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 exchangeablility
  - ◆ 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 )
        {...}
}
```

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 **`interface`**s
  - ◆ Modification of the visible interface of an object reference - Casting

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() {...}
}
```

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**

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

- 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 elemente as public variables
    public name() {}
    public name( Mapping_for_structure_elements ) {...}
}
```

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

- 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
}
```

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.
}
```

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 ) {...}
    }
}
```

11 Arrays

- IDL:

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

- Mapping to Java Arrays und *name*`Helper` and *name*`Holder` 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;
    ...
}
```

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;
    ...
}
```

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: *name***`Helper`**
- Holder class: **`org.omg.CORBA.FixedHolder`**

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;
    ...
}
```

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;
};
```

16 Interfaces

- IDL:

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

- Mapping to:
  - **`public`** Java interface *name***`Operations`**
  - **`public`** Java interface *name*
  - *name***`Helper`** and *name***`Holder`** 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 – 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 – 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 – 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 *type***`Holder`**

- Example:

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

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

16 Interfaces

- Example:

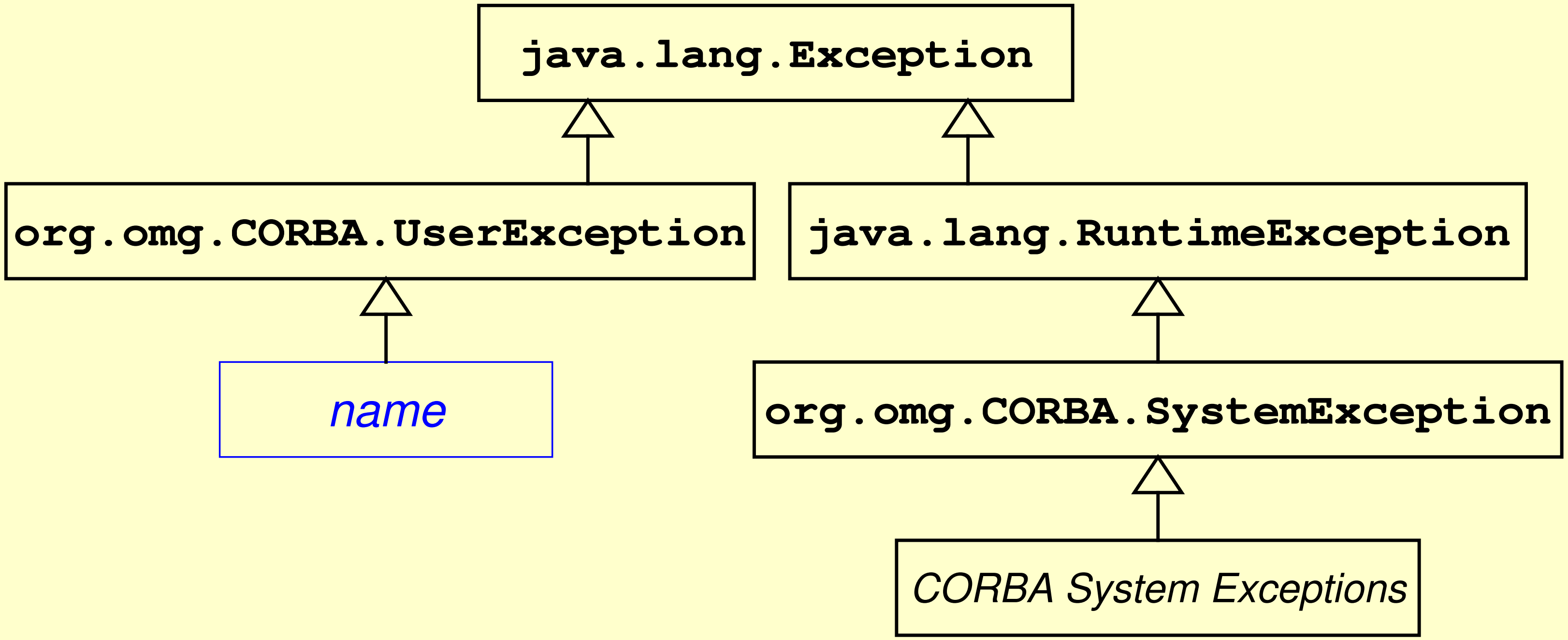
```
//IDL
module Bank {
    interface Account {
        void withdraw(in double amount);
        void deposit(in double amount);
        void transfer(inout Account src, in double amount);
        readonly attribute double balance;
    };
};

// 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

- IDL:

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

- Mapping to **`final public`** class in the following class hierarchy:



17 Exceptions (2)

- Mapping of local exceptions from IDL interface *name* to **`final public`** class in package *name***`Package`**
- 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;
    ...
}
```

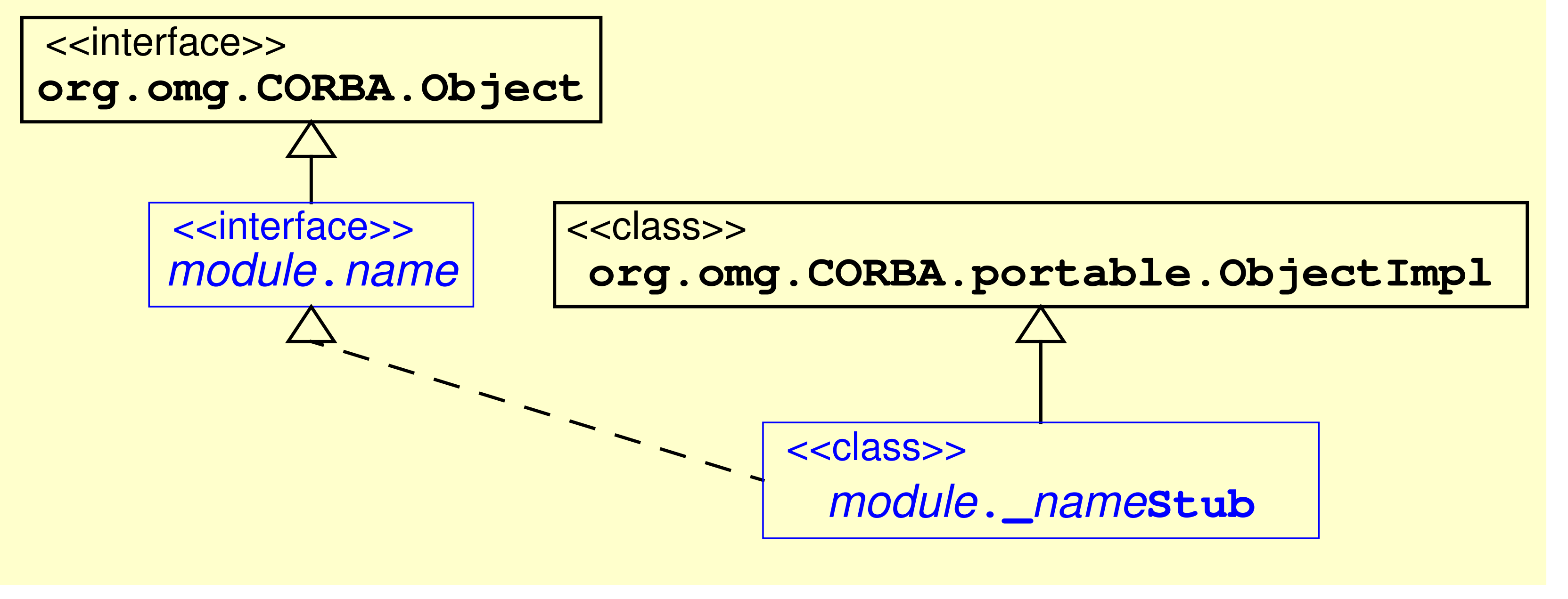
17 Exceptions (3)

- 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) ...
    ...
}
```

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*



19 Java Mapping Summary

- For each IDL there are two classes
  - ◆ A Holder class for out and inout parameter passing
  - ◆ A Helper classe 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

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 an more Pseudo Interfaces have been defined as local interfaces

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

- **`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

- **`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

- 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);

        ...
    };
};
```

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`**"

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 that 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

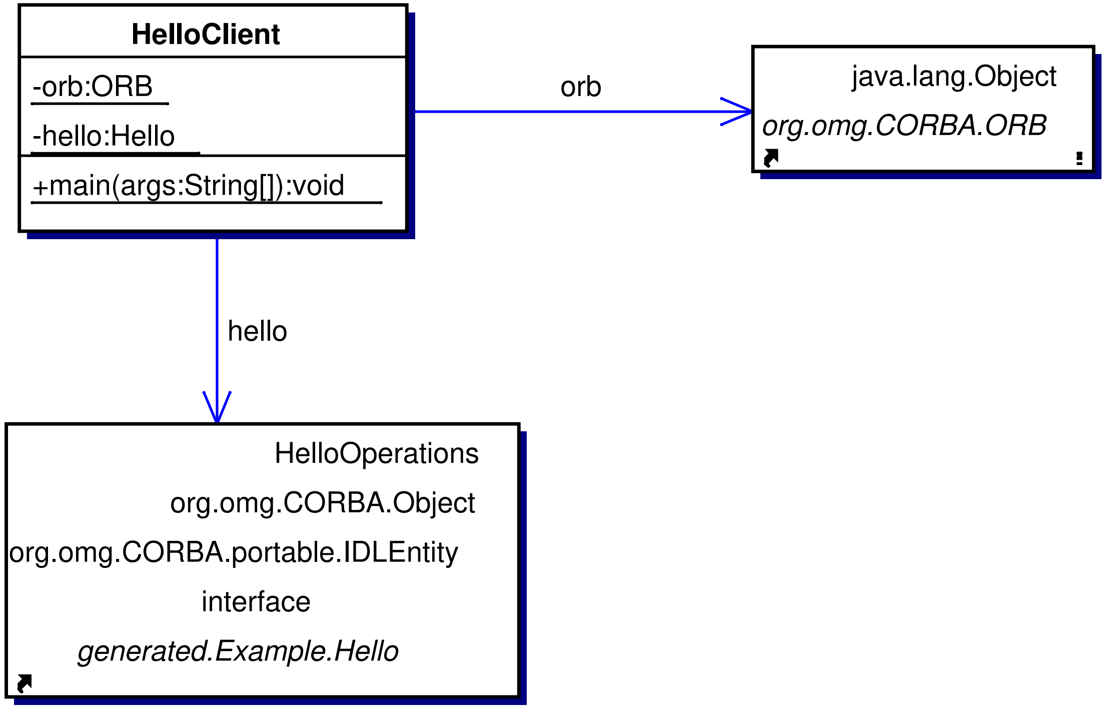
- IDL-Interface

```
// 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

- 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
```

8 Hello World Client – Generated Classes