

E.4 Mapping IDL to Java

- Mapping of IDL data types to Java
- Mapping of object interfaces to Java

1 General Remarks

- Mapping of IDL types to Java interfaces and classes
- Latest language mapping document from June 1999
- Contains mapping for POA interfaces
- Important goals:
 - ◆ Portable stubs
 - Stubs may be loaded over the network
 - Stubs must work with any ORB that is locally installed – independent of the ORB core
 - Interface between stubs and ORB core fixed to guarantee exchangeability
 - ◆ Reverse mapping of Java to IDL should be possible
- Identifiers from IDL source are used unchanged in Java
 - ◆ In case of clashes prepend _ (underscore)

2 Primitive Types

- Integer numbers
 - ◆ `short` becomes `short`
 - ◆ `unsigned short` becomes `short`
 - ◆ `long` becomes `int`
 - ◆ `unsigned long` becomes `int`
 - ◆ `long long` becomes `long`
 - ◆ `unsigned long long` becomes `long`
 - ◆ Large `unsigned` values become negative in Java!
- Floating point numbers
 - ◆ `float` becomes `float`
 - ◆ `double` becomes `double`
 - ◆ `long double` no mapping yet

2 Primitive Types (2)

- Characters
 - ◆ `char` becomes `char`
 - ◆ `wchar` becomes `char`
 - ◆ Because Java `char` is superset of IDL `char` marshalling may cause `CORBA::DATA_CONVERSION` exception
- `boolean`
 - ◆ Stays `boolean`
- `octet`
 - ◆ Becomes `byte`
- `any`
 - ◆ Class `org.omg.CORBA.Any`
 - ◆ `insert` and `extract` methods for primitive types in class `Any`
 - ◆ For other types `insert` and `extract` methods in Helper class of this type

3 Helper Classes

- One Helper class for each IDL type (here *name*)

```
public class nameHelper {
    public static void insert( org.omg.CORBA.Any a, Name t )
    { ... }
    public static name extract( org.omg.CORBA.Any a ) { ... }
    public static org.omg.CORBA.TypeCode type() { ... }
    public static String id() { ... }
    public static name read(
        org.omg.CORBA.portable.InputStream istream ) { ... }
    public static void write(
        org.omg.CORBA.portable.OutputStream ostream,
        name value ) { ... }

    // only for interface helpers
    public static name narrow( org.omg.CORBA.Object obj )
    { ... }
}
```

4 Holder Classes

- Java only has call-by-value semantics (Object references cannot be manipulated!)
- *out*- and *inout* parameters need call-by-reference
- Encapsulation of parameters in a Holder object (here for type *name*)

```
final public class nameHolder
    implements org.omg.CORBA.portable.Streamable {
    public name value;

    public nameHolder() { ... }
    public nameHolder( name initial ) { ... }

    public void _read( org.omg.CORBA.portable.InputStream i )
    { ... }
    public void _write(
        org.omg.CORBA.portable.OutputStream o ) { ... }

    public org.omg.CORBA.TypeCode _type() { ... }
}
```

3 Helper Classes (2)

- **extract** and **insert**
 - ◆ Methods to extract and insert this type from/into an **any** object
- **type** and **id**
 - ◆ Inquiry of type code and type identification (Repository ID) for this type
- **read** and **write**
 - ◆ Methods for marshalling and de-marshalling in portable stubs
- **narrow**
 - ◆ Only exists in Helpers for **interfaces**
 - ◆ Modification of the visible interface of an object reference - Casting

5 IDL Entity

- Empty marker interface
- Inherited by all IDL generated interfaces and classes
- Declaration:

```
package org.omg.CORBA.portable;

public interface IDLEntity
    extends java.io.Serializable
{ }
```

6 Modules

■ IDL:

```
module name {
    Declarations
};
```

■ Mapping to Java packages

■ Java:

```
package name;

Mapping for declarations
```

■ Mapping of module CORBA to package `org.omg.CORBA`

8 Structures

■ IDL:

```
struct name {
    Declarations of structure elements
};
```

■ Mapping to a `public final` class with Helper and Holder class

- ◆ Elements become `public` variables
- ◆ Empty constructor and constructor that takes values for all variables

■ Java:

```
public final class name
    implements org.omg.CORBA.portable.IDLEntity
{
    Mapping for structure elements as public variables
    public name() {}
    public name( Mapping_for_structure_elements ) {...}
}
```

7 Type Declarations

■ IDL:

```
typedef existing_type alias;
```

■ Java:

- ◆ Only Holder and Helper class for *alias*
- ◆ For the type itself mapping of *existing_type* has to be used

■ Example:

```
// IDL
typedef long IDNumber;

// Java
public class IDNumberHelper {...}
final public class IDNumberHolder
    implements org.omg.CORBA.portable.Streamable {
    public int value;
    ...
}
```

8 Structures (2)

■ Example:

```
// IDL
struct Example {
    float value;
    char currency;
};

// Java
final public class Example
    implements org.omg.CORBA.portable.IDLEntity
{
    public float value;
    public char currency;
    public Example() {}
    public Example( float value, char currency ) {
        this.value = value;
        this.currency = currency;
    }
}
```

8 Nested Structures

■ Example:

```
struct Outer {
    struct Inner {
        char foo;
    } fooBar;
};
```

■ Inner is mapped to class `Inner` with Helper and Holder class in a sub-package named `OuterPackage`

```
Outer.java:
final public class Outer ... {
    public OuterPackage.Inner fooBar;
    ...
}

OuterPackage/Inner.java:
package OuterPackage;
final public class Inner ... {
    public char foo;
    ...
}
```

9 Unions

■ Example:

```
// IDL
union Example switch( long ) {
    case 1:      long l;
    case 2:      float f;
};

// Java
final public class Example
    implements org.omg.CORBA.portable.IDLEntity
{
    private java.lang.Object _object;
    private int _disc;
    private int _defdisc = -2147483648;
    public Example() {}
    public int discriminator() { return _disc; }
    public int l() {...} // get l
    public void l( int value ) {...} // set l
    public float f() {...} // get f
    public void f( float value ) {...} // set f
    public void _default() {...} // set to impossible discr.
}
```

9 Unions

■ IDL:

```
union name switch( switch_type ) {
    case switch_constant: Declaration
    ...
    default: Declaration
};
```

■ Mapping to a `public final` class with Helper and Holder class

- ◆ Access method for switch type (discriminator) and all types of the Union
- ◆ Access method for default discriminator

■ Java:

```
public final class name
    implements org.omg.CORBA.portable.IDLEntity
{
    public name() {}
    public Mapping_for_switch_type discriminator() {...}
    public Mapping_for_union_element union_element_name() {...} //get
    public union_element_name( Mapping_for_union_element ) {...} //set
}
```

10 Enumerations

■ IDL:

```
enum name {
    value1, value2, ...
};
```

■ Mapping to a `public final` class with Helper and Holder class

- ◆ Enumeration values are mapped to Integer values (Identifier `_value1`, ...)
- ◆ And to static instances within the enumeration class

■ Java:

```
public final class name
    implements org.omg.CORBA.portable.IDLEntity
{
    public static final int _value1 = int_value1;
    public static final name value1 = new name( _value1 );
    ...
    private final int _value;
    private name( int value ) { this._value = value; }
    public int value() { return _value; }
    public static name from_int( int value ) {...};
}
```

10 Enumerations

■ Example:

```
// IDL
enum Color { GREEN, RED, BLUE };

// Java
final public class Color
    implements org.omg.CORBA.portable.IDLEntity
{
    final public static int _GREEN = 0;
    final public static int _RED = 1;
    final public static int _BLUE = 2;
    final public static Color GREEN = new Color( _GREEN );
    final public static Color RED = new Color( _RED );
    final public static Color BLUE = new Color( _BLUE );

    private int _value;
    private Color( int value ) { this._value = value; }
    public int value() { return _value; }
    public static Color from_int( int value ) {
        switch( value ) {...}
    }
}
```

12 Sequences

■ IDL:

```
typedef sequence<element_type> name; // unbounded
typedef sequence<element_type,positive_constant> name; // bounded
```

■ Mapping the same as for single dimension arrays

- ◆ Length check for bounded sequences will only be done while marshalling

■ Example:

```
// IDL
typedef sequence<long> Longs;

// Java
public class LongsHelper {...}
final public class LongsHolder
    implements org.omg.CORBA.portable.Streamable {
    public int[] value;
    ...
}
```

11 Arrays

■ IDL:

```
typedef element_type name[positive_constant][positive_constant]...;
```

■ Mapping to Java Arrays und `nameHelper` and `nameHolder` class

- ◆ Array elements have the type that arises from mapping `element_type`

■ Example:

```
// IDL
typedef long Matrix[3][3];

// Java
public class MatrixHelper {...}
final public class MatrixHolder
    implements org.omg.CORBA.portable.Streamable {
    public int[][] value;
    ...
}
```

13 Strings

■ IDL:

```
typedef string name; // unbounded
typedef string<positive_constant> name; // bounded
typedef wstring name; // unbounded
typedef wstring<positive_constant> name; // bounded
```

■ Mapping to `java.lang.String`

- ◆ Exceptions during marshalling when length is exceeded or characters cannot be mapped to CORBA `char`

■ Example:

```
// IDL
typedef string<80> Name;

// Java
public class NameHelper {...}
final public class NameHolder
    implements org.omg.CORBA.portable.Streamable {
    public java.lang.String value;
    ...
}
```

14 Fixed-Point Numbers

- IDL:

```
typedef fixed<positive_constant, scaling_constant> name;
```

- Mapping to `java.math.BigDecimal`

- Helper class: `nameHelper`

- Holder class: `org.omg.CORBA.FixedHolder`

15 Constants (2)

- Mapping of constants outside an IDL interface

- ◆ Class of its own with name of constant and local value `value`

- ◆ Example:

```
// IDL
module Example {
    const Color WARNING = RED;
};

// Java
package Example;
public interface WARNING {
    final public static Color value = (Color) Color.RED;
};
```

15 Constants

- Symbolic name for special values

- IDL:

```
const type name = constant_expression;
```

- Mapping of local constants in IDL interfaces

- ◆ `final public static` variables in Java interface

- ◆ Example:

```
// IDL
interface Example {
    const Color WARNING = RED;
};

// Java
public interface Example ... {
    final public static Color WARNING = (Color) Color.RED;
    ...
}
```

16 Interfaces

- IDL:

```
interface name {
    Declaration of attributes and operations (as well as types and exceptions)
};
```

- Mapping to:

- ◆ `public` Java interface `nameOperations`
- ◆ `public` Java interface `name`
- ◆ `nameHelper` and `nameHolder` class
- ◆ Stub and Skeleton class

16 Interfaces (2)

■ Java:

```
public interface nameOperations
{
    Mapping for attributes and operations
}
public interface name extends org.omg.CORBA.Object,
    nameOperations, org.omg.CORBA.portable.IDLEntity
{}

final public class nameHolder
    implements org.omg.CORBA.portable.Streamable {...}
public class nameHelper {...}
```

16 Interfaces – Attributes

■ IDL:

```
attribute type name;           // read & write
readonly attribute type name; // read-only
```

■ Mapping to a pair of access methods

■ Java:

```
public Mapping_for_type name(); // get attribute
public void name( Mapping_for_type ); // set attribute (not if read-only)
```

■ Example:

```
// IDL
interface Account {
    readonly attribute float balance;
};

// Java
public interface AccountOperations {
    public float balance();
}
```

16 Interfaces – Inheritance

■ IDL:

```
interface name : inherited_interface1, inherited_interface2, ... {
    Declaration of additional attributes and operations
};
```

■ Mapping to multiple inheritance of Java interfaces

■ Java:

```
public interface nameOperations
    extends inherited_interface1Operations,
        inherited_interface2Operations, ...
{
    Mapping for additional attributes and operations
}
public interface name
    extends inherited_interface1, inherited_interface2, ...,
        nameOperations, org.omg.CORBA.portable.IDLEntity
{}
final public class nameHolder
    implements org.omg.CORBA.portable.Streamable {...}
public class nameHelper {...}
```

16 Interfaces – Operations

■ IDL:

```
return_type name( parameter_list ) raises( exception_list );
```

■ Mapping to methods in the Java interface

■ Java:

```
public Mapping_for_return_type name( Mapping_for_parameter_list )
    throws Mapping_for_exception_list;
```

16 Interfaces – Parameter Transmission

■ IDL:

```
( copy_direction1 type1 name1, copy_direction2 type2 name2, ... )
```

■ Mapping of parameter types depends on copy direction

- ◆ **in** to *Mapping_for_type*
- ◆ **out** and **inout** to *typeHolder*

■ Example:

```
// IDL
interface Account {
    void makeWithdrawal( in float sum,
                        out float newBalance );
};

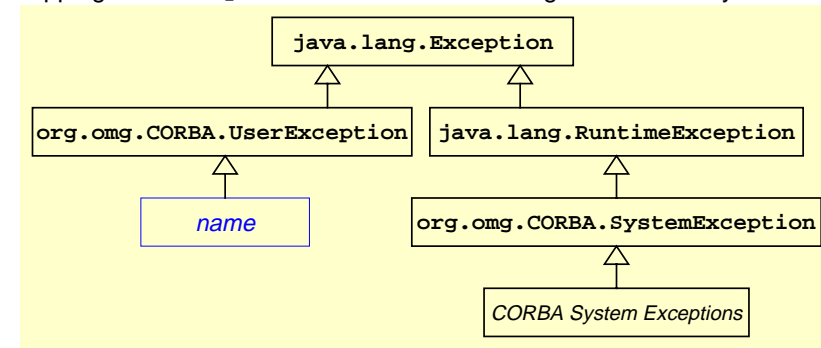
// Java
public interface AccountOperations {
    public void makeWithdrawal( float sum,
                               FloatHolder newBalance );
}
```

17 Exceptions

■ IDL:

```
exception name {
    Declarations of data elements
};
```

■ Mapping to final public class in the following class hierarchy:



16 Interfaces

■ Example:

```
//IDL
module Bank {
    interface Account {
        void withdraw(in double amount);
        void deposit(in double amount);
        void transfer(inout Account src, in double amount);
        readonly attribute double balance;
    };
};

// Java
package Bank;
public interface AccountOperations {
    public void withdraw(double amount);
    public void deposit(double amount);
    public void transfer(AccountHolder src, double amount);
    public double balance();
}
public interface Account extends org.omg.CORBA.Object,
    AccountOperations, org.omg.CORBA.portable.IDLEntity
{ }
```

17 Exceptions (2)

■ Mapping of local exceptions from IDL interface *name* to final public class in package *namePackage*

■ Example:

```
// IDL
interface Account {
    exception Overdraft { float howMuch };
    void withdraw( in double amount ) raises( Overdraft );
};

// Java
public interface AccountOperations {
    public void withdraw( double amount )
        throws AccountPackage.Overdraft;
}
public interface Account extends ... {}
package AccountPackage;
final public class Overdraft
    extends org.omg.CORBA.UserException {
    public float howMuch;
    ...
}
```


17 Exceptions (3)

- In addition: Creation of Helper and Holder class for exception
- Mapping of CORBA System Exceptions to `final public` Subclasses of `org.omg.CORBA.SystemException`

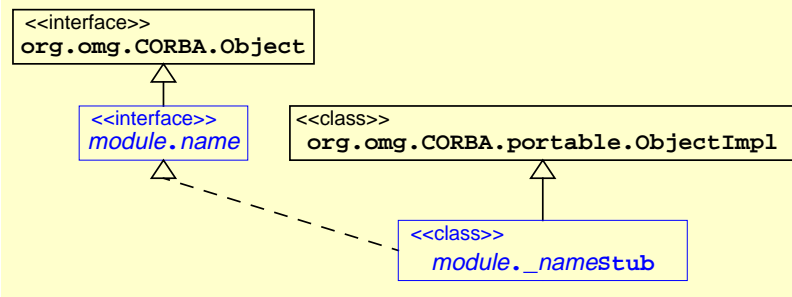
```
package org.omg.CORBA;
abstract public class SystemException
    extends java.lang.RuntimeException {
    public int minor;
    public CompletionStatus completed;
    protected SystemException( String reason, int minor,
        CompletionStatus status) {
        super(reason); this.minor = minor;
        this.status = status;
    }
}
// CORBA:UNKNOWN
final public class UNKNOWN
    extends org.omg.CORBA.SystemException {
    public UNKNOWN() ...
    public UNKNOWN(String reason) ...
    ...
}
```

19 Java Mapping Summary

- For each IDL there are two classes
 - ◆ A Holder class for out and inout parameter passing
 - ◆ A Helper class for marshalling and for insertion and extraction into/from any objects
- Primitive types mapped to Java types (Caution: no one-to-one relation)
- IDL arrays and sequences are Java arrays
- For other constructed types there are special classes
- IDL interfaces mapped to Java interfaces
- IDL exceptions are special Java exception classes
- Clients have Java references to stub objects

18 Stubs

- Client only has a Java reference to a local proxy object
 - ◆ Stub object
 - ◆ Stub class is automatically generated from the IDL description
 - ◆ Stub objects are transparent to the user – automatically created and destroyed by the CORBA system
- Class hierarchy for IDL interface `module::name`



E.5 Java Client

- Missing pieces for a complete client
- How to get the first reference to a CORBA object
- Example "Hello World!"

1 CORBA Pseudo Objects

- No real CORBA objects
 - ◆ Make sense only locally
 - ◆ Not remotely accessible
- Description of interface in Pseudo IDL (PIDL)
 - ◆ Syntax like IDL
 - ◆ Language mapping can define special mapping for each pseudo interface
- Examples:
 - ◆ `CORBA::Object` Features of CORBA object references
 - ◆ `CORBA::ORB` Interface to ORB features
 - ◆ `PortableServer::POA` Interface to the Portable Object Adaptor
- Recently more and more Pseudo Interfaces have been defined as local interfaces

2 Object References – CORBA::Object

- `InterfaceDef get_interface()`
 - ◆ Returns an interface description (from Interface Repository) for this object
 - ◆ Usually used in connection with the Dynamic Invocation Interface (DII)
- `boolean is_a(in string logical_type_id)`
 - ◆ Checks whether the object implements the given interface
 - ◆ Interface Repository ID as a string, e.g. `IDL:Bank/Account:1.0`
- `Object duplicate()`
`void release()`
 - ◆ Copying and deleting of object references
 - ◆ Reference counting only locally in the client
 - ◆ Object implementation will not be informed

2 Object References – CORBA::Object

- Operations that a client can invoke on each CORBA object:

```

module CORBA {
  interface Object {                               // PIDL
    InterfaceDef get_interface();
    boolean is_nil();
    Object duplicate();
    void release();
    boolean is_a( in string logical_type_id );
    boolean non_existent();
    boolean is_equivalent( in Object other_object );
    unsigned long hash( in unsigned long maximum );
    Status create_request(
      in Context ctx,
      in Identifier operation,
      in NVList arg_list,
      inout NamedValue result,
      out Request request,
      in Flags req_flags );
    ...
  };
};

```

2 Object References – CORBA::Object

- `boolean is_nil()`
 - ◆ Checks whether this is a valid object reference
- `boolean non_existent()`
 - ◆ Checks whether there is an implementation for this object
- `unsigned long hash(in unsigned long maximum)`
 - ◆ Hash to distinguish object references
- `boolean is_equivalent(in Object other_object)`
 - ◆ Checks whether two references point to the same CORBA object
 - ◆ Caution: only best-effort semantics
 - true: references point to the same object
 - false: references probably point to different objects
- `Status create_request(...)` Create a DII request

3 Object References – org.omg.CORBA.Object

■ Java mapping to interface org.omg.CORBA.Object

```
package org.omg.CORBA;

public interface Object {
    boolean _is_a( String Identifier );
    boolean _is_equivalent( Object that );
    boolean _non_existent();
    int _hash( int maximum );
    org.omg.CORBA.Object _duplicate();
    void _release();
    ImplementationDef _get_implementation();
    InterfaceDef _get_interface();
    ...
}
```

■ duplicate and release really not necessary

- ◆ Java uses built-in Garbage Collection instead of reference counting

■ Caution: Simple Object means in every package java.lang.Object!

4 ORB Interface – CORBA::ORB

```
string object_to_string( in Object obj )
Object string_to_object( in string str )
```

- ◆ Conversion of object references into unique strings and vice versa
- ◆ String format: IOR:00202020...

■ ObjectIdList list_initial_services()

- ◆ List of services the ORB knows about, e.g. NameService

■ Object resolve_initial_references(in ObjectId identifier) raises (InvalidName)

- ◆ Returns object reference for the requested ORB service
- ◆ ObjectId is a String, e.g. "NameService"

4 ORB Interface – CORBA::ORB

■ Common operations of the ORB

```
module CORBA {
    interface ORB { // PIDL
        string object_to_string( in Object obj );
        Object string_to_object( in string str );

        typedef string ObjectId;
        typedef sequence<ObjectId> ObjectIdList;
        exception InvalidName {};
        ObjectIdList list_initial_services();
        Object resolve_initial_references(
            in ObjectId identifier ) raises (InvalidName);
        ...
    };
};
```

5 ORB Interface – org.omg.CORBA.ORB

■ Java mapping to abstract class org.omg.CORBA.ORB

```
package org.omg.CORBA;

public abstract class ORB {

    public abstract String[] list_initial_services();
    public abstract org.omg.CORBA.Object
        resolve_initial_references( String object_name )
        throws org.omg.CORBA.ORBPackage.InvalidName;

    public abstract String
        object_to_string( org.omg.CORBA.Object obj );
    public abstract org.omg.CORBA.Object
        string_to_object( String str );

    ...
}
```

6 ORB Initialisation

- First step in every CORBA application
- Returns a reference to a `CORBA::ORB` object
- PIDL spec:

```
module CORBA {                                     // PIDL
    typedef string ORBid;
    typedef sequence<string> arg_list;
    ORB ORB_init( inout arg_list argv,
                 in ORBid orb_identifier);
};
```

- Selection of various ORBs (if there is more than one) via ORBid
- ORB parameters in command line arguments
 - ◆ e.g. `-ORB<suffix> <value>`

7 ORB Initialisation – org.omg.CORBA.ORB

- In Java ORB initialisation via static methods of `org.omg.CORBA.ORB`

```
public abstract class ORB {
    ...
    public static ORB init(Strings[] args,
                          Properties props );
    public static ORB init( Applet app, Properties props );
    public static ORB init();
    ...
}
```

- ◆ Special `init` method for ORB inside an Applet
- ◆ `init()` without parameters only returns a Singleton ORB
 - ▶ Can only create special structures like Typecodes
 - ▶ Not suitable for remote method invocations!
- Java properties to select ORB features, e.g.
 - ◆ `org.omg.CORBA.ORBClass` Class that is returned by `init` (implements `org.omg.CORBA.ORB`), e.g. `com.ooc.CORBA.ORB`

8 Hello World Client

- IDL-Interface

```
// Hello.idl

module Example {
    interface Hello {
        string say( in string msg );
    };
};
```

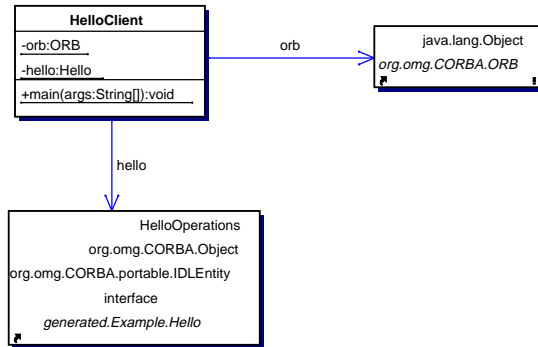
8 Hello World Client

```
// client/HelloClient.java
package client;

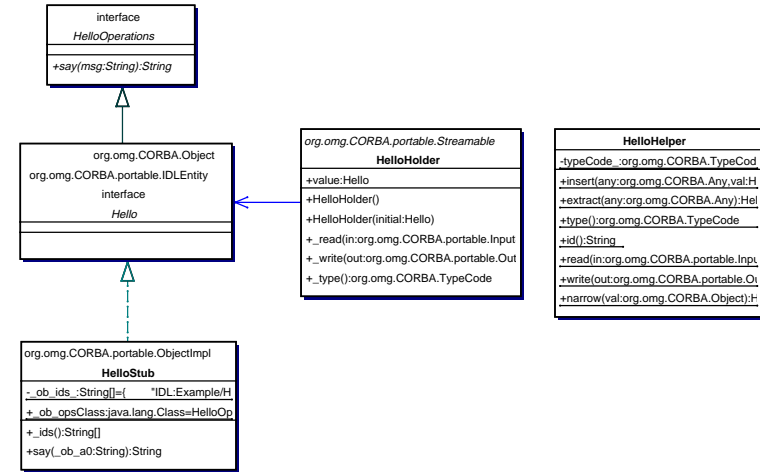
import generated.Example.*;
import org.omg.CORBA.*;

public class HelloClient {
    public static void main( String[] args ) {
        try {
            // Initialise ORB
            ORB orb = ORB.init( args, null );
            // Read object reference from file Hello.ior
            String s = ...
            // Create a stub object
            org.omg.CORBA.Object o = orb.string_to_object(s);
            // Narrow to the Hello interface
            Hello hello = HelloHelper.narrow( o );
            // Do the call
            System.out.println( hello.say( " world!" ) );
        } catch( Throwable t ) {
            t.printStackTrace();
        }
    }
}
```

8 Hello World Client



8 Hello World Client – Generated Classes



8 Hello World Client

■ Go to the example directory

```
> cd /proj/i4oods/pub/hello_java_client
```

■ Compile

```
> /local/ORBacus-4.0.3/bin/jidl --package generated  
Hello.idl  
> /local/java-1.3/bin/javac -classpath /local/ORBacus-4.0.3/  
lib/OB.jar:. client/HelloClient.java
```

■ Run

```
> /local/java-1.3/bin/java -classpath /local/ORBacus-4.0.3/  
lib/OB.jar:. -Dorg.omg.CORBA.ORBClass=com.ooc.CORBA.ORB  
-Dorg.omg.CORBA.ORBSingletonClass=com.ooc.CORBA.ORBSingleto  
n client.HelloClient
```