Date: August 2012

C++11 Language Mapping

FTF - Beta 2

OMG Document Number: ptc/2012-07-12
Standard document URL: http://www.omg.org/spec/CPP11/

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Preface

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OMG

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Times/Times New Roman - 10 pt.: Standard body text

Helvetica/Arial - 10 pt. Bold: OMG Interface Definition Language (OMG IDL) and syntax elements.

`Courier - 10 pt. Bold:` Programming language elements.

Helvetica/Arial - 10 pt: Exceptions

Note – Terms that appear in *italics* are defined in the glossary. Italic text also represents the name of a document, specification, or other publication.

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1 Scope

The IDL Language Mapping specifications contain language mapping information for several languages. Each language is described in a separate stand-alone volume. This particular specification explains how OMG IDL constructs are mapped to the constructs of the C++11 programming language.

2 Conformance

The C++11 mapping tries to avoid limiting the implementation freedoms of ORB developers. For each OMG IDL construct, the C++11 mapping explains the syntax and semantics of using the construct from C++11. A client or server program conforms to this mapping (is C++11 compliant) if it uses the constructs as described in the C++11 mapping chapters.

2.1 C++ Implementation Requirements

The mapping proposed here assumes that the target C++11 environment supports all the features described in C++11 as specified by the ISO/IEC 14822:2011 C++

2.2 No Implementation Descriptions

This mapping does not contain implementation descriptions. It avoids details that would constrain implementations. Some examples show possible implementations, but these are not required implementations.

3 Normative References

The following normative documents contain provisions which, through reference in this text, constitute provisions of this specification. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply.

- OMG CORBA 3.2 Part 1 Interfaces specification (formal/2011-11-01): http://www.omg.org/spec/CORBA/3.2/

4 Symbols (and abbreviated terms)

List of symbols/abbreviations.

- ORB - Object Request Broker
- CORBA - Common Object Request Broker Architecture

5 Additional Information

5.1 Changes to Adopted OMG Specifications

None in this specification.

5.2 Acknowledgements

The following companies submitted this revised submission to the Object Management Group:

- Remedy IT

6 C++11 Language Mapping Specification

6.1 Anonymous IDL types

Anonymous IDL types are deprecated by the IDL specification and are not supported in the IDL to C++11 language mapping specification. The IDL compiler that implements this mapping must throw an error when it detects an anonymous type.

6.2 Scoped Names

Scoped names in OMG IDL are specified by C++ scopes. These mappings allow the corresponding mechanisms in OMG IDL and C++11 to be used to build scoped names. For instance:

```
// IDL
module M
{
    struct E {
        long L;
    };
};
```

is mapped into:

```
// C++
namespace M
{
   class E final {
   public:
      void L (int32_t _L);
      int32_t L () const;
      int32_t& L();
      // Other methods not shown
   };
};
```

and **E** can be referred outside of **M** as **M::E**. Alternatively, a C++ **using** statement for namespace **M** can be used so that **E** can be referred to simply as **E**:

```
// C++
using namespace M;
E e;
e.L (3);
```

Another alternative is to employ a **using** statement only for **M::E**:

```
// C++
using M::E;
```

```
E e;
e.L (3);
```

To avoid C++ compilation problems, every use in OMG IDL of a C++11 keyword as an identifier is mapped into the same name preceded by the prefix "_cxx_". For example, an IDL interface named "try" would be named "_cxx_try" when its name is mapped into C++11. For consistency, this rule also applies to identifiers that are derived from IDL identifiers. The complete list of C++11 keywords can be found in "C++11 Keywords" on page 50.

6.3 C++ Type Size Requirements

The sizes of the C++ types used to represent OMG IDL types are implementation-dependent. That is, this mapping makes no requirements as to the **`sizeof(T)`** for anything except basic types (see "Mapping for Basic Data Types" on page 6).

6.4 Mapping for Modules

As shown in "Scoped Names" on page 5, a module defines a scope, and as such is mapped to a C++ **`namespace`** with the same name:

```
// IDL
module M
{
    // definitions
};

// C++
namespace M
{
   // definitions
};
```

6.5 Mapping for Basic Data Types

The basic data types have the mappings shown in Table 6.1.

Table 6.1 - Basic Data Type Mappings

OMG IDL	C++	Default value
short	int16_t	0
long	int32_t	0
long long	int64_t	0
unsigned short	uint16_t	0
unsigned long	uint32_t	0
unsigned long long	uint64_t	0
float	float	0.0
double	double	0.0
long double	long double	0.0
char	char	0

Table 6.1 - **Basic Data Type Mappings** ***(Continued)***

OMG IDL	C++	Default value
wchar	wchar_t	0
boolean	bool	false
octet	uint8_t	0

Each OMG IDL basic type is mapped to a basic C++11 type.

6.6 Mapping for Interfaces

An interface is mapped to a C++ class that gives access to the types, constants, operations, and exceptions defined in the interface. This example shows the behavior of the mapping of an interface:

```
// IDL
interface A
{
    struct S { short field; };
    void op (in S data);
};

// C++
// Conformant uses
A::S s; // declare a struct variable
s.field(3); // field access
IDL::traits<A>::ref_type p (...); // ...somehow obtain an objref...
p->op (s);
```

6.6.1 Reference Types

Several OMG IDL types are mapped to so called reference types. A reference points to a valid object or a nil object. The reference types are available as final C++ templates directly or through their related type traits. Strong reference types are available as **`ref_type`** trait and have the semantics of a **`std::shared_ptr`**. The reference must have a protected destructor preventing the user to directly delete an object reference instead of using the **`std::shared_ptr`** semantics. It is illegal for compliant application code to create specializations of the reference types.

Related to the strong reference type a weak reference trait **`weak_ref_type`** has to be delivered which must behave as a **`std::weak_ptr`**. From a strong reference a weak reference can be obtained using the **`weak_reference()`** operation. This weak reference must be convertable to a regular reference using the **`lock()`** operation.

Conversions of references to **`void*`**, assigning pointers to references, retrieving pointers from references, arithmetic operations, and relational operations, including test for equality, are all non-compliant. It is allowed to compare a reference with the C++11 keyword **`nullptr`** or to use it through a **`bool`** conversion operator. Any other comparison should lead to a compile error.

A reference can only be created from a **`nullptr`**, another reference, or using the **`CORBA::make_reference<>`** template which must deliver **`std::make_shared`** semantics using perfect forwarding. Any other creation of a reference type is not allowed and should lead to a compile error. Declaring a reference and initializing it with its default constructor will result in a nil reference.

The strong and weak reference types are grouped together into a reference type trait. The strong and weak reference types also provide this trait as their **`traits_type`** traits

For all reference types a specialization of **`std::swap<>`** must be provided to exchange the values of two references in an efficient matter.

6.6.2 Object Reference Types

The use of an interface type in OMG IDL denotes an object reference that has the semantics as described in “Reference Types” on page 7. For an interface **A**, the reference type trait **`IDL::traits<A>`** is available. Its strong reference type is known as the **`IDL::traits<A>::ref_type`** trait (aka **`A::_ref_type`** trait). The object reference type trait itself is also known as **`IDL::traits<A>::traits_type`** (aka **`A::_traits_type`**).

An operation can be performed on an object reference by using an arrow (“**`->`**”) on the reference. For example, if an interface defines an operation **`op`** with no parameters and **`obj`** is a reference to the interface type, then a call would be written **`obj->op()`**.

The weak object reference has to be available as **`IDL::traits<A>::weak_ref_type`** (aka **`A::_weak_ref_type`**).

```
// C++
IDL::traits<A>::ref_type a;
IDL::traits<A>::ref_type p (...); // ...somehow obtain an objref...
a = p;
IDL::traits<A>::weak_ref_type w = a.weak_reference();
if (p == nullptr) // legal comparison
if (p != nullptr ) // legal comparison
if (p) // legal usage, true if p != nullptr
if (!p)  // legal usage, true if p == nullptr
if (p == 0) // illegal comparison, should result in a compile error
if (p != 0) // illegal comparison, should result in a compile error
if (a == p) // illegal comparison, should result in a compile error
if (a != p) // illegal comparison, should result in a compile error
delete a; // illegal delete, should result in a compile error
```

6.6.3 Widening Object References

OMG IDL interface inheritance does not require that the corresponding C++ classes are related, though that is certainly one possible implementation. However, if interface B inherits from interface A, the following implicit widening operations for B must be supported by a compliant implementation:

- **`B`** to **`A`**
- **`B`** to **`Object`**

```
// C++
IDL::traits<B>::ref_type bp = ...
IDL::traits<A>::ref_type ap = bp; // implicit widening
IDL::traits<Object>::ref_type objp = bp; // implicit widening
objp = ap; // implicit widening
```

6.6.4 Object Reference Operations

Conceptually, the **Object** class in the **CORBA** module is the base interface type for all objects; therefore, any object reference can be widened to the type **`IDL::traits<Object>::ref_type`**.

6.6.5 Nil Object Reference

The mapping defines that a nil object reference is defined by **`nullptr`**. For any nil object reference A, the following call is guaranteed to return **`true`**:

```
// C++
bool true_result = (A == nullptr);
```

Any attempt to invoke an operation through a nil object reference should result in an INV_OBJREF exception.

6.6.6 Narrowing Object References

The object traits for type T define the method **`IDL::traits<T>::narrow`** (aka **`T::_narrow`**) to narrow an object reference. These methods return a new object reference given an existing reference. The narrow methods returns a nil object reference if the given reference is nil. The parameter to the narrow methods accepts a reference of an object of any interface type (**`IDL::traits<Object>::ref_type`**). If the actual (runtime) type of the parameter object can be narrowed to the requested interface's type, then the operation will return a valid object reference; otherwise, the operation will return a nil object reference. For example, suppose A, B, C, and D are interface types, and D inherits from C, which inherits from B, which in turn inherits from A. If an object reference to a C object is widened to an **`A`** variable called **`ap`**, then:

- **`IDL::traits<A>::narrow(ap)`** returns a valid object reference
- **`IDL::traits<B>::narrow(ap)`** returns a valid object reference
- **`IDL::traits<C>::narrow(ap)`** returns a valid object reference
- **`IDL::traits<D>::narrow(ap)`** returns a nil object reference

Narrowing to A, B, and C all succeed because the object supports all those interfaces. The **`IDL::traits<D>::narrow`** returns a nil object reference because the object does not support the D interface.

For another example, suppose A, B, C, and D are interface types. C inherits from B, and both B and D inherit from A. Now suppose that an object of type C is passed to a function as an A. If the function calls **`IDL::traits<B>::narrow`** or **`IDL::traits<C>::narrow`**, a new object reference will be returned. A call to **`IDL::traits<D>::narrow`** will return a nil reference.

If successful, the narrow methods creates a new object reference and does not change the given object reference. The narrow operations can throw system exceptions.

6.6.7 Mapping for Operations and Attributes

An operation maps to a non-const virtual C++ function with the same name as the operation. Each read-write attribute maps to a pair of overloaded C++ virtual functions (both with the same name), one to set the attribute's value and one to get the attribute's value. The *set* function takes an **in** parameter with the same type as the attribute, while the *get* function takes no parameters and returns the same type as the attribute. An attribute marked "**readonly"** maps to only one C++ function, to get the attribute's value. Parameters and return types for attribute functions obey the same parameter passing rules as for regular operations.

OMG IDL **oneway** operations are mapped the same as other operations with a return type of **void**; that is, there is no way to know by looking at the C++ signature whether an operation is **oneway** or not.

Operation and attribute signatures do not have exception specifications.

```
// IDL
interface A
{
    void f();
    oneway void g();
    attribute long x;
};

// C++
IDL::traits<A>::ref_type a (...); // retrieve the reference from somewhere
a->f();
a->g();
int32_t const n = a->x();
a->x(n + 1);
```

6.6.8 Argument Passing Considerations

The mapping of parameter passing modes is focused at simplicity and ease of use. For all primitive types, enums, and reference types, an **in** argument **A** of type **P**, that argument is passed as **P**. For all other types an **in** argument **A** of type **P** is passed as **const P&**. For an **inout** and **out** argument it is passed as **P&**. If we return a type of **P**, it is returned as **P**.

The following examples demonstrate the compliant behavior:

```
// IDL
struct S { string name; float age; };
interface A {
  void f(out S p);
};

// C++
IDL::traits<A>::ref_type ARef = ... // Retrieve object reference
S s;
ARef->f(s);
// use s
ARef->f(s); // first result will be overwritten
```

```
// IDL
interface B {
    void a(out string s);
    void b(in string s);
    void c(inout string s);
};

// C++
IDL::traits<B>::ref_type BRef (...); // Retrieve object reference
std::string s;
for (int8_t i = 0; i < 10; i++)
{
   BRef->a(s);
   BRef->b(s);
   BRef->c(s);
}
```

6.7 Mapping for Constants

OMG IDL constants are mapped directly to a C++11 constant definitions.

```
// IDL
const string name = "testing";

interface A
{
    const float pi = 3.14159;
};

// C++
const std::string name = "testing";

class A
{
   public:
      static constexpr float pi = 3.14159;
};
```

The mappings for wide character and wide string constants is identical to character and string constants, except that IDL literals are preceded by `L` in C++. For example, IDL constant:

const wstring ws = “Hello World”;

would map to

```
const std::wstring ws = L″Hello World″;
```

in C++11.

6.8 Mapping for Enums

An OMG IDL **enum** maps directly to the corresponding C++11 type definition. When an enum is used in a structured type, its default value is the first enum value specified.

```
// IDL
enum Color { red, green, blue };

// C++
enum class Color : uint32_t { red, green, blue };
```

6.9 Mapping for String Types

The OMG IDL string type, whether bounded or unbounded, is mapped to **`std::string`**.

C++11 does not have a built-in type that would provide a “close match” for IDL-bounded strings. As a result, the programmer is responsible for enforcing the bound of bounded strings at run time. Implementations of the mapping are under no obligation to prevent assignment of a string value to a bounded string type if the string value exceeds the bound. Implementations must (at run time) detect attempts to pass a string value that exceeds the bound as a parameter across an interface. It must raise a BAD_PARAM system exception to signal the error.

6.10 Mapping for Wide String Types

Both bounded and unbounded wide string types are mapped to **`std::wstring`** in C++11.

C++11 does not have a built-in type that would provide a “close match” for IDL-bounded wstrings. As a result, the programmer is responsible for enforcing the bound of bounded wstrings at run time. Implementations of the mapping are under no obligation to prevent assignment of a string value to a bounded wstring type if the wstring value exceeds the bound. Implementations must (at run time) detect attempts to pass a wstring value that exceeds the bound as a parameter across an interface. It must raise a BAD_PARAM system exception to signal the error.

6.11 Mapping for Sequence Types

A sequence is mapped to a **`C++ std::vector`**. C++11 does not have a built-in type that would provide a “close match” for IDL-bounded sequence. As a result, the programmer is responsible for enforcing the bound of bounded sequences at run time. Implementations of the mapping are under no obligation to prevent assignment of a sequence to a bounded sequence type if the sequence exceeds the bound. Implementations must at run time detect attempts to pass a sequence that exceeds the bound as a parameter across an interface. When an implementation detects this error, it must raise a BAD_PARAM system exception to signal the error.

Additionally the C++ **`std::vector`** can have a size that is larger than a maximum size of a IDL sequence that is limited in length to the maximum of **`ULong`**. When this happens the implementation must raise a BAD_PARAM system exception to signal the error.

```
// IDL
typedef sequence<long> LongSeq;
typedef sequence<LongSeq, 3> LongSeqSeq;
```

```
// C++
typedef std::vector <int32_t> LongSeq;
typedef std::vector <LongSeq> LongSeqSeq;
```

The example below shows full declarations for both a bounded and an unbounded sequence.

```
// IDL
typedef sequence<T> V1;          // unbounded sequence
typedef sequence<T, 2> V2;       // bounded sequence
typedef sequence<V1> V3;         // sequence of sequences
```

```
// C++
typedef std::vector <T> V1;
typedef std::vector <T> V2;
typedef std::vector <V1> V3;
```

6.12 Mapping for Array Types

Arrays are mapped to the corresponding C++ **`std::array<>`** definition, which allows the definition of statically-initialized data using the array.

```
// IDL
typedef float F[10];
typedef string V[10];
typedef string M[1][2][3];
interface Foo
{
    void op(out F p1, out V p2, out M p3);
}
```

```
// C++
typedef std::array <float, 10> F;
typedef std::array <std::string, 10> V;
typedef std::array <std::array <std::array <std::string, 3>, 2>, 1> M;
F f1; F f2;
V v1; V v2;
M m1; M m2;
IDL::traits<Foo>::ref_type ref (..); // obtain an object reference
ref->op(f2, v2, m2);
f1[0] = f2[1];
v1[1] = v2[1];
m1[0][1][2] = m2[0][1][2];
```

6.13 Mapping for Structured Types

The mapping for structured types is a final C++ class with a default constructor, a copy constructor, a move constructor, an assignment copy operator, an assignment move operator, and a destructor. The default constructor initializes object reference members to appropriately-typed nil object references, basic datatypes to their default value as listed in Table 6.1, and enums to their first value. All other members are initialized using their default constructors. The copy constructor performs a deep-copy from the existing structure to create a new structure. The move constructor moves all

arguments to their members. The copy assignment operator performs a deep-copy to create a new structure with strong exception safety, the move assignment operator performs a move of all members to the existing structure with strong exception safety. The destructor releases all members.

For each member a set of accessors must be provided. If we have a member **A** of type **T** in case **T** is a:

- short, long, long long, unsigned short, unsigned long, unsigned long long, float, double, long double, char, wchar, boolean, octet
- Enumeration
- Object reference (**`IDL::traits<T>::ref_type`**)
- Valuetype reference (**`IDL::traits<T>::ref_type`**)
- Typecode reference (**`IDL::traits<CORBA::TypeCode>::ref_type`**)
- Abstract base reference (**`IDL::traits<T>::ref_type`**)

The following set of accessors must be provided:

```
void A (T);
T A (void) const;
T& A (void);
```

In all other cases the following set of accessors has to be provided for **T**.

```
void A (const T&);
void A (T&&);
const T& A (void) const;
T& A (void);
```

First an accessor to set the value which accepts a const T&. Secondly an accessor that performs a move by accepting T&&. Thirdly an accessor that returns the member as const T& and as last an accessor that provides write access by returning the member as T&.

```
// IDL
struct S {
    string name;
    float age;
};
interface Foo {
    void f(out S p);
};

// C++
IDL::traits<Foo>::ref_type f_ref (...); // obtain a reference
S b;
f_ref->f(b);
S a = b; // deep-copy
cout << "names " << a.name() << ", " << b.name() << endl;
```

6.13.1 Mapping for Struct Types

An OMG IDL struct maps to a final C++ class, with each OMG IDL struct member mapped to a set of corresponding member methods. Additionally to the methods as described in “Mapping for Structured Types” on page 13 an explicit constructor accepting values for struct each member by value in the order they are specified in IDL.

The following examples illustrate usage of a struct, using the following OMG IDL definition:

```
// IDL
struct Variable {
    string name;
};
```

```
// C++
class Variable final
{
public:
   Variable (void);
   ~Variable (void);
   Variable (const Variable&);
   Variable (Variable&&);
   Variable& operator= (const Variable& x);
   Variable& operator= (Variable&& x);
   explicit Variable (std::string name);

   void name (const std::string& _name);
   void name (std::string&& _name);
   const std::string& name (void) const;
   std::string& name (void);
};

namespace std {
  template <>
  void swap (Variable& m1, Variable& m2);
};
```

A specialization of **`std::swap<>`** must be provided to exchange the values of two structs in an efficient matter.

6.13.2 Mapping for Union Types

A union maps to a final C++ class with accessor functions for the union members and discriminant. For each member a set of accessors must be provided as described in “Mapping for Structured Types” on page 13.

The default union constructor initializes the union. If there is a default case specified, the union is initialized to this default case. In case the union has an implicit default member it is initialized to that case. In all other cases it is initialized as empty. Assigning, copying, moving, and the destruction of default-constructed unions are safe. Assignment from or copying a default-constructed union results in the target of the assignment or copy being initialized the same as a default-constructed union.The copy constructor and copy assignment operator perform a deep-copy of their parameters. The move constructor and move assignment operator perform a move of their parameters. The destructor releases all storage owned by the union.

The union discriminant accessor and modifier functions have the name **_d** to both be brief and to avoid name conflicts with the union members. The **_d** discriminator modifier can only be used to set the discriminant to a value within the same union member. In addition to the **_d** accessor and modifier, a union with an implicit default member provides a **_default()** modifier function that sets the discriminant to a legal default value. A union has an implicit default member if it does not have a default case and not all permissible values of the union discriminant are listed. Assigning, copying, moving, and the destruction of a union immediately after calling **_default()** are safe. Assignment from or copying of such a union results in the target of the assignment or copy having the same safe state as it would if its **_default()** function were invoked.

Setting the union value through a modifier function automatically sets the discriminant and may release the storage associated with the previous value with strong exception safety. Attempting to get a value through an accessor that does not match the current discriminant results in a BAD_PARAM exception. If a modifier for a union member with multiple legal discriminant values is used to set the value of the discriminant, the union implementation will take the first discriminant specified in IDL. Calling a referent for a member that does not match the current discriminant results in a BAD_PARAM exception. The following example helps illustrate the mapping for union types:

```
// IDL
struct S { long len; };
interface A;
union U switch (long) {
    case 1: long x;
    case 2: string z;
    case 3:
    case 4: S w;
    default: A obj;
};

// C++
class S final { ... };
class U final
{
public:
   U();
   U(const U&);
   U(U&&)
   ~U();
   U &operator=(const U&);
   U &operator=(U&&);

   void _d(int32_t);
   int32_t _d() const;

   void x(inst32_t);
   int32_t x() const;
   int32_t& x();

   void z(const std::string&);
   void z(std::string&&);
   const std::string& () z const;
   std::string& z();
```

```
    void w(const S &);
    void w(S &&);
    const S &w() const;
    S &w();

    void obj(IDL::traits<A>::ref_type);
    IDL::traits<A>::ref_type obj() const;
    IDL::traits<A>::ref_type& obj();
};

namespace std {
  template <>
  void swap (U& m1, U& m2);
};
```

Accessor and modifier functions for union members provide semantics similar to that of struct data members. Modifier functions perform the equivalent of a deep-copy or move of their parameters. Referents can be used for read-write access.

The reference returned from a reference function continues to denote that member only for as long as the member is active. If the active member of the union is subsequently changed, the reference becomes invalid, and attempts to read or write the member via the reference result in undefined behavior.

The restrictions for using the **_d** discriminator modifier function are shown by the following examples, based on the definition of the union **U** shown above:

```
// C++
S s = {10};
U u;
u.w(s);         // member w selected
u._d(3);        // OK, member w selected
u._d(4);        // OK, member w selected
u._d(1);        // error, different member selected, results in BAD_PARAM
A a = ...;
u.obj(a);       // member obj selected
u._d(7);        // OK, member obj selected
u._d(1);        // error, different member selected, results in BAD_PARAM
s = u.w();      // error, member w not active, results in BAD_PARAM
```

As shown here, neither the **_d** modifier function nor the **w** referent can be used to implicitly switch between different union members. The following shows an example of how the **_default()** member function is used:

```
// IDL
union Z switch(boolean) {
        case TRUE: short s;
};

// C++
Z z;
z._default();           // implicit default member selected
bool disc = z._d();     // disc == false
```

```
U u;                    // union U from previous example
u._default();           // error, no _default() provided
```

For union **Z**, calling the **_default()** modifier function causes the union's value to be composed solely of the discriminator value of **false**, since there is no explicit default member. For union **U**, calling **_default()** causes a compilation error because **U** has an explicitly declared default case and thus no **_default()** member function. A **_default()** member function is only generated for unions with implicit default members.

A specialization of **std::swap<>** must be provided to exchange the values of two unions in an efficient matter.

6.14 Mapping for Fixed Types

The C++11 mapping for fixed is defined by the following C++ template in the **IDL** namespace:

```
// C++
template <uint16_t digits, uint16_t scale>
class Fixed final
{
public:
   // Constructors
   explicit Fixed(int16_t = 0);
   explicit Fixed(uint16_t);
   explicit Fixed(int32_t);
   explicit Fixed(uint32_t);
   explicit Fixed(int64_t);
   explicit Fixed(uint64_t);
   explicit Fixed(double);
   explicit Fixed(long double);
   explicit Fixed(const std::string&);
   Fixed(const Fixed&);
   Fixed(Fixed&& val);
   ~Fixed();

   // Conversions
   operator int64_t () const;
   operator long double() const;
   Fixed round(uint16_t) const;
   Fixed truncate(uint16_t) const;
   std::string to_string() const;

   // Operators
   Fixed& operator=(const Fixed&);
   Fixed& operator=(Fixed&&);
   Fixed& operator+=(const Fixed&);
   Fixed& operator-=(const Fixed&);
   Fixed& operator*=(const Fixed&);
   Fixed& operator/=(const Fixed&);
   Fixed& operator++();
   Fixed operator++(int);
   Fixed& operator--();
   Fixed operator--(int);
```

```
    Fixed operator+() const;
    Fixed operator-() const;
    bool operator!() const;

    // Other member functions
    uint16_t fixed_digits() const;
    uint16_t fixed_scale() const;
};
```

The **Fixed** template is never used directly by the user. The C++ mapping will create a C++ template instantiation for each typedef of fixed. Here is an example of the mapping:

```
// IDL
typedef fixed<5,2>F;
interface A
{
    void op(in F arg);
};

// C++
typedef IDL::Fixed<5,2> F;
class A
{
public:
    ...
    virtual void op(const F& arg);
    ...
};
```

The **Fixed** template has a number of constructors to guarantee that a fixed value can be constructed from any of the IDL standard integer and floating point types. The **Fixed(std::string&)** constructor and **Fixed operator " "** converts a string representation of a fixed-point literal, with an optional leading sign (+ or -) into a real fixed-point value. The **Fixed** template also provides conversion operators back to the **int64_t** and **long double** types. For conversion to integral types, digits to the right of the decimal point are truncated. If the magnitude of the fixed-point value does not fit in the target conversion type, then the DATA_CONVERSION system exception is thrown.

The **round** and **truncate** functions convert a fixed value to a new value with the specified scale. If the new scale requires the value to lose precision on the right, the **round** function will round away from zero values that are halfway or more to the next absolute value for the new fixed precision. The **truncate** function always truncates the value towards zero. If the value currently has fewer digits on the right than the new scale, **round** and **truncate** return the argument unmodified. For example:

```
// C++
F f1 = 0.1_fixed;
F f2 = 0.05_fixed;
F f3 = -0.005_fixed;
```

In this example, **f1.round(0)** and **f1.truncate(0)** both return 0, **f2.round(1)** returns 0.1, **f2.truncate(1)** returns 0.0, **f3.round(2)** returns -0.01 and **f3.truncate(2)** returns 0.00.

`to_string()` converts a fixed value to a string. Leading zeros are dropped, but trailing fractional zeros are preserved. (For example, a **fixed<4,2>** with the value 1.1 is converted "1.10"). The **`fixed_digits`** and **`fixed_scale`** functions return the smallest digits and scale value that can hold the complete fixed-point value.

Arithmetic operations on the **`Fixed`** template must calculate the result exactly, using an effective double precision (62 digit) temporary value. The results are then truncated at run time to fit in a maximum of 31 digits using the method defined in version 3.2 of the *Common Object Request Broker Architecture (CORBA)*, *OMG IDL Syntax and Semantics* clause, Semantics sub clause to determine the new digits and scale. If the result of any arithmetic operation produces more than 31 digits to the left of the decimal point, the DATA_CONVERSION exception will be thrown. If a fixed-point value, used as an actual operation parameter or assigned to a member of an IDL structured datatype, exceeds the maximum absolute value implied by the digits and scale, the DATA_CONVERSION exception will be thrown.

6.15 Mapping for Typedefs

A typedef creates an alias for a type. The example below illustrates the mapping.

```
// IDL
typedef long T;
interface A1;
typedef A1 A2;
typedef sequence<long> S1;
typedef S1 S2;

// C++
typedef int32_t T;
// ...definitions for A1...

typedef A1 A2;

// ...definitions for S1...
typedef std::vector <int32_t> S1;

typedef S1 S2;
```

6.16 Mapping for the Any Type

The IDL **any** type is mapped to the **`CORBA::Any`** class. A C++ mapping for the OMG IDL type **any** must fulfill two different requirements:

- Handling C++ types in a type-safe manner.
- Handling values whose types are not known at compile time.

The first item covers most normal usage of the **any** type—the conversion of typed values into and out of an **any**. The second item covers situations such as those involving the reception of a request or response containing an **any** that holds data of a type unknown to the receiver when it was created with a C++ compiler.

6.16.1 Handling Typed Values

To decrease the chances of creating an **any** with a mismatched **TypeCode** and value, the C++ function overloading facility is utilized. Specifically, for each distinct type in an OMG IDL specification, overloaded functions to insert and extract values of that type have to be provided. Overloaded operators are used for these functions so as to completely avoid any name space pollution. The nature of these functions, which are described in detail below, is that the appropriate **TypeCode** (see "TypeCode" on page 38) is implied by the C++ type of the value being inserted into or extracted from the **any**.

Since the type-safe **any** interface described below is based upon C++ function overloading, it requires C++ types generated from OMG IDL specifications to be distinct.

6.16.2 Insertion into an any

To allow a value to be set in an **any** in a type-safe fashion, an implementation must provide the following overloaded operator function for each separate OMG IDL type **T**.

```
// C++
void operator<<=(Any&, T);
```

This function signature suffices for types that are normally passed by value:

- short, long, long long, unsigned short, unsigned long, unsigned long long, float, double, long double, char, wchar, boolean, octet
- Enumeration
- Object reference (**IDL::traits<T>::ref_type**)
- Valuetype reference (**IDL::traits<T>::ref_type**)
- Typecode reference (**IDL::traits<CORBA::TypeCode>::ref_type**)
- Abstract base reference (**IDL::traits<T>::ref_type**)

For values of type **T** that are too large to be passed by value efficiently, such as array, string, wstring, struct, union, sequence, **Any**, and exception, the following functions are provided.

```
// C++
void operator<<=(CORBA::Any&, const T&);  // copying insert
void operator<<=(CORBA::Any&, T&&);       // move insert
```

These "left-shift-assign" operators are used to insert a typed value into an **any** as follows.

```
// C++
int32_t value = 42;
Any a;
a <<= value;
```

In this case, the version of **operator<<=** overloaded for type **int32_t** must be able to set both the value and the **TypeCode** properly for the **any** variable.

6.16.3 Extraction from any

To allow type-safe retrieval of a value from an **any**, the mapping provides the following operators for each OMG IDL type **T**:

```
// C++
bool operator>>=(const CORBA::Any&, T&);
```

This "right-shift-assign" operator is used to extract a typed value from an **any** as follows:

```
// C++
int32_t value;
CORBA::Any a;
a <<= int32_t(42);
if (a >>= value) {
// ... use the value ...
}
```

In this case, the version of **operator>>=** for type **int32_t** must be able to determine whether the **Any** truly does contain a value of type **int32_t** and, if so, copy its value into the reference variable provided by the caller and return **true**. If the **Any** does not contain a value of type **int32_t**, the value of the caller's reference variable is not changed, and **operator>>=** returns **false**.

For example, consider the following IDL struct:

```
// IDL
struct MyStruct {
    long lmem;
    short smem;
};
```

Such a struct could be extracted from an **any** as follows:

```
// C++
Any a;
// ... a is somehow given a value of type MyStruct ...
MyStruct struct;
if (a >>= struct) {
// ... use the value ...
}
```

If the extraction is successful the caller variable will contain the value that was stored by the **any**, and **operator>>=** will return **true**. If the extraction is not successful, the **operator>>=** returns **false**.

For strings, wide strings, and sequences, applications are responsible for checking the **TypeCode** of the **any** to be sure that they do not overstep the bounds of the sequence, string, or wide string object when using the extracted value.

6.16.4 TypeCode Replacement

The **type** accessor function returns a **TypeCode** reference to the **TypeCode** associated with the **Any**.

```
IDL::traits<CORBA::TypeCode>::ref_type type() const;
```

Because C++ **typedef**s are only aliases and do not define distinct types, inserting a type with a **tk_alias TypeCode** into an **Any** while preserving that **TypeCode** is not possible. For example:

// IDL
typedef long LongType;

```
// C++
Any any;
LongType val = 1234;
any <<= val;
IDL::traits<CORBA::TypeCode>::ref_type tc = any.type();
assert(tc->kind() == tk_alias);     // assertion failure!
assert(tc->kind() == tk_long);      // assertion OK
```

In this code, the **LongType** is an alias for **int32_t**. Therefore, when the value is inserted, standard C++ overloading mechanisms cause the insertion operator for **int32_t** to be invoked. In fact, because **LongType** is an alias for **int32_t**, an overloaded **operator<<=** for **LongType** cannot be generated anyway.

In cases where the **TypeCode** in the **Any** must be preserved as a **tk_alias TypeCode**, the application can use the **type** modifier function on the **Any** to replace its **TypeCode** with an equivalent one.

```
void type(IDL::traits<CORBA::TypeCode>::ref_type);
```

Revising the previous example:

```
// C++
Any any;
LongType val = 1234;
any <<= val;
any.type(_tc_LongType);             // replace TypeCode
IDL::traits<CORBA::TypeCode>::ref_type tc = any.type();
assert(tc->kind() == tk_alias);     // assertion OK
```

The **type** modifier function invokes the **TypeCode::equivalent** operation on the **TypeCode** in the target **Any**, passing the **TypeCode** it received as an argument. If **TypeCode::equivalent** returns true, the **type** modifier function replaces the original **TypeCode** in the **Any** with its argument **TypeCode**. If the two **TypeCode**s are not equivalent, the **type** modifier function raises the BAD_TYPECODE exception.

6.17 Mapping for Valuetypes

The IDL **valuetype** has features that make its C++11 mapping unlike that of any other IDL type. Specifically, from an application perspective all other IDL types comprise either pure state or pure interface, but a **valuetype** may include both.

An IDL **valuetype** is mapped to the C++ trait **IDL::traits<>::base_type**. This trait relates to an abstract base class (ABC), with pure virtual accessor and modifier functions corresponding to the state members of the **valuetype**, and pure virtual functions corresponding to the operations of the **valuetype**.

The C++ **IDL::traits<>::obv_type** trait is provided for referring to the OBV class that provides default implementations for the accessors and modifiers of the ABC base class. The application developer then overrides the pure virtual functions corresponding to **valuetype** operations in a concrete class derived directly or indirectly from the **OBV** trait.

In C++11 **valuetypes** map to so called valuetype references that behave as reference type as described in "Reference Types" on page 7. The reference type trait **IDL::traits<>** is available for each valuetype. The strong reference is delivered as **IDL::traits<>::ref_type** trait and the weak reference as **IDL::traits<>::weak_ref_type** trait.

All **init** initializers declared for a **valuetype** are mapped to pure virtual functions on a separate abstract C++ factory class. This class is available through the **IDL::traits<>::factory_type** trait.

6.17.1 Valuetype Data Members

The C++ mapping for **valuetype** data members follows the same rules as the C++ mapping for structured types as described in "Mapping for Structured Types" on page 13, except that the accessors and modifiers are pure virtual. Public state members are mapped to public pure virtual accessor and modifier functions of the C++ **valuetype** base class, and private state members are mapped to protected pure virtual accessor and modifier functions (so that derived concrete classes may access them). The actual data members of the OBV classes will be declared private.

For example:

```
// IDL
typedef octet Bytes[64];
struct S { ... };
interface A { ... };

valuetype Val {
    public Val t;
    private long v;
    public Bytes w;
    public string x;
    private S y;
    private A z;
};
```

```
// C++
typedef std::array <uint8_t, 64> Bytes;
class S final {
public:
  ...
};
class Val : public virtual ValueBase {
   public:
      ...
      virtual IDL::traits <Val>::ref_type t() const = 0;
      virtual IDL::traits <Val>::ref_type& t() = 0;
      virtual void t(IDL::traits <Val>::ref_type) = 0;

      virtual const Bytes& w() const = 0;
```

```
      virtual Bytes& w() = 0;
      virtual void w(const Bytes&) = 0;
      virtual void w(Bytes&&) = 0;

      virtual const std::string& x() const = 0;
      virtual std::string& x() = 0;
      virtual void x(const std::string&) = 0;
      virtual void x(std::string&&) = 0;

   protected:
      virtual int32_t v() const = 0;
      virtual int32_t& v() = 0;
      virtual void v(int32_t) = 0;

      virtual const S& y() const = 0;
      virtual S& y() = 0;
      virtual void y(S&&) = 0;
      virtual void y(const S&) = 0;

      virtual IDL::traits<A>::ref_type z() const = 0;
      virtual IDL::traits<A>::ref_type& z() = 0;
      virtual void z(IDL::traits<A>::ref_type) = 0;
      ...
};
```

These rules for the accessors correspond directly to the parameter passing rules for structured types as explained in “Mapping for Structured Types” on page 13.

6.17.2 Constructors, Assignment Operators, and Destructors

A C++ **`valuetype`** class defines a protected default constructor, protected copy constructor, protected move constructor, and a protected virtual destructor. The default constructor is protected to allow only derived class instances to invoke it, while the destructor is protected to prevent applications from deleting value instances directly instead of using the reference type. The destructor is virtual to provide for proper destruction of derived value class instances.

For the same reasons, the generated OBV classes define a protected default constructor, protected copy constructor, protected move constructor, a protected explicit constructor that takes an initializer for each **`valuetype`** data member, and a protected destructor. The parameters of the explicit constructor that takes an initializer for each member appear in the same order as the data members appear, top to bottom, in the IDL **valuetype** definition, regardless of whether they are public or private. If the valuetype inherits from a concrete valuetype, then parameters for the data members of the inherited valuetype appear first. All parameters for the member initializer constructor are passed by value.

6.17.3 Valuetype Operations

Operations declared on a **valuetype** are mapped to public pure virtual member functions in the corresponding **`valuetype`** C++ class. (Note that state member accessor and modifier functions are *not* considered to be operations—they are always referred to as accessor and modifier functions.) None of the pure virtual member functions corresponding to operations shall be declared **`const`** because unlike C++, IDL provides no way to distinguish between operations that change the state of an object and those that merely access that state.

The C++ signatures and memory management rules for **valuetype** operations are identical to those described in "Argument Passing Considerations" on page 10 for client-side **interface** operations.

As part of the valuetype traits **IDL::traits<>::downcast** is provided. This method is also provided as a static **_downcast** function by each **valuetype** class. These methods provide a portable way for applications to cast down the C++ inheritance hierarchy. If a nil reference is passed to one of these operations, it returns a nil reference. Otherwise, if the **valuetype** instance referenced to by the argument is an instance of the **valuetype** class being downcast to, a reference to the downcast-to class type is returned. If the **valuetype** instance pointed to by the argument is *not* an instance of the **valuetype** class being downcast to, a nil reference is returned.

6.17.4 Valuetype Example

For example, consider the following IDL **valuetype**:

```
// IDL
valuetype Example {
    short op1();
    long op2(in Example x);
    private short val1;
    public long val2;
    private string val3;
    private Example val5;
};
```

The C++ mapping for this **valuetype** is:

```
// C++
class Example : public virtual ValueBase {
public:
   virtual int16_t op1() = 0;
   virtual int32_t op2(IDL::traits<Example>::ref_type) = 0;
   virtual int32_t val2() const = 0;
   virtual int32_t& val2() = );
   virtual void val2(int32_t) = 0;
   static IDL::traits<Example>::ref_type _downcast
      (IDL::traits<ValueBase>::ref_type);
protected:
   Example();
   Example (const Example&);
   Example (Example&&);
   virtual ~Example();
   virtual int16_t val1() const = 0;
   virtual int16_6& val1() = 0;
   virtual void val1(int16_t) = 0;
   virtual const std::string& val3() const = 0;
   virtual std::string& val3() = 0;
   virtual void val3(const std::string&) = 0;
   virtual void val3(std::string&&) = 0;
   virtual IDL::traits<Example>::ref_type val5() const = 0;
   virtual IDL::traits<Example>::ref_type& val5() = 0;
```

```
   virtual void val5(IDL::traits<Example>::ref_type) = 0;
private:
   Example& operator=(const Example&) = delete;
   Example& operator=(Example&&) = delete;
};

class OBV_Example : public virtual Example {
public:
   virtual void val2 (int32_t);
   virtual int32_t val2 (void) const;
   virtual int32_t& val2 (void);
protected:
   OBV_Example();
   Example (const Example&);
   Example (Example&&);
   explicit OBV_Example (int16_t, int32_t, std::string, IDL::traits
      <Example>::ref_type;
   virtual ~OBV_Example();
   virtual int16_t val1() const override;
   virtual int16_t& val1() override;
   virtual void val1(int16_t) override;
   virtual const std::string& val3() const override;
   virtual std::string& val3() override;
   virtual void val3(const std::string&) override;
   virtual void val3(std::string&&) override;
   virtual IDL::traits<Example>::ref_type val5() const override;
   virtual IDL::traits<Example>::ref_type& val5() override;
   virtual void val5(IDL::traits<Example>::ref_type) override;
   // ...
};
```

6.17.5 ValueBase default methods

The C++ mapping for the **ValueBase** IDL type serves as an abstract base class for all C++ **valuetype** classes. **ValueBase** provides several virtual functions inherited by all **valuetype** classes:

```
// C++
class ValueBase {
public:
   virtual IDL::traits<ValueBase>::ref_type _copy_value();
   static IDL::traits<ValueBase>::ref_type
      _downcast(IDL::traits<ValueBase>::ref_type);
protected:
   ValueBase();
   ValueBase(&&);
   ValueBase(const ValueBase&);
   virtual ~ValueBase();
private:
   ValueBase operator=(ValueBase&&) = delete;
   ValueBase operator=(const ValueBase&) = delete;
```

```
};
```

The names of these operations begin with underscore to keep them from clashing with user-defined operations in derived **valuetype** classes. The copy_value operation returns by default a nil valuetype reference. The user can override this method to allow the copy of a valuetype reference using its base reference.

ValueBase also provides a protected default constructor, a protected copy constructor, a protected move constructor, and a protected virtual destructor. The copy and move constructors are protected to disallow construction of derived **valuetype** instances except from within derived class functions, and the destructor is protected to prevent direct deletion of instances of classes derived from **ValueBase**.

6.17.6 Value Boxes

A value box class essentially provides a shared version of its underlying type. Unlike normal **valuetype** classes, C++ classes for value boxes can be concrete since value boxes do not support methods, inheritance, or interfaces. Value box classes differ depending upon their underlying types. To fulfill the **ValueBase** interface, all value box classes are derived from **`ValueBase`**. Unlike **valuetype**s no Valuetype factory has to be provided by the user.

6.17.6.1 Parameter Passing for Underlying Boxed Type

All value box classes provide **`_value`** member functions that allow the underlying boxed value to be passed to functions taking parameters of the underlying boxed type. For example, invoking **`_value`** on a boxed string allows the actual string owned by the value box to be replaced:

```
// IDL
valuetype StringValue string;
interface X {
    void op(out string s);
};

// C++
IDL::traits<StringValue>::ref_type sval =
   CORBA::make_reference <StringValue>("string val");
X x (...)
x->op(sval->_value());           // boxed string is replaced
                                 // by op() invocation
```

Assume the implementation of **`op`** is as follows:

```
// C++
void op(std::string& s)
{
   s = "new string val";
}
```

The return value of the **`_value`** function shall be such that the string value boxed in the instance pointed to by **`sval`** is set to **`"new string val"`** after **`op`** returns.

6.17.6.2 Provided signature

Value box classes follow the rules of structured types as explained in “Mapping for Structured Types” on page 13. Additionally to these rules valueboxes also have:

- A public static **_downcast** function.
- Accessors are always named **_value**.
- A protected destructor and protected constructors

An example value box class for an enumerated type is shown below:

```
// IDL
enum Color { red, green, blue };
valuetype ColorValue Color;

// C++
class ColorValue : public ValueBase {
public:
   Color _value() const;
   Color& _value();
   void _value(Color val);

   static IDL::traits<ColorValue>::ref_type
      _downcast(IDL::traits<ValueBase>::ref_type base);

protected:
   ColorValue();
   explicit ColorValue(Color val);
   ColorValue(ColorValue&& val);
   ColorValue(const ColorValue& val);
   ColorValue& operator=(Color val);
   virtual ~ColorValue();
};
```

6.17.7 Abstract Valuetypes

Abstract IDL **valuetype**s follow the same C++ mapping rules as concrete IDL **valuetype**s, except that because they have no data members, the IDL compiler does not generate the **OBV** traits for them.

6.17.8 Valuetype Inheritance

For an IDL **valuetype** derived from other **valuetype**s or that supports **interface** types, several C++ inheritance scenarios are possible:

- *Concrete value base classes* are inherited as public virtual bases to allow for “ladder style” implementation inheritance.
- *Abstract value base classes* are inherited as public virtual base classes, since they may be multiply inherited in IDL.
- *Interface classes* supported by the IDL **valuetype** are not inherited (except for abstract interfaces because here the valuetype class has to support implicit widening; see Section 6.18.2).

- Instead, the operations on the interface (and base interfaces, if any) are mapped to pure virtual functions in the generated C++ base value class. In addition to this abstract base value class and the **`OBV_`** class, the IDL compiler generates a skeleton for this value type; this skeleton is available through the **`CORBA::servant_traits<>::base_type`** trait with the fully-scoped name of the **valuetype**. The base value class and the POA skeleton of the interface type are public virtual base classes of this skeleton.

An example of the mapping for a **valuetype** that supports an **interface** is shown below.

```
// IDL
interface A {
    void op();
};

valuetype B supports A {
    public short data;
};
```

```
// C++
class B : public virtual ValueBase {
public:
   virtual void op() = 0;

   virtual int16_t data() const = 0;
   virtual int16_t& data() = 0;
   virtual void data(int16_t) = 0;

   // ...
};

class B_impl :
   public virtual CORBA::servant_traits<A>::base_type,
   public virtual IDL::traits<B>::base_type
{
public:
   virtual void op() override;
   // ...
};
```

6.17.9 Valuetype Factories

Because concrete **valuetype** classes are provided by the application developer, the creation of values is problematic under certain circumstances. These circumstances include:

- *Unmarshaling*. The implementation cannot know *a priori* about all potential concrete value classes supplied by the application, and so the implementation unmarshaling mechanisms do not possess the capability to directly create instances of those classes.

- *Component Libraries*. Portions of an application, such as parts of a framework, may be limited to only manipulating **valuetype** instances while leaving creation of those instances to other parts of the application.

6.17.9.1 ValueFactoryBase Class

Just as they provide concrete C++ **valuetype** classes, applications must also provide factories for those concrete classes. The base of all value factory classes is the C++ **ValueFactoryBase** class:

```
// C++
class ValueFactoryBase : public virtual CORBA::LocalObject
{
public:
   static IDL::traits<ValueFactory>::ref_type _narrow(
      IDL::traits<ValueFactory>::ref_type& vf);

protected:
   virtual ~ValueFactoryBase();
   ValueFactoryBase();

private:
   virtual IDL::traits<ValueBase>::ref_type create_for_unmarshal() = 0;
};
```

The C++ mapping for the IDL **CORBA::ValueFactory** native type is a reference to the local **ValueFactoryBase** class, as shown above. Applications derive concrete factory classes from **ValueFactoryBase**, and register instances of those factory classes with the ORB via the **ORB::register_value_factory** function. If a factory is registered for a given value type and no previous factory was registered for that type, the **register_value_factory** function returns a nil reference.

When unmarshaling value instances, the implementation needs to be able to call up to the application to ask it to create those instances. Value instances are normally created via their type-specific value factories (see “Valuetype Factories” on page 30) so as to preserve any invariants they might have for their state. However, creation for unmarshaling is different because the implementation has no knowledge of application-specific factories, and in fact in most cases may not even have the necessary arguments to provide to the type-specific factories.

To allow the implementation to create value instances required during unmarshaling, the **ValueFactoryBase** class provides the **create_for_unmarshal** pure virtual function. The function is private so that only the implementation, through implementation-specific means (e.g., via a friend class), can invoke it. Applications are not expected to invoke the **create_for_unmarshal** function. Derived classes shall override the **create_for_unmarshal** function and shall implement it such that it creates a new value instance and returns a reference to it. Since the **create_for_unmarshal** function returns a reference to **ValueBase**, the caller may use the downcasting functions supplied by value types to downcast the reference back to a reference to a derived value type.

Once the implementation has created a value instance via the **create_for_unmarshal** function, it can use the value data member modifier functions to set the state of the new value instance from the unmarshaled data. How the implementation accesses the protected value data member modifiers of the value is implementation-specific and does not affect application portability.

The **_narrow** function on the factory allows the return type of the **ORB::lookup_value_factory** function to be narrowed to a reference to a type-specific factory (see “Valuetype Factories” on page 30).

6.17.9.2 Type-Specific Value Factories

All **valuetype**s that have initializer operations declared for them also have type-specific C++ value factory classes generated for them. For a **valuetype A**, the factory class can be retrieved using the **IDL::traits<A>::factory_type** trait. Each initializer operation maps to a pure virtual function in the factory class, and each of these initializers defined in IDL is mapped to an initializer function of the same name. Base **valuetype** initializers are not inherited, and so do not appear in the factory class. The initializer parameters are mapped using normal C++ parameter passing rules for **in** parameters. The return type of each **initializer** function is a reference to the created **valuetype**.

For example, consider the following **valuetype**:

```
// IDL
valuetype V {
    factory create_bool(in_boolean b);
    factory create_char(in_char c);
    factory create_octet(in octet o);
    factory create_other(in short s, in string p);
        ...
};
```

The factory class for the example given above will be generated as follows:

```
// C++
class V_factory : public ValueFactoryBase {
public:
   virtual IDL::traits<V>::ref_type create_bool(bool val) = 0;
   virtual IDL::traits<V>::ref_type create_char(char val) = 0;
   virtual IDL::traits<V>::ref_type create_octet(uint8_t val)= 0;
   virtual IDL::traits<V>::ref_type create_other(
      uint16_t s, const std::string& p) = 0;

   static IDL::traits<V>::ref_type
      _narrow(IDL::traits<ValueFactoryBase>::ref_type vf);

protected:
   virtual ~V_factory();
   V_factory();
};
```

Each generated factory class has a protected virtual destructor, a protected default constructor, and a public **_narrow** function allowing downcasting from a reference to the base **ValueFactoryBase** class. Each also supplies a public pure virtual function corresponding to each initializer. Applications derive concrete factory classes from these classes and register them with the implementation. Note that since each generated value factory derives from the base **ValueFactoryBase**, all derived concrete factory classes shall also override the private pure virtual **create_for_unmarshal** function inherited from **ValueFactoryBase**.

For **valuetype**s that have no operations or initializers, a concrete type-specific factory class is generated whose implementation of the **create_for_unmarshal** function simply constructs an instance of the **OBV_** class for the valuetype using the **CORBA::make_reference<>**.

For **valuetype**s that have operations, but no initializers, there are no type-specific abstract factory classes, but applications must still supply concrete factory classes. These classes, which are derived directly from **`ValueFactoryBase`**, need not supply **`_narrow`** functions, and only need to override the **`create_for_unmarshal`** function.

6.17.9.3 Unmarshaling Issues

When the implementation unmarshals a **valuetype** for a request handled via C++ static stubs or skeletons, it tries to find a factory for the **valuetype** via the **ORB::lookup_value_factory** operation. If the factory lookup fails, the client application receives a MARSHAL exception. Thus, applications utilizing static stubs or skeletons must ensure that a valuetype factory is registered for every **valuetype** it expects to receive via static invocation mechanisms.

Because of their dynamic nature, applications using the DII or DSI are not expected to have compile-time information for all the **valuetype**s they might receive. For these applications, **valuetype** instances are represented as **`Any`**, and so value factories are not required to be registered with the implementation to allow such **valuetype**s to be unmarshaled. However, value factories must be registered with the implementation and available for lookup if the application attempts extraction of the **valuetypes** via the statically-typed **`Any`** extraction functions. See “Extraction from any” on page 22 for more details.

6.17.10 Custom Marshaling

The C++ mappings for the IDL **CORBA::CustomerMarshal**, **CORBA::DataOutputStream**, and **CORBA::DataInputStream** types follow normal C++ **valuetype** mapping rules.

6.18 Mapping for Abstract Interfaces

The C++ mapping for abstract interfaces is almost identical to the mapping for regular interfaces. Rather than defining a complete C++ mapping for abstract interfaces, which would only duplicate much of the specification of the mapping for regular interfaces found in “Mapping for Interfaces” on page 7, only the ways in which the abstract interface mapping differs from the regular interface mapping are described here.

6.18.1 Abstract Interface Base

For abstract interfaces the **`IDL::traits<>`** trait must be provided. This trait delivers a strong reference type as **`IDL::traits<>::ref_type`** and a weak reference type as **`IDL::traits<>::weak_ref_type`**.

C++ classes for abstract interfaces are not derived from the **`CORBA::Object`** C++ class. In IDL, abstract interfaces have no common base. However, to facilitate narrowing from an abstract interface base class down to derived abstract interfaces, derived interfaces, and derived **valuetype** types, all abstract interface base classes that have no other base abstract interfaces derive directly from **`CORBA::AbstractBase`**. This base class provides the following:

- a protected default constructor
- a protected copy constructor
- a protected pure virtual destructor
- a **`_to_object`** and a **`_to_value`** operation

The **`AbstractBase`** class is shown below:

```
// C++
class AbstractBase {
   public:
      virtual IDL::traits<Object>::ref_type _to_object();
      virtual IDL::traits<ValueBase>::ref_type _to_value();

   protected:
      AbstractBase();
      AbstractBase(const AbstractBase& val);
      AbstractBase(AbstractBase&& val);
      virtual ~AbstractBase();
};
```

If the concrete type of an abstract interface instance is a normal object reference, the **_to_object** function returns a reference to that object, otherwise it returns a nil reference. If the concrete type is a valuetype, **_to_value** returns a reference to that valuetype, otherwise it returns a nil reference.

6.18.2 Client Side Mapping

The client side mapping for abstract interfaces is almost identical to the mapping for object references, except:

- C++ classes for abstract interfaces derive from **CORBA::AbstractBase**, not **CORBA::Object**.
- Because abstract interface classes can serve as base classes for application-supplied concrete **valuetype** classes, they shall provide a protected default constructor, a protected copy constructor, and a protected destructor (which is virtual by virtue of inheritance from **AbstractBase**).
- The mapping for object reference classes does not specify the type of inheritance used for base object reference classes. However, because abstract interfaces can serve as base classes for application-supplied concrete **valuetype** classes, which themselves can be derived from regular valuetype classes, abstract interface classes shall always be inherited as public virtual base classes.
- Normal **Any** insertion and extraction operators are generated for abstract interfaces.

Both interfaces that are derived from one or more abstract interfaces, and **valuetype**s that support one or more abstract interfaces support implicit widening to the reference for each abstract interface base class.

6.19 Mapping for Exception Types

- An OMG IDL exception is mapped to a C++ class that derives from the standard **UserException** class. All exception members must be initialized to their default value by the default constructor for the exception.
- The copy constructor, move constructor, assignment operator, move operator, and destructor automatically copy, move, or free the storage associated with the exception. For convenience, the mapping also defines an explicit constructor with one parameter for each exception member—this constructor initializes the exception members to the given values.The default constructor initialized all members to their default values as described in “Mapping for Structured Types” on page 13.

```
// C++
class Exception : public std::exception
{
public:
   virtual ~Exception();
   virtual void raise() const = 0;
```

```
   virtual const std::string& _name() const;
   virtual const std::string& _rep_id() const;
   virtual const char* what() const throw() override;
protected:
   Exception(void);
   Exception(const Exception &);
   Exception(Exception &&);
   Exception &operator=(const Exception &);
   Exception &operator=(Exception &&);
};
```

The **Exception** base class is abstract and may not be instantiated except as part of an instance of a derived class. It supplies one pure virtual function to the exception hierarchy: the **raise()** function. This function can be used to tell an exception instance to **throw** itself so that a **catch** clause can catch it by a more derived type. Each class derived from **Exception** implements **raise()** as follows:

```
// C++
void SomeDerivedException::raise() const
{
   throw *this;
}
```

The **_name()** function returns the unqualified (unscoped) name of the exception. The **_rep_id()** function returns the repository ID of the exception.

Each **Exception** class has to override **what()** which must return a null terminated character sequence containing a generic description of the exception. Both the wording of such description and the character width are implementation-defined.

The **UserException** class is derived from a base **Exception** class.

All standard exceptions are derived from a **SystemException** class. Like **UserException**, **SystemException** is derived from the base **Exception** class. The **SystemException** class interface is shown below.

```
// C++
enum class CompletionStatus : uint32_t {
   COMPLETED_YES,
   COMPLETED_NO,
   COMPLETED_MAYBE
};

class SystemException : public Exception
{
public:
   virtual ~SystemException();

   const int32_t& minor() const;
   void minor(const int32_t&);

   virtual void raise() const = 0;
   virtual const char* what() const throw() override;
```

```
   const CompletionStatus completed() const;
   void completed(CompletionStatus);
protected:
   SystemException();
   SystemException(const SystemException &);
   SystemException(SystemException &&);
   explicit SystemException(int32_t minor, CompletionStatus status);
   SystemException &operator=(const SystemException &);
   SystemException &operator=(SystemException &&);
};
```

The default constructor for **SystemException** causes **minor()** to return 0 and **completed()** to return **COMPLETED_NO.**

Each specific system exception is derived from **SystemException**:

```
// C++
class UNKNOWN final : public SystemException { ... };

class BAD_PARAM final : public SystemException { ... };
// etc.
```

This exception hierarchy allows any exception to be caught by simply catching the **Exception** type:

```
// C++
try
{
   ...
}
catch (const Exception &exc)
{
   ...
}
```

Alternatively, all user exceptions can be caught by catching the **UserException** type, and all system exceptions can be caught by catching the **SystemException** type:

```
// C++
try
{
      ...
}
catch (const UserException &ue)
{
      ...
}
catch (const SystemException &se)
{
      ...
}
```

Naturally, more specific types can also appear in **catch** clauses. Also the exceptions can be caught as **std::exception**.

6.19.1 UnknownUserException

Request invocations made through the DII may result in user-defined exceptions that cannot be fully represented in the calling program because the specific exception type was not known at compile-time. The mapping provides the **UnknownUserException** so that such exceptions can be represented in the calling process:

```
// C++
class UnknownUserException final : public UserException
{
   public:
      const Any& exception() const;
};
```

As shown here, **UnknownUserException** is derived from **UserException**. It provides the **exception()** accessor that returns an **Any** holding the actual exception. Ownership of the returned **Any** is maintained by the **UnknownUserException**—the **Any** merely allows access to the exception data. Conforming applications should never explicitly throw exceptions of type **UnknownUserException**—it is intended for use with the DII.

6.19.2 Any Insertion and Extraction for Exceptions

Conforming implementations shall generate **Any** insertion and extraction operators (**operator<<=** and **operator>>=**, respectively) that allow all system and user exceptions to be correctly inserted into and extracted from **Any**. Both copying and moving forms of the **Any** insertion operator shall be provided for all system and user exceptions.

In addition, conforming mapping implementations must support **Any** insertion (but not extraction) for **Exception**. This is required to allow DSI-based applications to catch exceptions as **Exception&** and store them into a **ServerRequest**:

```
// C++
try
{
      // ...
}
catch (const Exception& exc)
{
   Any any;
   any <<= exc;
   server_request->set_exception(any);
}
```

Note that this shall result in both the **TypeCode** and value for the actual derived exception type being stored into the **Any**. The following **Any** insertion for **Exception** shall be provided:

```
// C++
void operator<<=(Any&, const Exception&);
```

For applications using the DII or portable interceptors, it is useful to be able to extract system exceptions generically. The mapping provides the following operator to do this:

```
// C++
bool operator>>=(const Any&, SystemException& se);
```

The operator returns true if the **Any** on which it is invoked contains a system exception and the implementation has static type information for the actual system exception contained in the **Any**. In that case, **se** points at the base part of the actual exception after the operator returns. If the implementation does not have static type information for the system exception, the operator returns true and **se** points to an instance of **UNKNOWN**. Otherwise, the operator returns false and the value of **se** is unchanged.

6.20 Mapping of Pseudo Objects to C++

IDL pseudo objects must be mapped to IDL local interfaces. These local interfaces must be implemented following the regular mapping for local objects.

6.21 TypeCode

A **TypeCode** represents OMG IDL type information. Typecodes are handled as reference type as described in "Reference Types" on page 7. For typecodes the **IDL::traits** trait is provided. For the strong reference the mapping will provide the trait **IDL::traits<CORBA::TypeCode>::ref_type** .

No public constructors for **TypeCode**s are defined. However, in addition to the mapped interface, for each basic and defined OMG IDL type, an implementation provides access to a **TypeCode** reference (**IDL::traits<CORBA::TypeCode>::ref_type**) of the form **_tc_<type>** that may be used to set types in **Any**, as arguments for **equal**, and so on. In the names of these **TypeCode** reference constants, **<type>** refer to the local name of the type within its defining scope. Each C++ **_tc_<type>** constant must be defined at the same scoping level as its matching type.

6.21.1 TypeCode Interface

The **TypeCode** IDL interface is fully defined in version 3.2 of *Common Object Request Broker Architecture (CORBA)*, *Interface Repository* clause, *The TypeCode Interface* sub clause and is thus not duplicated here.

6.21.2 TypeCode C++ Class

```
// C++
class TypeCode
{
   public:
      class Bounds final : public UserException { ... };
      class BadKind final : public UserException { ... };

      bool equal(IDL::traits<CORBA::TypeCode>::ref_type) const;
      bool equivalent(IDL::traits<CORBA::TypeCode>::ref_type) const;
      TCKind kind() const;

      IDL::traits<CORBA::TypeCode>::ref_type get_compact_typecode() const;
```

```
        const std::string& id() const;
        const std::string& name() const;

        uint32_t member_count() const;
        const std::string& member_name(uint32_t index) const;

        IDL::traits<CORBA::TypeCode>::ref_type member_type(uint32_t index) const;

        const Any& member_label(uint32_t index) const;
        IDL::traits<CORBA::TypeCode>::ref_type discriminator_type() const;
        int32_t default_index() const;

        uint32_t length() const;

        IDL::traits<CORBA::TypeCode>::ref_type content_type() const;

        uint16_t fixed_digits() const;
        int16_t fixed_scale() const;

        Visibility member_visibility(uin32_t index) const;
        ValueModifier type_modifier() const;
        IDL::traits<CORBA::TypeCode>::ref_type concrete_base_type() const;
};
```

6.22 ORB

An **ORB** is the programmer interface to the Object Request Broker. This pseudo interface has to be implemented as a regular local interface.

6.22.1 Mapping of ORB Initialization Operations

The following PIDL specifies initialization operations for an ORB; this PIDL is part of the CORBA module (not the ORB interface) and is described in version 3.2 of *Common Object Request Broker Architecture (CORBA)*, *ORB Interface* clause, *ORB Initialization* sub clause.

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

The mapping of the preceding PIDL operations to C++ is as follows:

```
// C++
namespace CORBA {
        typedef std::string ORBid;
        static IDL::traits<ORB>::ref_type ORB_init(
                int& argc,
```

```
            char** argv,
            const std::string& orb_identifier = std::string ()
      );
};
```

The C++ mapping for **ORB_init** deviates from the regular C++11 mapping in its handling of the **arg_list** parameter. This is intended to provide a meaningful C++11 definition of the initialization interface, which has a natural C++ binding matching the main of an application. The **arg_list** sequence is replaced with **argv** and **argc** parameters.

The **argv** parameter is defined as an unbound array of strings (**char ****) and the number of strings in the array is passed in the **argc** (**int &**) parameter.

If an empty ORBid string is used then **argv** arguments can be used to determine which ORB should be returned. This is achieved by searching the **argv** parameters for one tagged *ORBid*, e.g., *-ORBid "ORBid_example."* If an empty ORBid string is used and no ORB is indicated by the **argv** parameters, the default ORB is returned.

Regardless of whether an empty or non-empty ORBid string is passed to **ORB_init**, the **argv** arguments are examined to determine if any ORB parameters are given. If a non-empty ORBid string is passed to **ORB_init**, all *-ORBid* parameters in the **argv** are ignored. All other *-ORB<suffix>* parameters may be of significance during the ORB initialization process.

For C++, the order of consumption of **argv** parameters may be significant to an application. In order to ensure that applications are not required to handle **argv** parameters they do not recognize, the ORB initialization function must be called before the remainder of the parameters is consumed. Therefore, after the **ORB_init** call the **argv** and **argc** parameters will have been modified to remove the ORB understood arguments. It is important to note that the ORB_init call can only reorder or remove references to parameters from the argv list. This restriction is made in order to avoid potential memory management problems caused by trying to free parts of the argv list or extending the argv list of parameters. This is why **argv** is passed as a **char**** and not a **char**&**.

6.23 Object

The rules in this section apply to OMG IDL interface **Object**, the base of the OMG IDL interface hierarchy. Interface **Object** defines a normal CORBA object and is mapped as defined in this specification. In addition to these rules, all operation names in interface **Object** have leading underscores in the corresponding C++ class.

6.24 Local Object

The C++ mapping of **LocalObject** is a class derived from **Object** that is used as a base class for locality constrained object implementations. The class mapping the interface should be (indirectly) derived from **LocalObject** and have the same name as the interface. An object reference referring to a local object must be created using the **CORBA::make_reference<>** factory method as described in “Reference Types” on page 7. Here is an example of how to implement a local interface:

```
// IDL
local interface LocalIF {
    void an_op(in long an_arg);
};

// C++
class MyLocalIF : public LocalIF {
```

```
public:
   MyLocalIF ();
   virtual ~MyLocalIF();

   void an_op(int32_t an_arg) override;
};

IDL::traits<LocalIF>::ref_type myref =
   CORBA::make_reference <MyLocalIF> ();
```

6.25 Server-Side Mapping

Server-side mapping refers to the portability constraints for an object implementation written in C++. The term *server* is not meant to restrict implementations to situations in which method invocations cross address space or machine boundaries. This mapping addresses any implementation of an OMG IDL interface.

6.25.1 Implementing Interfaces

To define an implementation in C++, one defines a C++ class with any valid C++ name. For each operation in the interface, the class defines a non-static member function with the mapped name of the operation (the mapped name is the same as the OMG IDL identifier except when the identifier is a C++ keyword, in which case the string "_cxx_" is prepended to the identifier). Note that the implementation may allow one implementation class to derive from another, so the statement "the class defines a member function" does not mean the class must explicitly define the member function—it could inherit the function.

The mapping specifies an *inheritance-based* mapping for the application-supplied implementation class and the generated class or classes for the interface.

6.25.2 Mapping of PortableServer::Servant

The **PortableServer** module for the Portable Object Adapter (POA) defines the native **Servant** type. The C++ mapping for **Servant** is as follows:

```
// C++
namespace PortableServer
{
   class Servant
   {
   public:
      virtual IDL::traits<PortableServer::POA>::ref_type _default_POA();
      virtual IDL::traits<CORBA::InterfaceDef>::ref_type _get_interface();
      virtual bool _is_a(const std::string& logical_type_id);
      virtual bool _non_existent();
   protected:
      virtual ~Servant();
      ServantBase();
      ServantBase(const ServantBase &);
      ServantBase(ServantBase &&);
      ServantBase& operator=(const ServantBase &);
```

```
      ServantBase& operator=(ServantBase &&);
   };
};
```

The **ServantBase** destructor is protected and virtual to ensure that skeleton classes derived from it can be properly destroyed but never be deleted directly. The default constructor, along with other implementation-specific constructors, must be protected so that instances of **ServantBase** cannot be created except as sub-objects of instances of derived classes. A default constructor (a constructor that either takes no arguments or takes only arguments with default values) must be provided so that derived servants can be constructed portably. Both a copy constructor and a protected default assignment operator must be supported so that application-specific servants can be copied if necessary. Note that copying a servant that is already registered with the object adapter, either by assignment or by construction, does not mean that the target of the assignment or copy is also registered with the object adapter. Similarly, assigning to a **Servant** or a class derived from it that is already registered with the object adapter does not in any way change its registration.

The default implementation of the **_default_POA** function provided by **Servant** returns an object reference to the root POA of the default ORB in this process—the same as the return value of an invocation of **ORB::resolve_initial_references("RootPOA")** on the default ORB. Classes derived from **Servant** can override this definition to return the POA of their choice, if desired.

Servant provides default implementations of the **_get_interface**, **_is_a**, and **_non_existent** object reference operations that can be overridden by derived servants if the default behavior is not adequate. The POA invokes these operations just like normal skeleton operations, thus allowing overriding definitions in derived servant classes to use **_this** and the **PortableServer::Current** interface within their function bodies.

The default implementation of **_non_existent** simply returns false.

6.25.3 Servant references

Given an interface **Foo** the mapping will provide a **CORBA::servant_traits<Foo>** trait. The strong reference type is provided as **CORBA::servant_traits<Foo>::ref_type** trait (aka **CORBA::servant_reference<>**) that can be used to store or pass a reference to the servant of type **Foo**. Also a weak reference **CORBA::servant_traits<Foo>::weak_ref_type** trait (aks **CORBA::weak_servant_reference<>**) has to be provided. These servant reference types behaves as references type as described in “Reference Types” on page 7.

This trait together with the **CORBA::make_reference<>** factory method must be used to write exception-safe and type-safe code for heap-allocated servants (a C++11 program is not allowed to use **new**/**delete** to allocate servants). For example if we have an interface **Test::Hello** that is implemented by **Foo_impl**:

```
CORBA::servant_traits<Test::Hello>::ref_type
Foo some_function()
{
   CORBA::servant_traits<Test::Hello>::ref_type foo_servant =
      CORBA::make_reference <Foo_impl> ();
   foo_servant->do_something();           // might throw...


   some_poa->activate_object_with_id(...);
   return foo_servant->_this ();
}
```

6.25.4 Servant argument passing

The POA will maintain servants as servant references with the semantics as described in “Reference Types” on page 7. For each POA, the **ServantActivator** and **ServantLocator** provide operations that either passes a **`Servant`** as a parameter or returns a **`Servant`** a **`CORBA::servant_traits<T>::ref_type`** will be passed.

6.25.5 Skeleton Operations

All skeleton classes provide a **`_this()`** member function. This member function has three purposes:

1. Within the context of a request invocation on the target object represented by the servant, it allows the servant to obtain the object reference for the target CORBA object it is incarnating for that request. This is true even if the servant incarnates multiple CORBA objects. In this context, **`_this()`** can be called regardless of the policies used to create the dispatching POA.
2. Outside the context of a request invocation on the target object represented by the servant, it allows a servant to be implicitly activated if its POA allows implicit activation. This requires the activating POA to have been created with the **IMPLICIT_ACTIVATION** policy. If the POA was not created with the **IMPLICIT_ACTIVATION** policy, the PortableServer::WrongPolicy exception is thrown. The POA used for implicit activation is acquired by invoking **`_default_POA()`** on the servant.
3. Outside the context of a request invocation on the target object represented by the servant, it will return the object reference for a servant that has already been activated, as long as the servant is not incarnating multiple CORBA objects. This requires the POA with which the servant was activated to have been created with the UNIQUE_ID and RETAIN policies. If the POA was created with the **MULTIPLE_ID** or **NON_RETAIN** policies, the PortableServer::WrongPolicy exception is thrown. The POA is acquired by invoking **`_default_POA()`** on the servant.

For example, for interface **A** defined as follows:

```
// IDL
interface A
{
    short op1();
    void op2(in long val);
};
```

The return value of **`_this()`** is a typed object reference for the interface type corresponding to the skeleton class. For example, the **`_this()`** function for the skeleton for interface **A** would be defined as follows:

```
// C++
class A_impl : public virtual CORBA::servant_traits<A>::base_type {
public:
   IDL::traits<A>::ref_type _this() override;
   ...
};
```

Assuming **`A_impl`** is a class derived from **`CORBA::servant_traits<A>::base_type`** that implements the **A** interface, and assuming that the servant’s POA was created with the appropriate policies, a servant of type **`A_impl`** can be created and implicitly activated as follows:

```
// C++
CORBA::servant_traits<A>::ref_type my_a =
   CORBA::make_reference<A_impl> ();
IDL::traits<A>::ref_type a = my_a->_this();
```

6.25.6 Inheritance-Based Interface Implementation

Implementation must be derived from a generated base class based on the OMG IDL interface definition. The generated base classes are known as *skeleton classes*, and the derived classes are known as *implementation classes*. Each operation of the interface has a corresponding virtual member function declared in the skeleton class. The signature of the member function is identical to that of the generated client stub class. The implementation class provides implementations for these member functions. The object adapter typically invokes the methods via calls to the virtual functions of the skeleton class.

Assume that IDL interface **A** is defined as follows:

```
// IDL
interface A
{
    short op1();
    void op2(in long val);
};
```

For IDL interface **A** as shown above, the IDL compiler generates an interface class **A**. This class contains the C++ definitions for the typedefs, constants, exceptions, attributes, and operations in the OMG IDL interface. It has a form similar to the following:

```
// C++
class A : public virtual ....
{
public:
   virtual int16_t op1();
   virtual void op2(const int32_t& val);
   ...
};
```

On the server side, a skeleton class is generated. This class is opaque to the programmer, though it will contain a member function corresponding to each operation in the interface. The type of the skeleton class is defined by the **CORBA::servant_traits<T>::base_type** trait related to the corresponding interface **T**. The type the traits refers to has to be either directly or indirectly derived from the servant base class **PortableServer::Servant**. The **PortableServer::Servant** class must be a virtual base class of the type related to the trait to allow portable implementations to multiply inherit from both skeleton classes and implementation classes for other base interfaces without error or ambiguity.

The **PortableServer::Servant** must have a protected destructor preventing the user to directly delete a servant instead of using the reference semantics.

The skeleton class for interface **A** shown above would appear as follows:

```
// C++
class A_skel : public virtual ...
{
public:
   // ...server-side implementation-specific detail
   // goes here...
   virtual int16_t op1() = 0;
   virtual void op2(const int32_t& val) = 0;
   ...
protected:
   A_skel ();
   virtual ~... ();
};
```

If interface **A** were defined within a module rather than at global scope, e.g., **Mod::A**, the trait for this skeleton class would be **`CORBA::servant_traits<Mod::A>::base_type`**.

To implement this interface using inheritance, a programmer must derive from this trait and implement each of the operations in the OMG IDL interface. An implementation class declaration for interface **A** would take the form:

```
// C++
class A_impl : public virtual CORBA::servant_traits<A>::base_type
{
public:
   virtual int16_t op1() override;
   virtual void op2(const int32_t val) override;
   ...
protected:
   virtual ~A_impl ();
};
```

Note that the presence of the **`_this()`** function implies that C++ servants must only be derived directly from a single skeleton class. Direct derivation from multiple skeleton classes could result in ambiguity errors due to multiple definitions of **`_this()`**. This should not be a limitation, since CORBA objects have only a single most-derived interface. Servants that are intended to support multiple interface types can be registered as DSI-based servants, as described in "Mapping of DSI to C++" on page 47.

For interfaces which inherit from one or more base interfaces, the generated POA skeleton class uses virtual inheritance:

```
// IDL
interface A { ... };
interface B : A { ... };
interface C : A { ... };
interface D : B, C { ... };

// C++
class A_skel : public virtual CORBA::servant_traits<A>::base_type { ... };
class B_skel : public virtual CORBA::servant_traits<B>::base_type { ... };
class D_skel : public virtual CORBA::servant_traits<B>::base_type, public
CORBA::servant_traits<C>::base_type
{ ... };
```

This guarantees that the POA skeleton class inherits only one version of each operation, and also allows optional inheritance of implementations. In this example, the implementation of interface **B** reuses the implementation of interface A:

```
// C++
class A_impl: public virtual CORBA::servant_traits<A>::base_type { ... };
class B_impl: public virtual CORBA::servant_traits<B>::base_type,
              public virtual A_impl
{};
```

For interfaces that inherit from an abstract interface, the POA skeleton class is also virtually derived directly from the abstract interface class, but with protected access:

```
// IDL
abstract interface A { ... };
interface B : A { ... };
```

```
// C++
class A { ... };
class POA_B : public virtual PortableServer::ServantBase,
   protected virtual A { ... };
```

The abstract interface is inherited with protected access to prevent accidental conversion of the skeleton reference to an abstract interface reference. This also allows implementation classes and valuetypes to share an implementation of the abstract interface:

```
// IDL
valuetype V supports A { ... };
```

```
// C++
class MyA : virtual CORBA::servant_traits<A>::base_type { ... };
class MyB : public virtual CORBA::servant_traits<B>::base_type,
            protected virtual MyA
{ ... };
class MyV : public virtual V, public virtual MyA { ... };
```

6.25.7 Implementing Operations

The signature of an implementation member function is the mapped signature of the OMG IDL operation. For example:

```
// IDL
interface A
{
    exception B {};
    void f() raises(B);
};
```

```
// C++
class MyA : public virtual CORBA::servant_traits<A>::base_type
{
public:
```

```
   virtual void f() override;
   ...
};
```

Within a member function, the “this” pointer refers to the implementation object’s data as defined by the class. In addition to accessing the data, a member function may implicitly call another member function defined by the same class. For example:

```
// IDL
interface A
{
   void f();
   void g();
};

// C++
class MyA : public virtual CORBA::servant_traits<A>::base_type
{
public:
   virtual void f() override;
   virtual void g() override;
private:
   int32_t x_;
};

void
MyA::f()
{
   this->x_ = 3;
   this->g();
}
```

However, when a servant member function is invoked in this manner, it is being called simply as a C++ member function, not as the implementation of an operation on a CORBA object. In such a context, any information available via the **`POA_Current`** object refers to the CORBA request invocation that performed the C++ member function invocation, not to the member function invocation itself.

When the application code needs a **`CORBA::servant_reference<>`** within the a member function it can retrieve a servant reference to this using **`this->_lock ()`** which returns a reference to this. This reference than can be passed to other operations which require a **`CORBA::servant_reference<>`**.

6.26 Mapping of DSI to C++

The *Common Object Request Broker Architecture (CORBA)* specification, *Dynamic Skeleton Interface* clause, *DSI: Language Mapping* sub clause contains general information about mapping the Dynamic Skeleton Interface to programming languages.

This sub clause contains the following information:

- Mapping of the Dynamic Skeleton Interface’s **ServerRequest** to C++
- Mapping of the Portable Object Adapter’s Dynamic Implementation Routine to C++

6.26.1 Mapping of ServerRequest to C++

The **ServerRequest** pseudo object maps to a C++ class which follows the local interface mapping.

6.26.2 Mapping of PortableServer Dynamic Implementation Routine

In C++, DSI servants inherit from the standard **DynamicImplementation** class. This class inherits from the **Servant** class and is also defined in the **PortableServer** namespace. The Dynamic Skeleton Interface (DSI) is implemented through servants that are members of classes that inherit from dynamic skeleton classes.

```
// C++
namespace PortableServer
{
   class DynamicImplementation : public virtual Servant
   {
   public:
      IDL::traits<Object>::ref_type _this();
      virtual void invoke(IDL::traits<ServerRequest>::ref_type request)= 0;
      virtual RepositoryId _primary_interface(const ObjectId& oid,
         IDL::traits<POA>::ref_type poa) = 0;
   };
};
```

The **_this()** function returns a **IDL::traits<Object>::ref_type** for the target object. Unlike **_this()** for static skeletons, its return type is not interface-specific because a DSI servant may very well incarnate multiple CORBA objects of different types. If **DynamicImplementation::_this()** is invoked outside of the context of a request invocation on a target object being served by the DSI servant, it raises the PortableServer::WrongPolicy exception.

The **invoke()** method receives requests issued to any CORBA object incarnated by the DSI servant and performs the **processing** necessary to execute the request. Requests for the standard object operations (**_get_interface**, **_is_a**, and **_non_existent**) do not call **invoke()**, but call the corresponding functions defined in **Servant** instead.

The **_primary_interface()** method receives an **ObjectId** value and a **POA** as input parameters and returns a valid **RepositoryId** representing the most-derived interface for that **oid**.

It is expected that the **invoke()** and **_primary_interface()** methods will be invoked only by the POA in the context of serving a CORBA request. Invoking this method in other circumstances may lead to unpredictable results.

6.27 PortableServer Functions

Objects registered with POAs use sequences of octet, specifically the **PortableServer::POA::ObjectId** type, as object identifiers. However, because C++ programmers will often want to use strings as object identifiers, the C++11 mapping provides several conversion functions that convert strings to **ObjectId** and vice-versa:

```
// C++
namespace PortableServer
{
   std::string ObjectId_to_string(const ObjectId&);
   std::wstring ObjectId_to_wstring(const ObjectId&);
```

```
   ObjectId string_to_ObjectId(const std::string&);
   ObjectId wstring_to_ObjectId(const std::wstring&);
};
```

If conversion of an **ObjectId** to a string would result in illegal characters in the string, the first two functions throw the BAD_PARAM exception.

6.28 Mapping for PortableServer::ServantManager

6.28.1 Mapping for Cookie

Since **PortableServer::ServantLocator::Cookie** is an IDL **native** type, its type must be specified by each language mapping. In C++, **Cookie** maps to **void***:

```
// C++
namespace PortableServer
{
      class ServantLocator {
         ...
         typedef void* Cookie;
      };
};
```

For the C++ mapping of the **PortableServer::ServantLocator::preinvoke()** operation, the **Cookie** parameter maps to a **Cookie&**, while for the **postinvoke()** operation, it is passed as a **Cookie**.

6.28.2 ServantManagers and AdapterActivators

Portable servants that implement the **PortableServer::AdapterActivator**, the **PortableServer::ServantActivator**, or **PortableServer::ServantLocator** interfaces are implemented just like any other servant using the inheritance-based approach.

6.28.3 Server Side Mapping for Abstract Interfaces

The only circumstances under which an IDL compiler should generate C++ code for abstract interfaces for the server side are when either an interface is derived from an abstract interface, or when a **valuetype** supports an abstract interface indirectly through one or more intermediate regular interface types. Abstract interfaces by themselves cannot be directly implemented or instantiated by portable applications. Because of this, standard C++ skeleton classes for abstract interfaces are not necessary.

6.29 std::ostream insertion

For each IDL type (T) of type:

- Enumeration
- Object reference (**IDL::traits<T>::ref_type**)
- Valuetype reference (**IDL::traits<T>::ref_type**)
- Typecode reference (**IDL::traits<CORBA::TypeCode>::ref_type**)

- Abstract base reference (**`IDL::traits<T>::ref_type`**)

an ostream inserter with the following signature will be provided:

```
// C++
std::ostream& operator<<(std::ostream &, T);
```

For all other types an ostream inserter with the following signature will be provided:

```
// C++
std::ostream& operator<<(std::ostream &, const T&);
```

This inserter prints information about IDL type onto an ostream. The format and amount of detail of the printed information is implementation dependent.

6.30 C++11 Keywords

Table 6.2 lists all C++11 keywords from the C++11 specification (ISO/IEC 14882:011) dated September 2011.

Table 6.2 - C++ Keywords

and	and_eq	asm	auto	bitand	bitor
bool	break	case	catch	char	class
compl	const	const_cast	continue	default	delete
do	double	dynamic_cast	else	enum	explicit
export	extern	false	float	for	friend
goto	if	inline	int	long	mutable
namespace	new	not	not_eq	operator	or
or_eq	private	protected	public	register	reinterpret_cast
return	short	signed	sizeof	static	static_cast
struct	switch	template	this	throw	true
thread_local	int16_t	int32_t	int64_t	uint16_t	uint32_t
try	typedef	typeid	typename	union	unsigned
uint64_t	uint8_t				
using	virtual	void	volatile	wchar_t	while
xor	xor_eq	alinas	alineof	constrexpr	decltype