expressions are substituted, the expression is actually *evaluated*, not just textually replaced. This means that you can write templates containing strings like '@obj.name()@'. Expressions must evaluate to strings. This feature should not be over-used—it is very easy to write incomprehensible template expressions. The vast majority of templates should only use simple string substitutions.

Commonly, it is necessary to nest definitions which are output inside other definitions. Stream objects keep track of a current indentation level to aid this. The methods `inc_indent()` and `dec_indent()` increment and decrement the current indent level respectively. The number of spaces corresponding to a single indent level is configured when the Stream is created. Occasionally, you may need to output code which ignores the current indent level (preprocessor directives in C, for example). The `niout()` method is identical to `out()` except that it performs no indentation.

The Stream constructor takes two arguments, a file opened for writing, and an integer specifying how many spaces to use for each indent level.

omniidl.output.Stream

Stream(file,indent_size)

Initialise a Stream with the given output file and indent size.

inc_indent()

Increment the indent level.

dec_indent()

Decrement the indent level.

out(template,key=val,...)

Output the template string `template` with `key/value` substitution and indenting.

niout(template,key=val,...)

As `out()`, but with no indenting.

2.2.1 Utility functions

The `omniidl.idlutil` module contains a number of useful functions:

`omniidl.idlutil`

`escapifyString(str)`

Convert any non-printable characters in string `str` into octal escape sequences.

`pruneScope(target, from)`

Given two scoped names represented as lists of strings, return `target` with any prefix it shares with `from` removed. For example:

```
>>> pruneScope(['A', 'B', 'C', 'D'], ['A', 'B', 'D'])
['C', 'D']
```

`slashName(sn, from)`

`dotName(sn, from)`

`ccolonName(sn, from)`

Prune scoped name list `sn` with `pruneScope(sn, from)`, then convert into a string with name components separated by `'/'`, `'.'` or `':'`.

2.3 Abstract Syntax Tree

The main meat of the back-end interface is in the `omniidl.idlast` and `omniidl.idltype` modules. When the compiler parses an IDL file, it creates a tree of objects representing the IDL declarations. The classes for these declarations are defined in the `idlast` module. The way an IDL declaration is split into objects closely follows the terms within the IDL grammar presented in chapter 3 of the CORBA 2.3 specification.

2.3.1 Visitor pattern

All objects within the back-end interface support the *visitor* pattern. They have an `accept(visitor)` method which acts on a visitor adhering to the interfaces in the `omniidl.idlvisitor` module. Note that Python's dynamic type system means that visitor objects need not actually derive from the classes defined in `idlvisitor`¹. Also note that you do not have to use the visitor pattern if you do not wish to.

¹It is even possible to use a Python module as a visitor object.

2.3.2 The root of the tree

The back-end's `run()` function (described in section 2.1) is passed an object of class `AST`.

<code>omniidl.idlast.AST</code>	
<code>file()</code>	The file name of the main IDL file being compiled.
<code>declarations()</code>	List of <code>Decl</code> objects corresponding to declarations at file scope.
<code>pragmas()</code>	List of strings containing <code>#pragmas</code> which occurred before any declarations. Later <code>#pragmas</code> are attached to <code>Decl</code> objects.
<code>comments()</code>	List of strings containing comments which were not attached to declarations (see section 1.5).
<code>accept(visitor)</code>	Visitor pattern accept.

2.3.3 Base declaration

All declarations in the tree are derived from the `Decl` class:

omniidl.idlast.Decl
file()

The name of the file in which this declaration was made.

line()

The line number within the file.

mainFile()

Boolean: true if the declaration is in the main IDL file; false if it is in an included file.

pragmas()

List of strings containing #pragmas which occurred after this declaration, but before any others.

comments()

List of strings containing comments attached to this declaration (see section 1.5).

accept(visitor)

Visitor pattern accept.

2.3.4 Declarations with a repository identifier

Some classes of declaration object also inherit from the DeclRepoId mixin class:

omniidl.idlast.DeclRepoId
identifier()

Name of the declaration as a string.

scopedName()

List of strings forming the fully-scoped name of the declaration. e.g. `::foo::bar::baz` is represented as `['foo', 'bar', 'baz']`.

repoId()

Repository identifier of the declaration.

2.3.5 Declaration classes

The declaration objects making up the tree have the following classes:

omniidl.idlast.Module (Decl,DeclRepoId)*Module declaration***definitions()**

List of Decl objects declared within this module, in the order they were declared.

continuations()

List containing Module objects which are continuations of this module. When modules are re-opened, multiple Module objects with the same name appear in the enclosing Module or AST object. In case it's useful, the first Module object for a particular module has a list containing continuations of that module. You will probably not have any use for this.

omniidl.idlast.Interface (Decl,DeclRepoId)*Interface declaration***abstract()**

Boolean: true if the interface is declared abstract.

inherits()

List of Interface objects from which this one inherits.

contents()

List of Decl objects for all items declared within this interface.

declarations()

Subset of contents() containing types, constants and exceptions.

callable()

Subset of contents() containing Operations and Attributes.

omniidl.idlast.Forward (Decl,DeclRepoId)*Forward-declared interface***abstract()**

Boolean: true if the interface is declared abstract.

fullDecl()

Interface object corresponding to the full interface declaration or None if there is no full declaration.

omniidl.idlast.Const (Decl,DeclRepoId)

Constant declaration

constType()

IdlType.Type object of the constant. Aliases not stripped.

constKind()

TypeCode kind of the constant with aliases stripped. So for a constant declared with:

```
typedef long MyLong;
const MyLong foo = 123;
```

constKind() will return tk_long, but constType() will return an IdlType.Declared object (see page 18) which refers to MyLong's typedef Declarator object.

value()

Value of the constant. Either an integer or an Enumerator object.

omniidl.idlast.Declarator (Decl,DeclRepoId)

Declarator used in typedefs, struct members, etc.

sizes()

List of array sizes, or None if it is a simple declarator.

alias()

Typedef object that the declarator is part of, or None if the object is not a typedef declarator.

omniidl.idlast.TypeDef (Decl)

Typedef declaration

aliasType()

IdlType.Type object that this is an alias to.

constrType()

Boolean: true if the alias type was constructed within this typedef declaration, like

```
typedef struct foo { long l; } bar;
```

declarators()

List of Declarator objects.

omniidl.idlast.Member (Decl)

Member of a struct or exception

memberType()

IdlType.Type object for the type of this member.

constrType()

Boolean: true if the member type was constructed within the member declaration. e.g.

```
struct S {
    struct T {
        long l;
    } the_T;
};
```

declarators()

List of Declarator objects.

omniidl.idlast.Struct (Decl,DeclRepoId)

Struct declaration

members()

List of Member objects for the struct contents.

recursive()

Boolean: true if the struct is recursive, e.g.

```
struct S {
    long l;
    sequence <S> ss;
};
```

omniidl.idlast.Exception (Decl,DeclRepoId)

Exception declaration

members()

List of Member objects for the exception contents.

omniidl.idlast.CaseLabel (Decl)

One label within a union

default()

Boolean: true if this is the default label.

value()

Label value. Either an integer or an Enumerator object. For the default case, returns a value used by none of the other union labels.

labelKind()

TypeCode kind of the label.

omniidl.idlast.UnionCase (Decl)

One case within a union

labels()

List of CaseLabel objects.

caseType()

IdlType.Type object for the case type.

constrType()

Boolean: true if the case type was constructed within the case.

declarator()

Declarator object

omniidl.idlast.Union (Decl,DeclRepoId)

Union declaration

switchType()

IdlType.Type object corresponding to the switch type.

constrType()

Boolean: true if the switch type was declared within the switch statement.
Only possible for Enums.

cases()

List of UnionCase objects.

recursive()

Boolean: true if the union is recursive.

omniidl.idlast.Enumerator (Decl,DeclRepoId)

Enumerator of an enum

No non-inherited functions.

omniidl.idlast.Enum (Decl,DeclRepoId)

Enum declaration

enumerators()

List of Enumerator objects.

omniidl.idlast.Attribute (Decl)

Attribute declaration

readonly()

Boolean: true if the attribute is read only.

attrType()

IdlType.Type object for the attribute's type.

identifiers()

List of strings containing the attribute identifiers. e.g. for the declaration

```
attribute long a, b;
```

identifiers() will return ['a', 'b'].

omniidl.idlast.Parameter (Decl)

Parameter of an operation

direction()

Integer: 0 == in, 1 == out, 2 == inout.

is_in()

Boolean: true if in or inout.

is_out()

Boolean: true if out or inout.

paramType()

IdlType.Type object for the parameter type.

identifier()

String containing the parameter identifier.

omniidl.idlast.Operation (Decl)*Operation declaration***oneway()**

Boolean: true if the operation is one way.

returnType()

IdlType.Type object for the return type.

identifier()

String containing the operation identifier.

parameters()

List of Parameter objects.

raises()

List of Exception objects which the operation can raise.

contexts()List of strings declared as context for the operation.

omniidl.idlast.Native (Decl)*Native declaration*

Native should not be used in normal IDL.

No non-inherited functions.

omniidl.idlast.StateMember (Decl)*State member of a concrete valuetype***memberAccess()**

Integer: 0 == public, 1 == private.

memberType()

IdlType.Type object for member type.

constrType()

Boolean: true if the member type is declared within the StateMember.

declarators()List of Declarator objects.

omniidl.idlast.Factory (Decl)	
<i>Factory method of a valuetype</i>	
identifier()	String containing the factory identifier.
parameters()	List of Parameter objects.

omniidl.idlast.ValueForward (Decl,DeclRepoId)	
<i>Forward-declared valuetype</i>	
abstract()	Boolean: true if declared abstract.
fullDecl()	Value or ValueAbs object corresponding to the full valuetype declaration or None if there is no full declaration.

omniidl.idlast.ValueBox (Decl,DeclRepoId)	
<i>Boxed valuetype declaration</i>	
boxedType()	IdlType.Type object for the boxed type.
constrType()	Boolean: true if boxed type is declared inside the valuetype declaration.

omniidl.idlast.ValueAbs (Decl,DeclRepoId)	
<i>Abstract valuetype declaration</i>	
inherits()	List of ValueAbs objects from which this inherits.
supports()	List of Interface objects which this valuetype supports.
contents()	List of Decl objects for all items defined within this valuetype.
declarations()	Subset of contents() containing types, constants and exceptions.
callable()	Subset of contents() containing Operations and Attributes.

omniidl.idlast.Value (Decl,DeclRepoId)

Valuetype declaration

custom()

Boolean: true if declared custom.

inherits()

List of valuetypes from which this inherits. The first may be a Value object or a ValueAbs object; any others will be ValueAbs objects.

truncatable()

Boolean: true if the inherited Value is declared truncatable; false if not, or there is no inherited Value.

supports()

List of Interface objects which this valuetype supports.

contents()

List of Decl objects for all items defined within this valuetype.

declarations()

Subset of contents() containing types, constants and exceptions.

callable()

Subset of contents() containing Operations, Attributes, StateMembers and Factorys.

2.3.6 Type objects

All type objects are derived from the base class Type:

omniidl.idltype.Type

Base class for types

kind()

TypeCode kind of type.

accept(visitor)

Visitor pattern accept.

The basic CORBA types (null, void, short, long, unsigned short, unsigned long, float, double, boolean, char, octet, any, TypeCode, Principal, long long, unsigned long long, long double, and wide char) are represented by objects of type omniidl.idltype.Base, derived from Type, with no extra methods.

The template types—string, wstring, sequence, and fixed—do not have associated Decl objects since they are not explicitly declared. They are always implicitly

declared as part of another declaration.

omniidl.idltype.String (Type)	
<i>String type</i>	
bound()	Bound of a bounded string, or 0 for unbounded strings.

omniidl.idltype.WString (Type)	
<i>Wide string type</i>	
bound()	Bound of a bounded wstring, or 0 for unbounded wstrings.

omniidl.idltype.Sequence (Type)	
<i>Sequence type</i>	
seqType()	IdlType.Type object representing what the sequence contains.
bound()	Bound of a bounded sequence, or 0 for unbounded sequences.

omniidl.idltype.Fixed (Type)	
<i>Fixed point type</i>	
digits()	Number of digits in number.
scale()	Scale of number.

All other types (interface, struct, union, enum, typedef, exception, valuetype) must be explicitly declared. They are represented with Declared objects:

omniidl.idltype.Declared (Type)

Explicitly declared type

decl()

omniidl.idlast.Decl object which corresponds to this type.

scopedName()

Fully scoped name of the type as a list of strings.

name()

Simple name of the type, i.e. the last element of the scoped name.

2.3.7 Finding a named Decl

Normally, back-ends walk over the tree of Decl objects, dealing with the declarations as they encounter them. Occasionally, however, it may be useful to find a declaration by its scoped name. Only Decls which inherit from DeclRepoId can be found in this way.

omniidl.idlast

findDecl(scopedName)

Find the Decl object which has the scoped name list `scopedName`. If a declaration with the specified name does not exist, the `DeclNotFound` exception is raised.

2.4 An example back-end

The following code is an extremely simple back-end which just prints the names of all operations declared within an IDL file. Unfortunately, it is so simple that it does not show many features of the back-end interface. You should look at the `dump.py` and `python.py` back-ends for a more extensive example.

```
from omniidl import idlast, idlvisitor, idlutil
import string
```

```
class ExampleVisitor (idlvisitor.AstVisitor):
```

```
    def visitAST(self, node):
        for n in node.declarations():
            n.accept(self)
```

```
    def visitModule(self, node):
        for n in node.definitions():
            n.accept(self)
```

```

def visitInterface(self, node):
    name = idlutil.ccolonName(node.scopedName())

    if node.mainFile():
        for c in node.callables():
            if isinstance(c, idlast.Operation):
                print name + "::" + \
                    c.identifier() + "()"

def run(tree, args):
    visitor = ExampleVisitor()
    tree.accept(visitor)

```

The visitor object simply recurses through the AST and Module objects, and prints the operation names it finds in Interface objects.

Note that since `AstVisitor` (and similarly `TypeVisitor` which is not used in the example) has all operations declared to be no-ops, the `ExampleVisitor` class does not have to declare visit functions for all node types. This can be a disadvantage if your back-end is supposed to perform some action for all node types, since there will be no error if you accidentally miss a node type. In those situations it is better to declare a visitor class which does not derive from the visitor base classes.

3 Front-end architecture

Not here yet.