Service Component Architecture Client and Implementation Model for C++ Specification Version 1.1

Committee Draft 06

14 October 2010

Specification URIs:
This Version:
http://docs.oasis-open.org/opencsa/sca-c-cpp/sca-cppcni-1.1-spec-cd06.html
http://docs.oasis-open.org/opencsa/sca-c-cpp/sca-cppcni-1.1-spec-cd06.doc
http://docs.oasis-open.org/opencsa/sca-c-cpp/sca-cppcni-1.1-spec-cd06.pdf (Authoritative)

Previous Version:
http://docs.oasis-open.org/opencsa/sca-c-cpp/sca-cppcni-1.1-spec-cd05.html
http://docs.oasis-open.org/opencsa/sca-c-cpp/sca-cppcni-1.1-spec-cd05.doc
http://docs.oasis-open.org/opencsa/sca-c-cpp/sca-cppcni-1.1-spec-cd05.pdf (Authoritative)

Latest Version:
http://docs.oasis-open.org/opencsa/sca-c-cpp/sca-cppcni-1.1-spec.html
http://docs.oasis-open.org/opencsa/sca-c-cpp/sca-cppcni-1.1-spec.doc

Technical Committee:
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Related work:
This specification replaces or supercedes:
• OSOA SCA C++ Client and Implementation V1.00

This specification is related to:
• OASIS Service Component Architecture Assembly Model Version 1.1
• OASIS SCA Policy Framework Version 1.1
• OASIS Service Component Architecture Web Service Binding Specification Version 1.1

Downloadable API Docuemntation:
http://docs.oasis-open.org/opencsa/sca-c-cpp/sca-cppcni-apidoc-1.1-cd06.zip

Hosted API Docuemntation:

Declared XML Namespace(s):
http://docs.oasis-open.org/ns/opencsa/sca/200912
Abstract:
This document describes the SCA Client and Implementation Model for the C++ programming language.

The SCA C++ implementation model describes how to implement SCA components in C++. A component implementation itself can also be a client to other services provided by other components or external services. The document describes how a C++ implemented component gets access to services and calls their operations.

The document also explains how non-SCA C++ components can be clients to services provided by other components or external services. The document shows how those non-SCA C++ component implementations access services and call their operations.

Status:
This document was last revised or approved by the Service Component Architecture / C and C++ TC on the above date. The level of approval is also listed above. Check the “Latest Version” or “Latest Approved Version” location noted above for possible later revisions of this document.

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1 Introduction

This document describes the SCA Client and Implementation Model for the C++ programming language. The SCA C++ implementation model describes how to implement SCA components in C++. A component implementation itself can also be a client to other services provided by other components or external services. The document describes how a C++ implemented component gets access to services and calls their operations.

The document also explains how non-SCA C++ components can be clients to services provided by other components or external services. The document shows how those non-SCA C++ component implementations access services and call their operations.

1.1 Terminology

The key words “MUST”, “MUST NOT”, “REQUIRED”, “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD NOT”, “RECOMMENDED”, “MAY”, and “OPTIONAL” in this document are to be interpreted as described in [RFC2119].

This specification uses predefined namespace prefixes throughout; they are given in the following list. Note that the choice of any namespace prefix is arbitrary and not semantically significant.

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Namespace</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>xs</td>
<td><a href="http://www.w3.org/2001/XMLSchema">http://www.w3.org/2001/XMLSchema</a></td>
<td>Defined by XML Schema 1.0 specification</td>
</tr>
<tr>
<td>sca</td>
<td><a href="http://docs.oasis-open.org/ns/opencsa/sca/200912">http://docs.oasis-open.org/ns/opencsa/sca/200912</a></td>
<td>Defined by the SCA specifications</td>
</tr>
<tr>
<td>cpp</td>
<td><a href="http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/200901">http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/200901</a></td>
<td>Defined by this specification</td>
</tr>
</tbody>
</table>

Table 1-1: Prefixes and Namespaces used in this Specification

1.2 Normative References


1.3 Non-Normative References

N/A

1.4 Conventions

1.4.1 Naming Conventions

This specification follows naming conventions for artifacts defined by the specification:

- For the names of elements and the names of attributes within XSD files, the names follow the CamelCase convention, with all names starting with a lower case letter.
  e.g. `<element name="componentType" type="sca:ComponentType"/>

- For the names of types within XSD files, the names follow the CamelCase convention with all names starting with an upper case letter
  e.g. `<complexType name="ComponentService">

- For the names of intents, the names follow the CamelCase convention, with all names starting with a lower case letter, EXCEPT for cases where the intent represents an established acronym, in which case the entire name is in upper case.
  An example of an intent which is an acronym is the "SOAP" intent.

1.4.2 Typographic Conventions

This specification follows typographic conventions for specific constructs:

- Normative statements are highlighted, [numbered] and cross-referenced to Normative Statement Summary

- XML attributes are identified in text as @attribute

- Language identifiers used in text are in courier

- Literals in text are in italics
2 Basic Component Implementation Model

This section describes how SCA components are implemented using the C++ programming language. It shows how a C++ implementation based component can implement a local or remotable service, and how the implementation can be made configurable through properties.

A component implementation can itself be a client of services. This aspect of a component implementation is described in the basic client model section.

2.1 Implementing a Service

A component implementation based on a C++ class (a C++ implementation) provides one or more services.

A service provided by a C++ implementation has an interface (a service interface) which is defined using one of:

- a C++ abstract base class
- a WSDL 1.1 portType [WSDL11]

An abstract base class is a class which has only pure virtual member functions. A C++ implementation MUST implement all of the operation(s) of the service interface(s) of its componentType. [CPP20001]

Snippet 2-1 – Snippet 2-3 show a C++ service interface and the C++ implementation class of a C++ implementation.

// LoanService interface
class LoanService {
public:
    virtual bool approveLoan(unsigned long customerNumber, unsigned long loanAmount) = 0;
};

Snippet 2-1: A C++ Service Interface

class LoanServiceImpl : public LoanService {
public:
    LoanServiceImpl();
    virtual ~LoanServiceImpl();
    virtual bool approveLoan(unsigned long customerNumber, unsigned long loanAmount);
};

Snippet 2-2: C++ Service Implementation Declaration

#include "LoanServiceImpl.h"

LoanServiceImpl::LoanServiceImpl()
{
...
}

LoanServiceImpl::~LoanServiceImpl()
{
...
}

bool LoanServiceImpl::approveLoan(unsigned long customerNumber,
unsigned long loanAmount)
{
    ...
}

Snippet 2-3: C++ Service Implementation

The following snippet shows the component type for this component implementation.

Snippets 2-4: Component Type for Service Implementation in Snippet 2-3

Figure 2-1 shows the relationship between the C++ header files and implementation files for a component that has a single service and a single reference.

2.1.1 Implementing a Remotable Service

A @remotable="true" attribute on an interface.cpp element indicates that the interface is remotable as described in the Assembly Specification [ASSEMBLY]. Snippet 2-5 shows the component type for a remotable service:

Snippets 2-5: ComponentType for a Remotable Service
2.1.2 AllowsPassByReference

Calls to remotable services have by-value semantics. This means that input parameters passed to the service can be modified by the service without these modifications being visible to the client. Similarly, the return value or exception from the service can be modified by the client without these modifications being visible to the service implementation. For remote calls (either cross-machine or cross-process), these semantics are a consequence of marshalling input parameters, return values and exceptions “on the wire” and unmarshalling them “off the wire” which results in physical copies being made. For local calls within the same operating system address space, C++ calling semantics include by-reference and therefore do not provide the correct by-value semantics for SCA remotable interfaces. To compensate for this, the SCA runtime can intervene in these calls to provide by-value semantics by making copies of any by-reference values passed.

The cost of such copying can be very high relative to the cost of making a local call, especially if the data being passed is large. Also, in many cases this copying is not needed if the implementation observes certain conventions for how input parameters, return values and exceptions are used. An @allowsPassByReference="true" attribute allows implementations to indicate that they use input parameters, return values and exceptions in a manner that allows the SCA runtime to avoid the cost of copying by-reference values when a remotable service is called locally within the same operating system address space. See Implementation.cpp and Implementation Function for a description of the @allowsPassByReference attribute and how it is used.

2.1.2.1 Marking services and references as “allows pass by reference”

Marking a service member function implementation as “allows pass by reference” asserts that the member function implementation observes the following restrictions:

- Member function execution will not modify any input parameter before the member function returns.
- The service implementation will not retain a reference or pointer to any by-reference input parameter, return value or exception after the member function returns.
- The member function will observe “allows pass by value” client semantics, as defined in the next paragraph for any callbacks that it makes.

Marking a client as “allows pass by reference” asserts that for all reference’s member functions, the client observes the restrictions:

- The client implementation will not modify any member function’s input parameters before the member function returns. Such modifications might occur in callbacks or separate client threads.
- If a member function is one-way, the client implementation will not modify any of the member function’s input parameters at any time after calling the operation. This is because one-way member function calls return immediately without waiting for the service member function to complete.

2.1.2.2 Using “allows pass by reference” to optimize remotable calls

The SCA runtime MAY use by-reference semantics when passing input parameters, return values or exceptions on calls to remotable services within the same system address space if both the service member function implementation and the client are marked “allows pass by reference”. [CPP20014]

The SCA runtime MUST use by-value semantics when passing input parameters, return values and exceptions on calls to remotable services within the same system address space if the service member function implementation is not marked “allows pass by reference” or the client is not marked “allows pass by reference”. [CPP20015]

2.1.3 Implementing a Local Service

A service interface not marked as remotable is local.
2.2 Component Implementation Scopes

SCA defines the concept of implementation scope, which specifies the lifecycle contract an implementation has with the runtime. Invocations on a service offered by a component will be dispatched by the SCA runtime to an implementation instance according to the semantics of its scope.

Scopes are specified using the `@scope` attribute of the `implementation.cpp` element.

When a scope is not specified on an implementation class, the SCA runtime will interpret the implementation scope as `stateless`.

An SCA runtime MUST support these scopes: `stateless` and `composite`. Additional scopes MAY be provided by SCA runtimes. [CPP20003]

Snippet 2-6 shows the component type for a composite scoped component:

```xml
<component name="LoanService">
  <implementation.cpp library="loan" class="LoanServiceImpl"
  scope="composite"/>
</component>
```

Snippet 2-6: Component Type for a CompositeScoped Component

Independent of scope, component implementations have to manage any state maintained in global variables or static data members. A library can be loaded as early as when any component implemented by the library enters the running state [ASSEMBLY] but no later than the first member function invocation of a service provided by a component implemented by the library. Component implementations can not make any assumptions about when a library might be unloaded. An SCA runtime MUST NOT perform any synchronization of access to component implementations. [CPP20018]

2.2.1 Stateless Scope

For stateless scope components, there is no implied correlation between implementation instances used to dispatch service requests.

The concurrency model for the stateless scope is single threaded. An SCA runtime MUST ensure that a stateless scoped implementation instance object is only ever dispatched on one thread at any one time. In addition, within the SCA lifecycle of an instance, an SCA runtime MUST only make a single invocation of one business member function. [CPP20012]

2.2.2 Composite Scope

All service requests are dispatched to the same implementation instance for the lifetime of the composite containing the component. The lifetime of the containing composite is defined as the time it placed in the running state to the time it is removed form the running state, either normally or abnormally.

A composite scoped implementation can also specify eager initialization using the `@eagerInit="true"` attribute on the `implementation.cpp` element of a component definition. When marked for eager initialization, the implementation instance will be created when the component is placed in running state, otherwise, initialization is lazy and the instance will be created when the first client request is received.

The concurrency model for the composite scope is multi-threaded. An SCA runtime MAY run multiple threads in a single composite scoped implementation instance object. [CPP20013]

2.3 Implementing a Configuration Property

Component implementations can be configured through properties. The properties and their types (not their values) are defined in the component type file. The C++ component can retrieve the properties using the `getProperties()` on the `ComponentContext` class.

Snippet 2-7 shows how to get the property values.
```cpp
#include "ComponentContext.h"
using namespace oasis::sca;

void clientFunction()
{
    ...
    ComponentContextPtr context = ComponentContext::getCurrent();
    DataObjectPtr properties = context->getProperties();
    long loanRating = properties->getInteger("maxLoanValue");
    ...
}
```

**Snippet 2-7: Retrieving Property Values**

### 2.4 Component Type and Component

For a C++ component implementation, a component type is specified in a side file. By default, the `componentType` side file is in the root directory of the composite containing the component or some subdirectory of the composite root directory with a name matching the implementation class of the component. The location can be modified as described in `Implementation.cpp`.

This Client and Implementation Model for C++ extends the SCA Assembly model [ASSEMBLY] providing support for the C++ interface type system and support for the C++ implementation type.

Snippet 2-8 – Snippet 2-10 show a C++ service interface and the C++ implementation class of a C++ service.

```cpp
// LoanService interface
class LoanService {
    public:
        virtual bool approveLoan(unsigned long customerNumber,
                                  unsigned long loanAmount) = 0;
};
```

**Snippet 2-8: A C++ Service Interface**

```cpp
class LoanServiceImpl : public LoanService {
    public:
        LoanServiceImpl();
        virtual ~LoanServiceImpl();
        virtual bool approveLoan(unsigned long customerNumber,
                                   unsigned long loanAmount);
};
```

**Snippet 2-9: C++ Service Implementation Declaration**

```cpp
#include "LoanServiceImpl.h"
// Construction/Destruction
LoanServiceImpl::LoanServiceImpl() {
    ...
}
LoanServiceImpl::~LoanServiceImpl() {
    ...
}
```


```cpp
// Implementation

bool LoanServiceImpl::approveLoan(unsigned long customerNumber,
    unsigned long loanAmount)
{
    ... 
}
```  

Snippet 2-10: C++ Service Implementation

Snippet 2-11 shows the component type for this component implementation.

```xml
<componentType xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200912">
    <service name="LoanService">
        <interface.cpp header="LoanService.h"/>
    </service>
</componentType>
```

Snippet 2-11: Component Type for Service Implementation in Snippet 2-10

Snippet 2-12 shows a component using the implementation.

```xml
<composite xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200912"
    name="LoanComposite" >
    ...
    <component name="LoanService">
        <implementation.cpp library="loan" class="LoanServiceImpl"/>
    </component>
</composite>
```

Snippet 2-12: Component Using Implementation in Snippet 2-10

2.4.1 Interface.cpp

Snippet 2-13 shows the pseudo-schema for the C++ interface element used to type services and references of component types.

```xml
<!-- interface.cpp schema snippet -->
<interface.cpp xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200912"
    header="string" class="Name"? remotable="boolean"?
    callbackHeader="string" callbackClass="Name"?
    requires="listOfQNames"? policySets="listOfQNames"? >
    <function ... />*
    <callbackFunction ... />*
    <requires/>*
    <policySetAttachment/>*
</interface.cpp>
```

Snippet 2-13: Pseudo-schema for C++ Interface Element

The `interface.cpp` element has the attributes:

- **header : string (1..1)** – full name of the header file that describes the interface, including relative path from the composite root.
- **class : Name (0..1)** – name of the class declaration for the interface in the header file, including any namespace definition. If the header file identified by the @header attribute of an <interface.cpp/> element contains more than one class, then the @class attribute MUST be specified for the <interface.cpp/> element. [CPP20005]

- **callbackHeader : string (0..1)** – full name of the header file that describes the callback interface, including relative path from the composite root.

- **callbackClass : Name (0..1)** – name of the class declaration for the callback interface in the callback header file, including any namespace definition. If the header file identified by the @callbackHeader attribute of an <interface.cpp/> element contains more than one class, then the @callbackClass attribute MUST be specified for the <interface.cpp/> element. [CPP20006]

- **remotable : boolean (0..1)** – indicates whether the service is remotable or local. The default is local. See Implementing a Remotable Service

- **requires : listOfQNames (0..1)** – a list of policy intents. See the Policy Framework specification [POLICY] for a description of this attribute. If intents are specified at both the class and member function level, the effective intents for the member function is determined by merging the combined intents from the member function with the combined intents for the class according to the Policy Framework rules for merging intents within a structural hierarchy, with the member function at the lower level and the class at the higher level.

- **policySets : listOfQNames (0..1)** – a list of policy sets. See the Policy Framework specification [POLICY] for a description of this attribute.

The interface.cpp element has the **child elements**:

- **function : CPPFunction (0..n)** – see Function and CallbackFunction

- **callbackFunction : CPPFunction (0..n)** – see Function and CallbackFunction

- **requires : requires (0..n)** - See the Policy Framework specification [POLICY] for a description of this element.

- **policySetAttachment : policySetAttachment (0..n)** - See the Policy Framework specification [POLICY] for a description of this element.

### 2.4.2 Function and CallbackFunction

A member function of an interface might have behavioral characteristics that need to be identified. This is done using a **function** or **callbackFunction** child element of **interface.cpp**. These child elements are also used when not all functions in a class are part of the interface.

- If the header file identified by the @header attribute of an <interface.cpp/> element contains function declarations that are not operations of the interface, then the functions that are not operations of the interface MUST be excluded using <function/> child elements of the <interface.cpp/> element with @exclude="true". [CPP20016]

- If the header file identified by the @callbackHeader attribute of an <interface.cpp/> element contains function declarations that are not operations of the callback interface, then the functions that are not operations of the callback interface MUST be excluded using <callbackFunction/> child elements of the <interface.cpp/> element with @exclude="true". [CPP20017]

Snippet 2-14 shows the **interface.cpp** pseudo-schema with the pseudo-schema for the **function** and **callbackFunction** child elements:

```xml
<interface.cpp xmlns="http://docs.oasis-open.org/ns/openCSA/sca/200912" ...
  <function name="NCName" requires="listOfQNames" policySets="listOfQNames" oneWay="Boolean" exclude="Boolean"/>
</interface.cpp>
```
The function and callbackFunction elements have the attributes:

- **name**: NCName (1..1) – name of the method being decorated. The @name attribute of a <function/> child element of a <interface.cpp/> MUST be unique amongst the <function/> elements of that <interface.cpp/>. [CPP20007]
- requires : listOfQNames (0..1) – a list of policy intents. See the Policy Framework specification [POLICY] for a description of this attribute.
- policySets : listOfQNames (0..1) – a list of policy sets. See the Policy Framework specification [POLICY] for a description of this attribute.
- oneWay : boolean (0..1) – see Non-blocking Calls
- exclude : boolean (0..1) – if true, the member function is excluded from the interface. The default is false.

The function and callbackFunction elements have the child elements:

- **requires : requires (0..n)** - See the Policy Framework specification [POLICY] for a description of this element.
- **policySetAttachment : policySetAttachment (0..n)** - See the Policy Framework specification [POLICY] for a description of this element.

### 2.4.3 Implementation.cpp

Snippet 2-15 shows the pseudo-schema for the C++ implementation element used to define the implementation of a component.

```xml
<implementation.cpp xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200912" library="NCName" path="string"? class="Name" scope="scope"? componentType="string"? allowsPassByReference="Boolean"? eagerInit="boolean"? requires="listOfQNames"? policySets="listOfQNames"?/>
</implementation.cpp>
```

Snippet 2-15: Pseudo-schema for C++ Implementation Element

The implementation.cpp element has the attributes:
• **library**: NCName (0..1) – name of the dll or shared library that holds the factory for the service component. This is the root name of the library.

• **path**: string (0..1) - path to the library which is either relative to the root of the contribution containing the composite or is prefixed with a contribution import name and is relative to the root of the import. See C++ Contributions.

• **class**: Name (0..1) – name of the class declaration of the implementation, including any namespace definition. The name of the componentType file for a C++ implementation MUST match the class name (excluding any namespace definition) of the implementations as defined by the @class attribute of the `<implementation.cpp/>` element. [CPP2009] The SCA runtime will append .componentType to the class name to find the componentType file.

• **scope**: CPPImplementationScope (0..1) – identifies the scope of the component implementation. The default is stateless. See Component Implementation Scopes

• **componentType**: string (0..1) – path to the componentType file which is relative to the root of the contribution containing the composite or is prefixed with a contribution import name and is relative to the root of the import.

• **allowsPassByReference**: boolean (0..1) – indicates the implementation allows pass by reference data exchange semantics on calls to it or from it. These semantics apply to all services provided by and references used by an implementation. See AllowsPassByReference

• **eagerInit**: boolean (0..1) – indicates a composite scoped implementation is to be initialized when it is loaded. See Composite Scope

• **requires**: listOfQNames (0..1) – a list of policy intents. See the Policy Framework specification [POLICY] for a description of this attribute. If intents are specified at both the class and member function level, the effective intents for the member function is determined by merging the combined intents from the member function with the combined intents for the class according to the Policy Framework rules for merging intents within a structural hierarchy, with the member function at the lower level and the class at the higher level.

• **policySets**: listOfQNames (0..1) – a list of policy sets. See the Policy Framework specification [POLICY] for a description of this attribute.

The `implementation.cpp` element has the child elements:

• **function**: CPPImplementationMethod (0..n) – see Implementation Function

• **requires**: requires (0..n) - See the Policy Framework specification [POLICY] for a description of this element.

• **policySetAttachment**: policySetAttachment (0..n) - See the Policy Framework specification [POLICY] for a description of this element.

### 2.4.4 Implementation Function

A member function of an implementation might have operational characteristics that need to be identified. This is done using a `function` child element of `implementation.cpp`

Snippet 2-16 shows the `implementation.cpp` schema with the schema for a `method` child element:
Snippet 2-16: Pseudo-schema for Implementation Function Sub-element

The function element has the attributes:

- **name**: NCName (1..1) – name of the method being decorated. The @name attribute of a <function/> child element of a <implementation.cpp/> MUST be unique amongst the <function/> elements of that <implementation.cpp/>. [CPP20010]

- **requires**: listOfQNames (0..1) – a list of policy intents. See the Policy Framework specification [POLICY] for a description of this attribute.

- **policySets**: listOfQNames (0..1) – a list of policy sets. See the Policy Framework specification [POLICY] for a description of this attribute.

- **allowsPassByReference**: boolean (0..1) – indicates the member function allows pass by reference data exchange semantics. See AllowsPassByReference

The function element has the child elements:

- **requires**: requires (0..n) - See the Policy Framework specification [POLICY] for a description of this element.

- **policySetAttachment**: policySetAttachment (0..n) - See the Policy Framework specification [POLICY] for a description of this element.

### 2.5 Instantiation

A C++ implementation class MUST be default constructable by the SCA runtime to instantiate the component. [CPP20011]
3 Basic Client Model

This section describes how to get access to SCA services from both SCA components and from non-SCA components. It also describes how to call methods of these services.

3.1 Accessing Services from Component Implementations

A component can get access to a service using a component context. Snippet 3-1 shows the ComponentContext C++ class with its getService() member function.

```cpp
namespace oasis {
  namespace sca {
    class ComponentContext {
      public:
        static ComponentContextPtr getCurrent();
        virtual ServiceProxyPtr getService(
          const std::string& referenceName) const = 0;
        ...
    }
  }
}
```

Snippet 3-1: Partial ComponentContext Class Definition

The getService() member function takes as its input argument the name of the reference and returns a pointer to a proxy providing access to the service. The returned pointer is to a generic ServiceProxy and is assigned to a pointer to a proxy which is derived from ServiceProxy and implements the interface of the reference.

Snippet 3-2 a sample of how the ComponentContext is used in a C++ component implementation. The getService() member function is called on the ComponentContext passing the reference name as input. The return of the getService() member function is cast to the abstract base class defined for the reference.

```cpp
#include "ComponentContext.h"
#include "CustomerServiceProxy.h"
using namespace oasis::sca;
void clientFunction()
{
  unsigned long customerNumber = 1234;
  ComponentContextPtr context = ComponentContext::getCurrent();
  ServiceProxyPtr service = context->getService("customerService");
  CustomerServiceProxyPtr customerService =
    dynamicCast<CustomerServiceProxy>(service);
  if (customerService)
    short rating = customerService->getCreditRating(customerNumber);
}
```
### 3.2 Interface Proxies

For each Reference used by a client, a proxy class is generated by an SCA implementation. The proxy class for a Reference is derived from both the base `ServiceProxy` and the interface of the Reference (details below) and implements the necessary functionality to inform the SCA runtime that an operation is being invoked and submit the request over the transport determined by the wiring.

The base `ServiceProxy` class definition (in the namespace `oasis::sca`) is:

```cpp
class ServiceProxy {
  public:
    // Possible future extensions
};
```

#### Snippet 3-3: ServiceProxy Class Definition

A remotable interface is always mappable to WSDL, which can be mapped to C++ as described in WSDL to C++ and C++ to WSDL Mapping. The proxy class for a remotable interface is derived from `ServiceProxy` and contains the member functions mapped from the WSDL definition for the interface. If a remotable interface is defined with a C++ class, an SCA implementation SHOULD map the interface definition to WSDL before generating the proxy for the interface. [CPP30001]

For the interface definition:

```xml
<definitions xmlns="http://schemas.xmlsoap.org/wsd1/
xmlns:soap="http://schemas.xmlsoap.org/wsd1/soap/
xmlns:tns="http://www.example.org/
xmlns:cpp="http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/cpp/200901"
targetNamespace="http://www.example.org/">
  <xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
    xmlns:tns="http://www.example.org/"
    attributeFormDefault="unqualified"
    elementFormDefault="unqualified"
    targetNamespace="http://www.example.org/">
    <xs:element name="GetLastTradePrice" type="tns:GetLastTradePrice"/>
    <xs:element name="GetLastTradePriceResponse" type="tns:GetLastTradePriceResponse"/>
    <xs:complexType name="GetLastTradePrice">
      <xs:sequence>
        <xs:element name="tickerSymbol" type="xs:string"/>
      </xs:sequence>
    </xs:complexType>
    <xs:complexType name="GetLastTradePriceResponse">
      <xs:sequence>
        <xs:element name="return" type="xs:float"/>
      </xs:sequence>
    </xs:complexType>
  </xs:schema>
</definitions>
```
Snippet 3-4: Sample WSDL Interface

The resulting abstract proxy class is:

```c++

// @WebService(name="StockQuote", targetNamespace="http://www.example.org/"
//  serviceName="StockQuoteService")
class StockQuoteServiceProxy: public ServiceProxy {
  // @WebFunction(operationName="GetLastTradePrice",
  //  action="urn:GetLastTradePrice")
  float getTradePrice(const std::string& tickerSymbol);
};
```

Snippet 3-5: Proxy Class for Interface in Snippet 3-4

The proxy class for a local interface is derived from ServiceProxy and contains the member functions of the C++ class defining the interface. For the interface definition:

```c++

// LoanService interface
class LoanService {
public:
  virtual bool approveLoan(unsigned long customerNumber,
                           unsigned long loanAmount) = 0;
};
```

Snippet 3-6: Sample C++ Interface

The resulting proxy class is:

```c++

class LoanServiceProxy : public ServiceProxy {
public:
  virtual bool approveLoan(unsigned long customerNumber,
                           unsigned long loanAmount) = 0;
};
```

Snippet 3-7: Proxy Class for Interface in Snippet 3-6

For each reference of a component, an SCA implementation MUST generate a service proxy derived from ServiceProxy that contains the operations of the reference’s interface definition. [CPP30002]
3.3 Accessing Services from non-SCA Component Implementations

Non-SCA components can access component services by obtaining a DomainContextPtr from the SCA runtime and then following the same steps as a component implementation as described above.

Snippet 3-8 shows a sample of how the DomainContext is used in non-SCA C++ code.

```cpp
#include "DomainContext.h"
#include "CustomerServiceProxy.h"

void externalFunction()
{
    unsigned long customerNumber = 1234;

    DomainContextPtr context = myImplGetDomain("http://example.com/mydomain");

    ServiceProxyPtr service = context->getService("customerService");
    CustomerServiceProxyPtr customerService =
        dynamicCast<CustomerServiceProxy>(service);

    if (customerService)
    short rating = customerService->getCreditRating(customerNumber);
}
```

Snippet 3-8: Using DomainContext

No SCA metadata is specified for the client. E.g. no binding or policies are specified. Non-SCA clients cannot call services that use callbacks.

The SCA infrastructure decides which binding is used OR extended form of serviceURI is used:

- componentName/serviceName/bindingName

The function myImplGetDomain() in Snippet 3-8 is an example of how a non-SCA client might get a DomainContextPtr and is not a function defined by this specification. The specific mechanism for how an SCA runtime implementation returns a DomainContextPtr is not defined by this specification.

3.4 Calling Service Operations

Accessing Services from Component Implementations and Accessing Services from non-SCA Component Implementations show how to get access to a service. Once you have access to the service, calling an operation of the service is like calling a member function of a C++ class via a ServiceProxy.

If you have access to a service whose interface is marked as remotable, then on calls to operations of that service you will experience remote semantics. Arguments and return are passed by-value and it is possible to get a ServiceUnavailableException, which is a ServiceRuntimeException.

3.5 Long Running Request-Response Operations

The Assembly Specification [ASSEMBLY] allows service interfaces or individual operations to be marked long-running using an @requires="asyncInvocation" intent, with the meaning that the operation(s) might not complete in any specified time interval, even when the operations are request-response operations.

If you have access to a service whose interface is marked as remotable, then on calls to operations of that service you will experience remote semantics. Arguments and return are passed by-value and it is possible to get a ServiceUnavailableException, which is a ServiceRuntimeException.

For a service operation with signature
the asynchronous invocation style includes a member function in the interface proxy class

```cpp
<proxy_class>::<response_message_name>Response <function name>Async(
        <in_parameters>);
```

**Snippet 3-9: AsynchronousInvocation Member Function Format**

where `<response_message_name>Response` is the response class for the operation as defined by the Response Class. The client uses this member function to issue a request through the SCA runtime. The response is returned immediately, and can be used to access the response when it becomes available.

An SCA runtime MUST include an asynchronous invocation member function for every operation of a reference interface with a `@requires="asyncInvocation"` intent applied either to the operation or the reference as a whole. [CPP30003]

Snippet 3-10 shows a sample proxy class interface providing an asynchronous API.

```cpp
using namespace oasis::sca;
using namespace commonj::sdo;

class CustomerServiceProxy : public ServiceProxy {
    public:
        // synchronous member function
        virtual short getCreditRating(unsigned long customerNumber) = 0;
        // forward declare callback class
        class getCreditRatingCallback;
        // asynchronous response object
        class getCreditRatingResponse {
            public:
                // IOU/Future member functions
                virtual void cancel() = 0;
                virtual bool isCancelled() = 0;
                virtual bool isReady() = 0;
                virtual void setCallback(getCreditRatingCallbackPtr callback) = 0;
            virtual short getReturn() = 0;
        }
        // asynchronous callback object
        class getCreditRatingCallback {
            public:
                virtual void invoke(getCreditRatingResponsePtr) = 0;
        }
        // asynchronous member function
        virtual getCreditRatingResponsePtr getCreditRatingAsync(unsigned long customerNumber) = 0;
    }
```

**Snippet 3-10: Proxy with an Asynchronous API**

Snippet 3-11 shows a sample of how the asynchronous invocation style is used in a C++ component implementation.
#include "ComponentContext.h"
#include "CustomerServiceProxy.h"

using namespace oasis::sca;

void clientFunction()
{
    ComponentContextPtr context = ComponentContext::getCurrent();
    ServiceProxyPtr service = context->getService("customerService");
    CustomerServiceProxyPtr customerService =
        dynamicCast<CustomerServiceProxy>(service);

    if (customerService) {
        getCreditRatingResponsePtr response =
            customerService->getCreditRatingAsync(1234);
        // ...
    }
}

Snippet 3-11: Using an Asynchronous API

Once a response object has been returned, the user can use the provided API in order to set a callback object to be invoked when the response is ready, to poll the variable waiting for the response to become available, or to block the current thread waiting for the response to become available.

3.5.1 Response Callback

If a callback is specified on a response object, that callback will be invoked when the response is received by the runtime. Snippet 3-12 demonstrates creating a response object and setting it on a response instance:

#include "ComponentContext.h"
#include "CustomerServiceProxy.h"

using namespace oasis::sca;

class CreditRatingCallback:
    public CustomerServiceProxy::getCreditRatingCallback {

        virtual void invoke(getCreditRatingResponsePtr response) {
            try {
                short rating = response->getReturn();
            } catch (...) {
                // ...
            }
        }
    };

void clientFunction()
{
    ComponentContextPtr context = ComponentContext::getCurrent();
    ServiceProxyPtr service = context->getService("customerService");
    CustomerServiceProxyPtr customerService =
        dynamicCast<CustomerServiceProxy>(service);

    if (customerService) {
        CustomerServiceProxy::getCreditRatingResponsePtr response =
            // ...
        }
    }
}
Snippet 3-12: Using a Response Object

```cpp
customerService->getCreditRatingAsync(1234);
CustomerServiceProxy::getCreditRatingCallbackPtr callback =
    new CreditRatingCallback();
response->setCallback(callback);
// ...
}
```

### 3.5.2 Response Polling

A client can poll a response object in order to determine if a response has been received.

```cpp
#include "ComponentContext.h"
#include "CustomerServiceProxy.h"
using namespace oasis::sca;
void clientFunction()
{
    ComponentContextPtr context = ComponentContext::getCurrent();
    ServiceProxyPtr service = context->getService("customerService");
    CustomerServiceProxyPtr customerService =
        dynamicCast<CustomerServiceProxy>(service);
    if (customerService) {
        CustomerServiceProxy::getCreditRatingResponsePtr response =
            customerService->getCreditRatingAsync(1234);
        while (!response->isReady()) {
            // do something else
        }
        // The response is ready and can be accessed without blocking.
        try {
            short rating = response->getReturn();
        } catch (...) {
            // ...
        }
    }
}
```

Snippet 3-13: Polling a Response Object

### 3.5.3 Synchronous Response Access

If a client chooses to block until a response becomes available, they can attempt to access a part of the response object. If the response has not been received, the call will block until the response is available. Once the response is received and the response object is populated, the call will return.

```cpp
#include "ComponentContext.h"
#include "CustomerServiceProxy.h"
using namespace oasis::sca;
void clientFunction()
```
```cpp
ComponentContextPtr context = ComponentContext::getCurrent();
ServiceProxyPtr service = context->getService("customerService");
CustomerServiceProxyPtr customerService = dynamicCast<CustomerServiceProxy>(service);

if (customerService) {
    CustomerServiceProxy::getCreditRatingResponsePtr response =
        customerService->getCreditRatingAsync(1234);

    // The response is ready and can be accessed without blocking.
    try {
        short rating = response->getReturn();
    }
    catch (...) {
        // ...
    }
}
```

**Snippet 3-14: Blocking on a Response Object**

### 3.5.4 Response Class

The proxy for an interface includes a response class for a response message type returned by an operation that can be invoked asynchronously. A response class presents the following interface to the client component.

```cpp
class <response_message_name>Response {
public:
    virtual <response_message_type> getReturn() const = 0;
    virtual void setCallback(<response_message_name>CallbackPtr callback) = 0;
    virtual boolean isReady() const = 0;
    virtual void cancel() const = 0;
    virtual boolean isCancelled() const = 0;
};
```

**Snippet 3-15: AsynchronousInvocation Response Class Definition**

An SCA runtime MUST include a response class for every response message of a reference interface that can be returned by an operation of the interface with a `@requires="asyncInvocation"` intent applied either to the operation of the reference as a whole. [CPP30004]

#### 3.5.4.1 getReturn

A C++ component implementation uses `getReturn()` to retrieve the response data for an asynchronous invocation.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has an outstanding asynchronous call</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td></td>
</tr>
<tr>
<td>Return</td>
<td>Response data for the operation.</td>
</tr>
<tr>
<td>Throws</td>
<td>Any exceptions defined for the operation.</td>
</tr>
<tr>
<td>Post Condition</td>
<td>The response object is marked as done.</td>
</tr>
</tbody>
</table>

**Table 3-1: AsynchronousInvocation Response::getReturn Details**
### 3.5.4.2 setCallback

A C++ component implementation uses `setCallback()` to set a callback object for an asynchronous invocation.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has an outstanding asynchronous call</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td><code>callback</code></td>
</tr>
<tr>
<td></td>
<td>A pointer to the callback object for the response</td>
</tr>
<tr>
<td>Return</td>
<td></td>
</tr>
<tr>
<td>Post Condition</td>
<td>The response object is marked as done.</td>
</tr>
</tbody>
</table>

*Table 3-2: AsynchronousInvocation Response::setCallback Details*

### 3.5.4.3 isReady

A C++ component implementation uses `isReady()` to determine if the response data for an polling invocation is available.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has an outstanding polling call</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td></td>
</tr>
<tr>
<td>Return</td>
<td>True if the response is available</td>
</tr>
<tr>
<td>Post Condition</td>
<td>No change</td>
</tr>
</tbody>
</table>

*Table 3-3: AsynchronousInvocation Response::isReady Details*

### 3.5.4.4 cancel

A C++ component implementation uses `cancel()` to cancel an outstanding invocation.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has an outstanding asynchronous call</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td></td>
</tr>
<tr>
<td>Return</td>
<td></td>
</tr>
<tr>
<td>Post Condition</td>
<td>If a response is subsequently received for the operation, it will be discarded.</td>
</tr>
</tbody>
</table>

*Table 3-4: AsynchronousInvocation Response::cancel Details*

### 3.5.4.5 isCancelled

A C++ component implementation uses `isCancelled()` to determine if another thread has cancelled an outstanding invocation.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has an outstanding asynchronous call</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td></td>
</tr>
<tr>
<td>Return</td>
<td>True if the operation has been cancelled</td>
</tr>
<tr>
<td>Post Condition</td>
<td>No change</td>
</tr>
</tbody>
</table>

*Table 3-5: AsynchronousInvocation Response::isCancelled Details*
4 Asynchronous Programming

Asynchronous programming of a service is where a client invokes a service and carries on executing without waiting for the service to execute. Typically, the invoked service executes at some later time. Output from the invoked service, if any, is fed back to the client through a separate mechanism, since no output is available at the point where the service is invoked. This is in contrast to the call-and-return style of synchronous programming, where the invoked service executes and returns any output to the client before the client continues. The SCA asynchronous programming model consists of support for non-blocking operation calls and callbacks.

4.1 Non-blocking Calls

Non-blocking calls represent the simplest form of asynchronous programming, where the client of the service invokes the service and continues processing immediately, without waiting for the service to execute.

Any member function that returns void, has only by-value parameters and has no declared exceptions can be marked with the @oneWay="true" attribute in the interface definition of the service. An operation marked as oneWay is considered non-blocking and the SCA runtime MAY use a binding that buffers the requests to the member function and sends them at some time after they are made. [CPP40001]

Snippet 4-1 shows the component type for a service with the reportEvent() member function declared as a one-way operation:

```
<componentType xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200912">
  <service name="LoanService">
    <interface.cpp header="LoanService.h">
      <function name="reportEvent" oneWay="true" />
    </interface.cpp>
  </service>
</componentType>
```

Snippet 4-1: ComponentType with oneWay Member Function

SCA does not currently define a mechanism for making non-blocking calls to methods that return values or are declared to throw exceptions. It is considered to be a best practice that service designers define one-way member function as often as possible, in order to give the greatest degree of binding flexibility to deployers.

4.2 Callbacks

Callback services are used by bidirectional services as defined in the Assembly Specification [ASSEMBLY].

A callback interface is declared by the @callbackHeader and @callbackClass attributes in the interface definition of the service. Snippet 4-2 shows the component type for a service MyService with the interface defined in MyService.h and the interface for callbacks defined in MyServiceCallback.h,

```
<componentType xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200912">
  <service name="MyService">
    <interface.cpp header="MyService.h" callbackHeader="MyServiceCallback.h"/>
  </service>
</componentType>
```

Snippet 4-2: ComponentType with a Callback Interface
4.2.1 Using Callbacks

Bidirectional interfaces and callbacks are used when a simple request/response pattern isn't sufficient to capture the business semantics of a service interaction. Callbacks are well suited for cases when a service request can result in multiple responses or new requests from the service back to the client, or where the service might respond to the client some time after the original request has completed.

Snippet 4-3—Snippet 4-5 show a scenario in which bidirectional interfaces and callbacks could be used. A client requests a quotation from a supplier. To process the enquiry and return the quotation, some suppliers might need additional information from the client. The client does not know which additional items of information will be needed by different suppliers. This interaction can be modeled as a bidirectional interface with callback requests to obtain the additional information.

```cpp
class Quotation {
    public:
        virtual double requestQuotation(std::string productCode,
                                          unsigned int quantity) = 0;
    }

class QuotationCallback {
    public:
        virtual std::string getState() = 0;
        virtual std::string getZipCode() = 0;
        virtual std::string getCreditRating() = 0;
    }

Snippet 4-3: C++ Interface with a Callback Interface
```

In Snippet 4-3, the `requestQuotation` operation requests a quotation to supply a given quantity of a specified product. The `QuotationCallback` interface provides a number of operations that the supplier can use to obtain additional information about the client making the request. For example, some suppliers might quote different prices based on the state or the zip code to which the order will be shipped, and some suppliers might quote a lower price if the ordering company has a good credit rating. Other suppliers might quote a standard price without requesting any additional information from the client.

Snippet 4-4 illustrates a possible implementation of the example service.

```cpp
#include "QuotationImpl.h"
#include "QuotationCallbackProxy.h"
#include "ComponentContext.h"
using namespace oasis::sca;

double QuotationImpl::requestQuotation(std::string productCode,
                                         unsigned int quantity) {
    double price = getPrice(productQuote, quantity);
    double discount = 0;

    ComponentContextPtr context = ComponentContext::getCurrent();
    ServiceReferencePtr serviceRef = context->getSelfReference();
    ServiceProxyPtr callback = serviceRef->getCallback();
    QuotationCallbackQuotationCallbackProxyPtr quotationCallback =
        dynamicCast<QuotationCallbackProxy>(callback);

    if (quotationCallback) {
        if (quantity > 1000 && callback->getState().compare("FL") == 0)
            discount = 0.05;
        if (quantity > 10000 && callback->getCreditRating().data() == 'A')
            discount += 0.05;
    }
    return price * (1 - discount);
```

Snippet 4-4: Example Implementation
Snippet 4-4: Implementation of Forward Service with Interface in Snippet 4-3

Snippet 4-5 is taken from the client of this example service. The client’s service implementation class implements the member functions of the QuotationCallback interface as well as those of its own service interface ClientService.

```cpp
#include "QuotationCallback.h"
#include "QuotationServiceProxy.h"
#include "ComponentContext.h"

using namespace oasis::sca;

void ClientImpl::aClientFunction() {
    ComponentContextPtr context = ComponentContext::getCurrent();
    ServiceProxyPtr service = context->getService("quotationService");
    QuotationServiceProxyPtr quotationService =
        dynamicCast<QuotationServiceProxy>(service);
    if (quotationService)
        quotationService->requestQuotation("AB123", 2000);
}

std::string QuotationCallbackImpl::getState() {
    return "TX";
}

std::string QuotationCallbackImpl::getZipCode() {
    return "78746";
}

std::string QuotationCallbackImpl::getCreditRating() {
    return "AA";
}
```

Snippet 4-5: Implementation of Callback Interface in Snippet 4-3

For each service of a component that includes a bidirectional interface, an SCA implementation MUST generate a service proxy derived from ServiceProxy that contains the operations of the reference’s callback interface definition. [CPP40002]

If a service of a component that has a callback interface contains operations with a @requires="asyncInvocation" intent applied either to the operation of the reference as a whole, an SCA implementation MUST include asynchronous invocation member functions and response classes as described in Long Running Request-Response Operations. [CPP40003]

In the example the callback is stateless, i.e., the callback requests do not need any information relating to the original service request. For a callback that needs information relating to the original service request (a stateful callback), this information can be passed to the client by the service provider as parameters on the callback request.

4.2.2 Callback Instance Management

Instance management for callback requests received by the client of the bidirectional service is handled in the same way as instance management for regular service requests. If the client implementation has stateless scope, the callback is dispatched using a newly initialized instance. If the client implementation has composite scope, the callback is dispatched using the same shared instance that is used to dispatch regular service requests.

As described in Using Callbacks, a stateful callback can obtain information relating to the original service request from parameters on the callback request. Alternatively, a composite-scoped client could store information relating to the original request as instance data and retrieve it when the callback request is received. These approaches could be combined by using a key passed on the callback request (e.g., an
order ID) to retrieve information that was stored in a composite-scoped instance by the client code that made the original request.

4.2.3 Implementing Multiple Bidirectional Interfaces

Since it is possible for a single class to implement multiple services, it is also possible for callbacks to be defined for each of the services that it implements. To access the callbacks the

ServiceReference::getCallback(serviceName) member function is used, passing in the name of the service for which the callback is to be obtained.
5 Error Handling

Clients calling service operations will experience business exceptions, and SCA runtime exceptions.

Business exceptions are raised by the implementation of the called service operation. It is expected that these will be caught by client invoking the operation on the service.

SCA runtime exceptions are raised by the SCA runtime and signal problems in the management of the execution of components, and in the interaction with remote services. Currently the SCA runtime exceptions defined are:

- SCAException – defines a root exception type from which all SCA defined exceptions derive.
  - SCANullPointerException – signals that code attempted to dereference a null pointer from a RefCountingPointer object.
  - ServiceRuntimeException – signals problems in the management of the execution of SCA components.
  - ServiceUnavailableException – signals problems in the interaction with remote services. This extends ServiceRuntimeException. These are exceptions that could be transient, so retrying is appropriate. Any exception that is a ServiceRuntimeException that is not a ServiceUnavailableException is unlikely to be resolved by retrying the operation, since it most likely requires human intervention.
  - MultipleServicesException – signals that a member function expecting identification of a single service is called where there are multiple services defined. Thrown by ComponentContext::getService(), ComponentContext::getSelfReference() and ComponentContext::getServiceReference().
6 C++ API

All the C++ interfaces are found in the namespace oasis::sca, which has been omitted from the definitions for clarity.

6.1 Reference Counting Pointers

These are a derived version of the familiar smart-pointer. The pointer class holds a real (dumb) pointer to the object. If the reference counting pointer is copied, then a duplicate pointer is returned with the same real pointer. A reference count within the object is incremented for each copy of the pointer, so only when all pointers go out of scope will the object be freed.

Reference counting pointers in SCA have the same name as the type they are pointing to, with a suffix of Ptr. (E.g. ComponentContextPtr, ServiceReferencePtr).

RefCountingPointer defines member functions with raw pointer like semantics. This includes defining operators for dereferencing the pointer (*, ->), as well as operators for determining the validity of the pointer.

```cpp
template <typename T>
class RefCountingPointer {
public:
T& operator* () const;
T* operator-> () const;
operator void* () const;
bool operator! () const;
};
```

```cpp
template <typename T, typename U>
RefCountingPointer<T> constCast(RefCountingPointer<U> other);
```

```cpp
template <typename T, typename U>
RefCountingPointer<T> dynamicCast(RefCountingPointer<U> other);
```

```cpp
template <typename T, typename U>
RefCountingPointer<T> reinterpretCast(RefCountingPointer<U> other);
```

```cpp
template <typename T, typename U>
RefCountingPointer<T> staticCast(RefCountingPointer<U> other);
```

Snippet 6-1: RefCountingPointer Class Definition

6.1.1 operator*

A C++ component implementation uses the * operator to dereferences the underlying pointer of a reference counting pointer. This is equivalent to calling *p where p is the underlying pointer.

| Precondition | C++ component instance is running and has a reference counting pointer |
| Return       | A reference to the value of the pointer |
| Throws       | SCANullPointerException if the pointer is NULL |
| Post Condition | No change |

Table 6-1: RefCountingPointer operator* Details
6.1.2 operator->

A C++ component implementation uses the -> operator to invoke member functions on the underlying pointer of a reference counting pointer. This is equivalent to invoking p->func() where func() is a member function defined on the underlying pointer type.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has a reference counting pointer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td></td>
</tr>
<tr>
<td>Throws</td>
<td>SCANullPointerException if the pointer is NULL</td>
</tr>
<tr>
<td>Post Condition</td>
<td>The underlying member functions has been processed.</td>
</tr>
</tbody>
</table>

Table 6-2: RefCountingPointer operator-> Details

6.1.3 operator void*

A C++ component implementation uses the void* operator to determine if the underlying pointer of a reference counting pointer is set, i.e. if (p) { /* do something */ }.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has a reference counting pointer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>Zero if the underlying pointer is null, otherwise a non-zero value</td>
</tr>
<tr>
<td>Post Condition</td>
<td>No change</td>
</tr>
</tbody>
</table>

Table 6-3: RefCountingPointer operator void* Details

6.1.4 operator!

A C++ component implementation uses the ! operator to determine if the underlying pointer of a reference counting pointer is not set, i.e. if (!p) { /* do something */ }.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has a reference counting pointer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>A non-zero value if the underlying pointer is null, otherwise zero</td>
</tr>
<tr>
<td>Post Condition</td>
<td>No change</td>
</tr>
</tbody>
</table>

Table 6-4: RefCountingPointer operator! Details

6.1.5 constCast

The constCast global function provides the semantic behavior of the const_cast operator for use with RefCountingPointers.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has a reference counting pointer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>A RefCountingPointer instance templatized on the target type.</td>
</tr>
<tr>
<td>Post Condition</td>
<td>No change</td>
</tr>
</tbody>
</table>

Table 6-5: constCast for RefCountingPointers Details

6.1.6 dynamicCast

The dynamicCast global function provides the semantic behavior of the dynamic_cast operator for use with RefCountingPointers.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has a reference counting pointer</th>
</tr>
</thead>
</table>
Return | A RefCountingPointer instance templatized on the target type. This can return an invalid RefCountingPointer instance if the cast fails.
---|---
Post Condition | No change

Table 6-6: dynamicCast for RefCountingPointers Details

### 6.1.7 reinterpretCast

The reinterpretCast global function provides the semantic behavior of the reinterpret_cast operator for use with RefCountingPointers.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has a reference counting pointer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>A RefCountingPointer instance templatized on the target type.</td>
</tr>
<tr>
<td>Post Condition</td>
<td>No change</td>
</tr>
</tbody>
</table>

Table 6-7: reinterpretCast for RefCountingPointers Details

### 6.1.8 staticCast

The staticCast global function provides the semantic behavior of the static_cast operator for use with RefCountingPointers.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has a reference counting pointer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>A RefCountingPointer instance templatized on the target type.</td>
</tr>
<tr>
<td>Post Condition</td>
<td>No change</td>
</tr>
</tbody>
</table>

Table 6-8: staticCast for RefCountingPointers Details

### 6.2 Component Context

The complete ComponentContext interface definition is:

```cpp
class ComponentContext {
    public:
        static ComponentContextPtr getCurrent();
        virtual std::string getURI() const = 0;
        virtual ServiceProxyPtr getService(const std::string& referenceName) const = 0;
        virtual ServiceProxyPtr getService(const std::string& serviceName)const = 0;
        virtual std::vector<ServiceProxyPtr> getServices();
        virtual std::vector<ServiceProxyPtr> getServiceReferences();
        virtual ServiceReferencePtr getServiceReference(const std::string& referenceName) const = 0;
        virtual ServiceReferencePtr getServiceReference(const std::string& referenceName) const = 0;
        virtual ServiceReferencePtr getServiceReference(const std::string& referenceName) const = 0;
        virtual ServiceReferencePtr getServiceReference(const std::string& referenceName) const = 0;

        virtual commonj::sdo::DataObjectPtr getProperties() const = 0;
        virtual commonj::sdo::DataFactoryPtr getDataFactory() const = 0;
        virtual ServiceReferencePtr getSelfReference() const = 0;
        virtual ServiceReferencePtr getSelfReference(const std::string& serviceName)const = 0;
    };
```
6.2.1 getCurrent

A C++ component implementation uses `ComponentContext::getCurrent()` to get a `ComponentContext` object for itself.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td></td>
</tr>
<tr>
<td>Return</td>
<td><code>ComponentContext</code> for the current component</td>
</tr>
<tr>
<td>Post Condition</td>
<td>The component instance has a valid context object to use for subsequent runtime calls.</td>
</tr>
</tbody>
</table>

Table 6-9: `ComponentContext::getCurrent` Details

6.2.2 getURI

A C++ component implementation uses `getURI()` to get a structural URI [ASSEMBLY] for itself.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has a <code>ComponentContext</code></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td></td>
</tr>
<tr>
<td>Return</td>
<td>Structural URI for the current component</td>
</tr>
<tr>
<td>Post Condition</td>
<td>No change</td>
</tr>
</tbody>
</table>

Table 6-10: `ComponentContext::getURI` Details

6.2.3 getService

A C++ component implementation uses `getService()` to get a service proxy implementing the interface defined for a Reference.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has a <code>ComponentContext</code></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td><code>referenceName</code> Name of the Reference to get an interface object for</td>
</tr>
<tr>
<td>Return</td>
<td>Pointer to a <code>ServiceProxy</code> implementing the interface of the Reference. This will be NULL if <code>referenceName</code> is not defined for the component.</td>
</tr>
<tr>
<td>Throws</td>
<td><code>MultipleServicesException</code> if the reference resolves to more than one service</td>
</tr>
<tr>
<td>Post Condition</td>
<td>A <code>ServiceProxy</code> object for the Reference is constructed. This <code>ServiceProxy</code> object is independent of any <code>ServiceReference</code> that are obtained for the Reference.</td>
</tr>
</tbody>
</table>

Table 6-11: `ComponentContext::getService` Details

6.2.4 getServices

A C++ component implementation uses `getServices()` to get a vector of service proxies implementing the interface defined for a Reference.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has a <code>ComponentContext</code></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td><code>referenceName</code> Name of the Reference to get an interface object for</td>
</tr>
<tr>
<td>Return</td>
<td>Vector of pointers to <code>ServiceProxy</code> objects implementing the interface of the</td>
</tr>
</tbody>
</table>
Reference. This vector will be empty if referenceName is not defined for the component. Operations need to be invoked on each object in the vector.

**Post Condition**
ServiceProxy objects for the Reference are constructed. These ServiceProxy objects are independent of any ServiceReferences that are obtained for the Reference.

---

### 6.2.5 getServiceReference

A C++ component implementation uses `getServiceReference()` to get a ServiceReference for a Reference.

<table>
<thead>
<tr>
<th>Precondition</th>
<th><strong>C++ component instance is running and has a ComponentContext</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td>referenceName</td>
</tr>
<tr>
<td>Return</td>
<td>ServiceReference for the Reference. This will be NULL if referenceName is not defined for the component.</td>
</tr>
<tr>
<td>Throws</td>
<td>MultipleServicesException if the reference resolves to more than one service</td>
</tr>
<tr>
<td>Post Condition</td>
<td>A ServiceReference for the Reference is constructed.</td>
</tr>
</tbody>
</table>

---

### 6.2.6 getServiceReferences

A C++ component implementation uses `getServiceReferences()` to get a vector of ServiceReference for a Reference.

<table>
<thead>
<tr>
<th>Precondition</th>
<th><strong>C++ component instance is running and has a ComponentContext</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td>referenceName</td>
</tr>
<tr>
<td>Return</td>
<td>Vector of ServiceReferences for the Reference. This vector will be empty if referenceName is not defined for the component.</td>
</tr>
<tr>
<td>Post Condition</td>
<td>ServiceReferences for the Reference are constructed.</td>
</tr>
</tbody>
</table>

---

### 6.2.7 getProperties

A C++ component implementation uses `getProperties()` to get its configured property values.

<table>
<thead>
<tr>
<th>Precondition</th>
<th><strong>C++ component instance is running and has a ComponentContext</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td></td>
</tr>
<tr>
<td>Return</td>
<td>An SDO [SDO21] from which all the properties defined in the componentType file can be retrieved.</td>
</tr>
<tr>
<td>Post Condition</td>
<td>An SDO with the property values for the component instance is constructed.</td>
</tr>
</tbody>
</table>

---

Table 6-12: ComponentContext::getServices Details

Table 6-13: ComponentContext::getServiceReference Details

Table 6-14: ComponentContext::getServiceReferences Details

Table 6-15: ComponentContext::getProperties Details
6.2.8 getDataFactory

A C++ component implementation uses `getDataFactory()` to get its an SDO DataFactory which can be used to create DataObjects for complex data types used by this component.

Precondition | C++ component instance is running and has a ComponentContext
--- | ---
Input Parameter |  
Return | An SDO DataFactory which has definitions for all complex data types used by a component.
Post Condition | An SDO DataFactory is constructed

Table 6-16: ComponentContext::getDataFactory Details

6.2.9 getSelfReference

A C++ component implementation uses `getSelfReference()` to get a ServiceReference for use with some callback APIs.

There are two variations of this API.

Precondition | C++ component instance is running and has a ComponentContext
--- | ---
Input Parameter |  
Return | A ServiceReference for the service provided by this component.
Post Condition | A ServiceReference object is constructed

and

Precondition | C++ component instance is running and has a ComponentContext
--- | ---
Input Parameter | serviceName
Return | A ServiceReference for the service provided by this component.
Post Condition | A ServiceReference object is constructed

Table 6-17: ComponentContext::getSelfReference Details

6.3 ServiceReference

The ServiceReference interface definition is:

```c++
class ServiceReference {
public:
  virtual ServiceProxyPtr getService() const = 0;
  virtual ServiceProxyPtr getCallback() const = 0;
};
```

Snippet 6-3: ServiceReference Class Definition
The detailed description of the usage of these member functions is described in Asynchronous Programming.

### 6.3.1 getService

A C++ component implementation uses `getService()` to get a service proxy implementing the interface defined for a `ServiceReference`.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has a <code>ServiceReference</code></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td></td>
</tr>
<tr>
<td>Return</td>
<td>Pointer to a <code>ServiceProxy</code> implementing the interface of the <code>ServiceReference</code>.</td>
</tr>
<tr>
<td>Post Condition</td>
<td>A <code>ServiceProxy</code> object for the <code>ServiceReference</code> is constructed.</td>
</tr>
</tbody>
</table>

*Table 6-18: `ServiceReference::getService` Details*

### 6.3.2 getCallback

A C++ component implementation uses `getCallback()` to get a service proxy implementing the callback interface defined for a `ServiceReference`.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has a <code>ServiceReference</code></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td></td>
</tr>
<tr>
<td>Return</td>
<td>Pointer to a <code>ServiceProxy</code> implementing the callback interface of the <code>ServiceReference</code>. This will be NULL if no callback interface is defined.</td>
</tr>
<tr>
<td>Post Condition</td>
<td>A <code>ServiceProxy</code> object for the callback interface of the <code>ServiceReference</code> is constructed.</td>
</tr>
</tbody>
</table>

*Table 6-19: `ServiceReference::getCallback` Details*

### 6.4 DomainContext

The `DomainContext` interface definition is:

```cpp
class DomainContext {
public:
    virtual ServiceProxyPtr getService(
        const std::string& serviceURI) const = 0;
};
```

*Snippet 6-4: DomainContext Class Definition*

### 6.4.1 getService

Non-SCA C++ code uses `getService()` to get a service proxy implementing the interface of a service in an SCA domain.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td>serviceURI</td>
</tr>
<tr>
<td>Return</td>
<td>Pointer to a <code>ServiceProxy</code> object implementing the interface of the Service. This will be NULL if <code>serviceURI</code> is not defined in the domain.</td>
</tr>
</tbody>
</table>

*Table 6-20: `DomainContext::getService` Details*
### 6.5 SCAException

The SCAException interface definition is:

```cpp
class SCAException : public std::exception {
public:
    const char* getEClassName() const;
    const char* getMessageText() const;
    const char* getFileName() const;
    unsigned long getLineNumber() const;
    const char* getFunctionName() const;
};
```

**Snippet 6-5: SCAException Class Definition**

The details concerning this class and its derived types are described in Error Handling.

#### 6.5.1 getEClassName

A C++ component implementation uses `getEClassName()` to get the name of the exception type.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has caught an SCA Exception</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td></td>
</tr>
<tr>
<td>Return</td>
<td>The type of the exception as a string. e.g. “ServiceUnavailableException”</td>
</tr>
<tr>
<td>Post Condition</td>
<td>No change</td>
</tr>
</tbody>
</table>

**Table 6-21: SCAException::getEClassName Details**

#### 6.5.2 getMessageText

A C++ component implementation uses `getMessageText()` to get any message included with the exception.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has caught an SCA Exception</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td></td>
</tr>
<tr>
<td>Return</td>
<td>The message which the SCA runtime attached to the exception</td>
</tr>
<tr>
<td>Post Condition</td>
<td>No change</td>
</tr>
</tbody>
</table>

**Table 6-22: SCAException::getMessageText Details**

#### 6.5.3 getFileName

A C++ component implementation uses `getFileName()` to get the filename containing the function where the exception occurred.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has caught an SCA Exception</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td></td>
</tr>
</tbody>
</table>

---

**Post Condition**

A `ServiceProxy` object for the Service is constructed.

**Table 6-20: DomainContext::getService Details**
Return | The filename within which the exception occurred – Will be an empty string if the filename is not known
--- | ---
Post Condition | No change

Table 6-23: SCAException::getFileName Details

6.4.4 getLineNumber

A C++ component implementation uses getLineNumber() to get the line number in the source file where the exception occurred.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has caught an SCA Exception</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td></td>
</tr>
<tr>
<td>Return</td>
<td>The line number at which the exception occurred – Will 0 if the line number is not known</td>
</tr>
<tr>
<td>Post Condition</td>
<td>No change</td>
</tr>
</tbody>
</table>

Table 6-24: SCAException::getLineNumber Details

6.5.5 getFunctionName

A C++ component implementation uses getFunctionName() to get the function name where the exception occurred.

<table>
<thead>
<tr>
<th>Precondition</th>
<th>C++ component instance is running and has caught an SCA Exception</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Parameter</td>
<td></td>
</tr>
<tr>
<td>Return</td>
<td>The function name in which the exception occurred – Will be an empty string if the function name is not known</td>
</tr>
<tr>
<td>Post Condition</td>
<td>No change</td>
</tr>
</tbody>
</table>

Table 6-25: SCAException::getFunctionName Details

6.6 SCANullPointerException

The SCANullPointerException interface definition is:

```cpp
class SCANullPointerException : public SCAException {
};
```

Snippet 6-6: SCANullPointerException Class Definition

6.7 ServiceRuntimeException

The ServiceRuntimeException interface definition is:

```cpp
class ServiceRuntimeException : public SCAException {
};
```

Snippet 6-7: ServiceRuntimeException Class Definition
6.8 ServiceUnavailableException

The `ServiceUnavailableException` interface definition is:

```cpp
class ServiceUnavailableException : public ServiceRuntimeException {
};
```

Snippet 6-8: `ServiceUnavailableException` Class Definition

6.9 MultipleServicesException

The `MultipleServicesException` interface definition is:

```cpp
class MultipleServicesException : public ServiceRuntimeException {
};
```

Snippet 6-9: `MultipleServicesException` Class Definition
7 C++ Contributions

Contributions are defined in the Assembly specification [ASSEMBLY]. C++ contributions are typically, but not necessarily contained in .zip files. In addition to SCDL and potentially WSDL artifacts, C++ contributions include binary executable files, componentType files and potentially C++ interface headers. No additional discussion is needed for header files, but there are additional considerations for executable and componentType files.

7.1 Executable files

Executable files containing the C++ implementations for a contribution can be contained in the contribution, contained in another contribution or external to any contribution. In some cases, it could be desirable to have contributions share an executable. In other cases, an implementation deployment policy might dictate that executables are placed in specific directories in a file system.

7.1.1 Executable in contribution

When the executable file containing a C++ implementation is in the same contribution, the @path attribute of the implementation.cpp element is used to specify the location of the executable. The specific location of an executable within a contribution is not defined by this specification. Snippet 7-1 shows a contribution containing a DLL.

```
META-INF/
  sca-contribution.xml
  bin/
    autoinsurance.dll
  AutoInsurance/
    AutoInsurance.composite
    AutoInsuranceService/
      AutoInsurance.h
      AutoInsuranceImpl.componentType
    include/
      Customers.h
      Underwriting.h
      RateUtils.h
```

Snippet 7-1: Contribution Containing a DLL

The SCDL for the AutoInsuranceService component of Snippet 7-1 is:

```
<component name="AutoInsuranceService">
  <implementation cpp library="autoinsurance" path="bin/"
    class="AutoInsuranceImpl" />
</component>
```

Snippet 7-2: Component Definition Using Implementation in a Common DLL

7.1.2 Executable shared with other contribution(s) (Export)

If a contribution contains an executable that also implements C++ components found in other contributions, the contribution has to export the executable. An executable in a contribution is made visible to other contributions by adding an export.cpp element to the contribution definition as shown in Snippet 7-3.

```
<contribution>
```
It is also possible to export only a subtree of a contribution. For a contribution:

```xml
META-INF/
  sca-contribution.xml
bin/
  rates.dll
RateUtilities/
  RateUtilities.composite
  RateUtilitiesService/
    RateUtils.h
    RateUtilsImpl.componentType
```

**Snippet 7-4: Contribution with a Subdirectory to be Shared**

An export of the form:

```xml
<contribution>
  <deployable composite="myNS:RateUtilities"
    <export.cpp name="contribNS:rates"
      path="bin/">
  </contribution>
```

**Snippet 7-5: Exporting a Subdirectory of a Contribution**

only makes the contents of the bin directory visible to other contributions. By placing all of the executable files of a contribution in a single directory and exporting only that directory, the amount of information available to a contribution that uses the exported executable files is limited. This is considered a best practice.

### 7.1.3 Executable outside of contribution (Import)

When the executable that implements a C++ component is located outside of a contribution, the contribution has to import the executable. If the executable is located in another contribution, the `import.cpp` element of the contribution definition uses a `@location` attribute that identifies the name of the export as defined in the contribution that defined the export as shown in Snippet 7-6.

```xml
<contribution>
  <deployable composite="myNS:Underwriting"
    <import.cpp name="rates"
      location="contribNS:rates">
  </contribution>
```

**Snippet 7-6: Contribution with an Import**

The SCDL for the UnderwritingService component of Snippet 7-6 is:

```xml
<component name="UnderwritingService">
  <implementation cpp library="rates"
    class="UnderwritingImpl" />
</component>
```

**Snippet 7-7: Component Definition Using Implementation in an External DLL**
If the executable is located in the file system, the @location attribute identifies the location in the files system used as the root of the import as shown in Snippet 7-8.

```xml
<contribution>
  <deployable composite="myNS:CustomerUtilities">
    <import.cpp name="usr-bin" location="/usr/bin/"/>
  </deployable>
</contribution>
```

Snippet 7-8: Component Definition Using Implementation in a File System

### 7.2 componentType files

As stated in Component Type and Component, each component implemented in C++ has a corresponding componentType file. This componentType file is, by default, located in the root directory of the composite containing the component or a subdirectory of the composite root with the name <implementation class>.componentType, as shown in Snippet 7-9.

```xml
META-INF/
  sca-contribution.xml
bin/
  autoinsurance.dll
AutoInsurance/
  AutoInsurance.composite
  AutoInsuranceService/
    AutoInsurance.h
    AutoInsuranceImpl.componentType
```

Snippet 7-9: Contribution with ComponentType

The SCDL for the AutoInsuranceService component of Snippet 7-9 is:

```xml
<component name="AutoInsuranceService">
  <implementation.cpp library="autoinsurance" path="bin/"
    class="AutoInsuranceImpl"/>
</component>
```

Snippet 7-10: Component Definition with Local ComponentType

Since there is a one-to-one correspondence between implementations and componentTypes, when an implementation is shared between contributions, it is desirable to also share the componentType file. ComponentType files can be exported and imported in the same manner as executable files. The location of a .componentType file can be specified using the @componentType attribute of the implementation.cpp element.

```xml
<component name="UnderwritingService">
  <implementation.cpp library="rates" path="rates:bin/"
    class="UnderwritingImpl" componentType="rates:types/UnderwritingImpl"/>
</component>
```

Snippet 7-11: Component Definition with Imported ComponentType
7.3 C++ Contribution Extensions

7.3.1 Export.cpp
Snippet 7-12 shows the pseudo-schema for the C++ export element used to make an executable or componentType file visible outside of a contribution.

```xml
<!-- export.cpp schema snippet -->
<export.cpp xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200912"
    name="QName" path="string"> &gt;
```

Snippet 7-12: Pseudo-schema for C++ Export Element

The export.cpp element has the following attributes:

- **name : QName (1..1)** – name of the export. The @name attribute of a `<export.cpp/>` element MUST be unique amongst the `<export.cpp/>` elements in a domain. [CPP70001]

- **path : string (0..1)** – path of the exported executable relative to the root of the contribution. If not present, the entire contribution is exported.

7.3.2 Import.cpp
Snippet 7-13 shows the pseudo-schema for the C++ import element used to reference an executable or componentType file that is outside of a contribution.

```xml
<!-- import.cpp schema snippet -->
<import.cpp xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200912"
    name="QName" location="string" />
```

Snippet 7-13: Pseudo-schema for C++ Import Element

The import.cpp element has the following attributes:

- **name : QName (1..1)** – name of the import. The @name attribute of a `<import.cpp/>` child element of a `<contribution/>` MUST be unique amongst the `<import.cpp/>` elements in of that contribution. [CPP70002]

- **location : string (1..1)** – either the QName of a export or a file system location. If the value does not match an export name it is taken as an absolute file system path.
8 C++ Interfaces

A service interface can be defined by a C++ class which has only pure virtual public member functions. The class might additionally have private or protected member functions, but these are not part of the service interface.

When mapping a C++ interface to WSDL or when comparing two C++ interfaces for compatibility, as defined by the Assembly specification [ASSEMBLY], it is necessary for an SCA implementation to determine the signature (return type, name, and the names and types of the parameters) of every member function of the class defining the service interface. An SCA implementation MUST translate a class to tokens as part of conversion to WSDL or compatibility testing. [CPP80001] Macros and typedefs in member function declarations might lead to portability problems. Complete member function declarations within a macro are discouraged. The processing of typedefs needs to be aware of the types that impact mapping to WSDL (see Table 9-1 and Table 9-2)

8.1 Types Supported in Service Interfaces

Not all service interfaces support the complete set of the types available in C++.

8.1.1 Local Service

Any fundamental or compound type defined by C++ can be used in the interface of a local service.

8.1.2 Remotable Service

For a remotable service being called by another service the data exchange semantics is by-value. The return type and types of the parameters of a member function of a remotable service interface MUST be one of:

- Any of the C++ types specified in Simple Content Binding. These types may be passed by-value, by-reference, or by-pointer and may be contained in an array, an std::vector, std::list or one of the variations of an std::deque. Unless the member function and client indicate that they allow by-reference semantics (see AllowsPassByReference), a copy will be explicitly created by the runtime for any parameters passed by-reference or by-pointer.

- An SDO DataObjectPtr instance. This type may be passed by-value, by-reference, or by-pointer and may be contained in an array, an std::vector, std::list or one of the variations of an std::deque. Unless the member function and client indicate that they allow by-reference semantics (see AllowsPassByReference), a deep-copy of the DataObjectPtr will be created by the runtime for any parameters passed by-value, by-reference, or by-pointer. When by-reference semantics are allowed, the DataObjectPtr itself will be passed. [CPP80002]

8.2 Header Files

A C++ header file used to define an interface MUST declare at least one class with:

- At least one public member function.
- All public member functions are pure virtual. [CPP80003]
9 WSDL to C++ and C++ to WSDL Mapping

The SCA Client and Implementation Model for C++ applies the WSDL to Java and Java to WSDL mapping rules (augmented for C++) as defined by the JAX-WS specification [JAXWS21] for generating remotable C++ interfaces from WSDL portTypes and vice versa. Use of the JAX-WS specification as a guideline for WSDL to C++ and C++ to WSDL mappings does not imply that any support for the Java language is mandated by this specification.

For the purposes of the C++ to WSDL mapping algorithm, the interface is treated as if it had a @WebService annotation on the class, even if it doesn't. For the WSDL to C++ mapping, the generated @WebService annotation implies that the interface is @Remotable.

For the mapping from C++ types to XML schema types SCA supports the SDO 2.1 [SDO21] mapping. A detailed mapping of C++ to WSDL types and WSDL to C++ types is covered in section SDO Data Binding.

Items in the JAX-WS WSDL to Java and Java to WSDL mapping that are not supported:

- JAX-WS style external binding. (See JAX-WS Sec. 2)
- MIME binding. (See JAX-WS Sec. 2.1.1)
- Holder classes. (See JAX-WS Sec. 2.3.3)
- Asynchronous mapping. (See JAX-WS Sec. 2.3.4)
- Generation of Service classes from WSDL. (See JAX-WS Sec. 2.7)
- Generation of WSDL from Service implementation classes. (See JAX-WS Sec. 3.3)
- Templates when converting from C++ to WSDL. (See JAX-WS Sec. 3.9)

General rules for the application of JAX-WS to C++:

- References to Java are considered references to C++.
- References to Java classes are considered references to C++ classes.
- References to Java methods are considered references to C++ member functions.
- References to Java interfaces are considered references to C++ classes which only define pure virtual member functions.

Major divergences from JAX-WS:

- Algorithms for converting WSDL namespaces to C++ namespaces (and vice-versa).
- Mapping of WSDL faults to C++ exceptions and vice-versa.
- Managing of data bindings.

9.1 Augmentations for WSDL to C++ Mapping

An SCA implementation MUST map a WSDL portType to a remotable C++ interface definition. [CPP10009]

9.1.1 Mapping WSDL targetNamespace to a C++ namespace

Since C++ does not define a standard convention for the use of namespaces, the SCA specification does not define an implicit mapping of WSDL targetNamespaces to C++ namespaces. A WSDL file might define a namespace using the <sca:namespace> WSDL extension, otherwise all C++ classes MUST be placed in a default namespace as determined by the implementation. Implementations SHOULD provide a mechanism for overriding the default namespace. [CPP100001]
9.1.2 Mapping WSDL Faults to C++ Exceptions

WSDL operations that specify one or more <wsdl:fault> elements will produce a C++ member function that is annotated with an @WebThrows annotation listing a C++ exception class associated with each <wsdl:fault>.

The C++ exception class associated with a fault will be generated based on the message that is associated with the <wsdl:fault> element, and in particular with the global element that the wsdl:fault/wsdl:message/@part indicates.

```c++
<FaultException>(const char* message, const <FaultInfo>& faultInfo);
<FaultInfo> getFaultInfo() const;
```

Snippet 9-1: Fault Exception Class Member Functions

Where <FaultException> is the name of the generated exception class, and where <FaultInfo> is the name of the C++ type representing the fault’s global element type.

9.1.2.1 Multiple Fault References

If multiple operations within the same portType indicate that they throw faults that reference the same global element, an SCA implementation MUST generate a single C++ exception class with each C++ member function referencing this class in its @WebThrows annotation. [CPP100002]

9.1.3 Mapping of in, out, in/out parts to C++ member function parameters

C++ diverges from the JAX-WS specification in its handling of some parameter types, especially around how passing of out and in/out parameters are handled in the context of C++’s various pass-by styles. The following outlines an updated mapping for use with C++.

- For unwrapped messages, an SCA implementation MUST map:
  - **in** - the message part to a member function parameter, passed by const-reference.
  - **out** - the message part to a member function parameter, passed by reference, or to the member function return type, returned by-reference.
  - **in/out** - the message part to a member function parameter, passed by reference. [CPP100003]

- For wrapped messages, an SCA implementation MUST map:
  - **in** - the wrapper child to a member function parameter, passed by const-reference.
  - **out** - the wrapper child to a member function parameter, passed by reference, or to the member function return type, returned by-reference.
  - **in/out** - the wrapper child to a member function parameter, passed by reference. [CPP100004]

9.2 Augmentations for C++ to WSDL Mapping

Where annotations are discusses as a means for an application to control the mapping to WSDL, an implementation-specific means of controlling the mapping can be used instead. An SCA implementation MUST map a C++ interface definition to WSDL as if it has a @WebService annotation with all default values on the class. [CPP100010]

An application can customize the name of the portType and port using the @WebService annotation.

9.2.1 Mapping C++ namespaces to WSDL namespaces

Since C++ does not define a standard convention for the use of namespaces, the SCA specification does not define an implicit mapping of C++ namespaces to WSDL namespace URIs. The default
targetNamespace is defined by the implementation. **An SCA implementation SHOULD provide a mechanism for overriding the default targetNamespace.** [CPP100005]

### 9.2.2 Parameter and return type classification

The classification of parameters and return types in C++ are determined based on how the value is passed into the function.

An SCA implementation **MUST** map a method’s return type as an **out** parameter, a parameter passed by-reference or by-pointer as an **in/out** parameter, and all other parameters, including those passed by-const-reference as **in** parameters. [CPP100006]

An application can customize parameter classification using the @WebParam annotation.

### 9.2.3 C++ to WSDL Type Conversion

C++ types are mapped to WSDL and schema types based on the mapping described in Section Simple Content Binding.

### 9.2.4 Service-specific Exceptions

C++ classes that define a web service interface can indicate which faults they might throw using the @WebThrows annotation. @WebThrows lists the names of each C++ class that might be thrown as a fault from a particular member function. By default, no exceptions are mapped to operation faults.

### 9.3 SDO Data Binding

#### 9.3.1 Simple Content Binding

The translation of XSD simple content types to C++ types follows the convention defined in the SDO specification. Table 9-1 summarizes that mapping as it applies to SCA services.

<table>
<thead>
<tr>
<th>XSD Schema Type</th>
<th>C++ Type</th>
<th>XSD Schema Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>anySimpleType</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>anyType</td>
<td>commonj::sdo::DataObject</td>
<td>anyType</td>
</tr>
<tr>
<td>anyURI</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>base64Binary</td>
<td>char*</td>
<td>string</td>
</tr>
<tr>
<td>boolean</td>
<td>bool</td>
<td>boolean</td>
</tr>
<tr>
<td>byte</td>
<td>int8_t</td>
<td>byte</td>
</tr>
<tr>
<td>date</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>dateTime</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>decimal</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>double</td>
<td>double</td>
<td>double</td>
</tr>
<tr>
<td>duration</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>ENTITIES</td>
<td>std::list<a href="">std::string</a></td>
<td>IDREFS</td>
</tr>
<tr>
<td>ENTITY</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>float</td>
<td>float</td>
<td>float</td>
</tr>
<tr>
<td>XSD Type</td>
<td>C++ Type</td>
<td>C++ Type</td>
</tr>
<tr>
<td>------------------</td>
<td>------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>gDay</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>gMonth</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>gMonthDay</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>gYear</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>gYearMonth</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>hexBinary</td>
<td>char*</td>
<td>string</td>
</tr>
<tr>
<td>ID</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>IDREF</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>IDREFS</td>
<td>std::list<a href="">std::string</a></td>
<td>IDREFS</td>
</tr>
<tr>
<td>int</td>
<td>int32_t</td>
<td>int</td>
</tr>
<tr>
<td>integer</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>language</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>long</td>
<td>int64_t</td>
<td>long</td>
</tr>
<tr>
<td>Name</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>NCName</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>negativeInteger</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>NMToken</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>NMTokenS</td>
<td>std::list<a href="">std::string</a></td>
<td>IDREFS</td>
</tr>
<tr>
<td>nonNegativeInteger</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>nonPositiveInteger</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>normalizedString</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>NOTATION</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>positiveInteger</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>QName</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>short</td>
<td>int16_t</td>
<td>short</td>
</tr>
<tr>
<td>string</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>time</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>token</td>
<td>std::string</td>
<td>string</td>
</tr>
<tr>
<td>unsignedByte</td>
<td>uint8_t</td>
<td>unsignedByte</td>
</tr>
<tr>
<td>unsignedInt</td>
<td>uint32_t</td>
<td>unsignedInt</td>
</tr>
<tr>
<td>unsignedLong</td>
<td>uint64_t</td>
<td>unsignedLong</td>
</tr>
<tr>
<td>unsignedShort</td>
<td>int16_t</td>
<td>unsignedShort</td>
</tr>
</tbody>
</table>

Table 9-1: XSD simple type to C++ type mapping
Table 9-2 defines the mapping of C++ types to XSD schema types that are not covered in Table 9-1.

<table>
<thead>
<tr>
<th>C++ Type</th>
<th>XSD Schema Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>char</td>
<td>string</td>
</tr>
<tr>
<td>wchar_t</td>
<td>string</td>
</tr>
<tr>
<td>signed char</td>
<td>byte</td>
</tr>
<tr>
<td>unsigned char</td>
<td>unsignedByte</td>
</tr>
<tr>
<td>short</td>
<td>short</td>
</tr>
<tr>
<td>unsigned short</td>
<td>unsignedShort</td>
</tr>
<tr>
<td>int</td>
<td>int</td>
</tr>
<tr>
<td>unsigned int</td>
<td>unsignedInt</td>
</tr>
<tr>
<td>long</td>
<td>long</td>
</tr>
<tr>
<td>unsigned long</td>
<td>unsignedLong</td>
</tr>
<tr>
<td>long long</td>
<td>long</td>
</tr>
<tr>
<td>wchar_t</td>
<td>string</td>
</tr>
<tr>
<td>long double</td>
<td>decimal</td>
</tr>
<tr>
<td>time_t</td>
<td>dateTime</td>
</tr>
<tr>
<td>struct tm</td>
<td>dateTime</td>
</tr>
</tbody>
</table>

Table 9-2: C++ type to XSD type mapping

The C++ standard does not define value ranges for integer types so it is possible that on a platform parameters or return values could have values that are out of range for the default XSD schema type. In these circumstances, the mapping would need to be customized, using @WebParam or @WebResult if supported, or some other implementation-specific mechanism.

An SCA implementation MUST map simple types as defined in Table 9-1 and Table 9-2 by default.

[CPP100008]

9.3.2 Complex Content Binding

For unwrapped messages, a message part with a complex type that is a sequence with a single element with type = xyz and maxOccurs with a value > 1 is mapped to a parameter or return type with type std::list<mapping of xyz>. For wrapped messages, a wrapper child with a complex type that is a sequence with a single element with type = xyz and maxOccurs with a value > 1 is mapped to a parameter or return type with type std::list<mapping of xyz>. In all other circumstances, any XSD complex types are mapped to an instance of an SDO DataObject.

A return type or a parameter with at type that is an array, std::vector, std::list or one of the variations of std::deque is mapped to an XSD sequence with a single element with maxOccurs = unbounded.
10 Conformance

The XML schema pointed to by the RDDL document at the SCA namespace URI, defined by the Assembly specification [ASSEMBLY] and extended by this specification, are considered to be authoritative and take precedence over the XML schema in this document.

The XML schema pointed to by the RDDL document at the SCA C++ namespace URI, defined by this specification, is considered to be authoritative and takes precedence over the XML schema in this document.

Normative code artifacts related to this specification are considered to be authoritative and take precedence over specification text.

An SCA implementation MUST reject a composite file that does not conform to http://docs.oasis-open.org/opencsa/sca/200912/sca-interface-cpp-1.1.xsd or http://docs.oasis-open.org/opencsa/sca/200912/sca-implementation-cpp-1.1.xsd. [CPP110001]

An SCA implementation MUST reject a componentType file that does not conform to http://docs.oasis-open.org/opencsa/sca/200912/sca-interface-cpp-1.1.xsd. [CPP110002]

An SCA implementation MUST reject a contribution file that does not conform to http://docs.oasis-open.org/opencsa/sca/200912/sca-contribution-cpp-1.1.xsd. [CPP110003]

An SCA implementation MUST reject a WSDL file that does not conform to http://docs.oasis-open.org/opencsa/sca-c-cpp/200901/sca-wsdlext-cpp-1.1.xsd. [CPP110004]

10.1 Conformance Targets

The conformance targets of this specification are:

- **SCA implementations**, which provide a runtime for SCA components and potentially tools for authoring SCA artifacts, component descriptions and/or runtime operations.
- **SCA documents**, which describe SCA artifacts, and specific elements within these documents.
- **C++ component implementations**, which execute under the control of an SCA runtime.
- **C++ files**, which define SCA service interfaces and implementations.
- **WSDL files**, which define SCA service interfaces.

10.2 SCA Implementations

An implementation conforms to this specification if it meets these conditions:

1. It MUST conform to the SCA Assembly Model Specification [ASSEMBLY] and the SCA Policy Framework [POLICY].
2. It MUST comply with all statements in Table F-1 and Table F-4 related to an SCA implementation, notably all mandatory statements have to be implemented.
3. It MUST implement the SCA C++ API defined in section C++ API.
4. It MUST implement the mapping between C++ and WSDL 1.1 [WSDL11] defined in WSDL to C++ and C++ to WSDL Mapping.
5. It MUST support <interface.cpp/> and <implementation.cpp/> elements as defined in Component Type and Component in composite and componentType documents.
6. It MUST support <export.cpp/> and <import.cpp/> elements as defined in C++ Contributions in contribution documents.
7. It MAY support source file annotations as defined in C++ SCA Annotations, C++ SCA Policy Annotations and C++ WSDL Mapping Annotations. If source file annotations are supported, the implementation MUST comply with all statements in Table F-2 related to an SCA implementation, notably all mandatory statements in that section have to be implemented.
8. It MAY support WSDL extensions as defined in WSDL C++ Mapping Extensions. If WSDL extensions are supported, the implementation MUST comply with all statements in Table F-3 related to an SCA implementation, notably all mandatory statements in that section have to be implemented.

10.3 SCA Documents

An SCA document conforms to this specification if it meets these conditions:

1. It MUST conform to the SCA Assembly Model Specification [ASSEMBLY] and, if appropriate, the SCA Policy Framework [POLICY].

2. If it is a composite document, it MUST conform to the http://docs.oasis-open.org/opencsa/sca/200912/sca-interface-cpp-1.1.xsd and http://docs.oasis-open.org/opencsa/sca/200912/sca-implementation-cpp-1.1.xsd schema and MUST comply with the additional constraints on the document contents as defined in Table F-1.

3. If it is a componentType document, it MUST conforms to the http://docs.oasis-open.org/opencsa/sca/200912/sca-interface-cpp-1.1.xsd schema and MUST comply with the additional constraints on the document contents as defined in Table F-1.

4. If it is a contribution document, it MUST conforms to the http://docs.oasis-open.org/opencsa/sca/200912/sca-contribution-cpp-1.1.xsd schema and MUST comply with the additional constraints on the document contents as defined in Table F-1.

10.4 C++ Files

A C++ file conforms to this specification if it meets the condition:

1. It MUST comply with all statements in Table F-1, Table F-2 and Table F-4 related to C++ contents and annotations, notably all mandatory statements have to be satisfied.

10.5 WSDL Files

A WSDL file conforms to this specification if it meets these conditions:

1. It is a valid WSDL 1.1 [WSDL11] document.

2. It MUST comply with all statements in Table F-1, Table F-3 and Table F-4 related to WSDL contents and extensions, notably all mandatory statements have to be satisfied.
A C++ SCA Annotations

To allow developers to define SCA related information directly in source files, without having to separately author SCDL files, a set of annotations is defined. If annotations are supported by an implementation, the annotations defined here MUST be supported and MUST be mapped to SCDL as described. The SCA runtime MUST only process the SCDL files and not the annotations. [CPPA0001]

The annotations are defined as C++ comments in interface and implementation header files, for example:

```cpp
// @Scope("stateless")
```

Snippet A-1: Example Annotation

A.1 Application of Annotations to C++ Program Elements

In general an annotation immediately precedes the program element it applies to. If multiple annotations apply to a program element, all of the annotations SHOULD be in the same comment block. [CPPA0002]

- **Class**
  The annotation immediately precedes the class.
  
  Example:
  ```cpp
  // @Scope("composite")
  class LoanServiceImpl : public LoanService {
   ...
  }
  ```

  Snippet A-2: Example Class Annotation

- **Member function**
  The annotation immediately precedes the member function.
  
  Example:
  ```cpp
  class LoanService
  {
   public:
   // @OneWay
   virtual void reportEvent(int eventId) = 0;
   ...
  }
  ```

  Snippet A-3: Example Member Function Annotation

- **Data Member**
  The annotation immediately precedes the data member.
  
  Example:
  ```cpp
  // @Property(name="loanType", type="xsd:int")
  long loanType;
  ```

  Snippet A-4: Example Data Member Annotation

Annotations follow normal inheritance rules. An annotation on a base class or any element of a base class applies to any classes derived from the base class.

A.2 Interface Header Annotations

This section lists the annotations that can be used in the header file that defines a service interface.
A.2.1 @Interface
Annotation used to indicate a class defines an interface when multiple classes exist in a header file.

Corresponds to: @class attribute of an interface.cpp element.

Format:

```plaintext
// @Interface
```

Snippet A-5: @Interface Annotation Format

Applies to: Class

Example:

```plaintext
Interface header:
// @Interface
class LoanService {
  ...
};
```

Service definition:
```
<service name="LoanService">
  <interface.cpp header="LoanService.h" class="LoanService" />
</service>
```

Snippet A-6: Example of @Interface Annotation

A.2.2 @Remotable
Annotation on service interface class to indicate that a service is remotable and implies an @Interface annotation applies as well. An SCA implementation MUST treat a class with an @WebService annotation specified as if a @Remotable annotation was specified. [CPPA0003]

Corresponds to: @remotable="true" attribute of an interface.cpp element.

Format:

```plaintext
// @Remotable
```

Snippet A-7: @Remotable Annotation Format

The default is false (not remotable).

Applies to: Class

Example:

```plaintext
Interface header:
// @Remotable
class LoanService {
  ...
};
```

Service definition:
```
<service name="LoanService">
  <interface.cpp header="LoanService.h" remotable="true" />
</service>
```

Snippet A-8: Example of @Remotable Annotation

A.2.3 @Callback
Annotation on a service interface class to specify the callback interface.
Corresponds to: @callbackHeader and @callbackClass attributes of an interface.cpp element.

**Format:**

```cpp
// @Callback(header="headerName", class="className")
```

**Snippet A-9: @Callback Annotation Format**

where

- **headerName (1..1)** – is the name of the header defining the callback service interface.
- **className (0..1)** – is the name of the class for the callback interface.

**Applies to:** Class

Example:

**Interface header:**

```cpp
// @Callback(header="MyServiceCallback.h", class="MyServiceCallback")
class MyService {
  public:
    virtual void someFunction( unsigned int arg ) = 0;
};
```

**Service definition:**

```xml
<service name="MyService">
  <interface.cpp header="MyService.h">
    <function name="reportEvent" oneWay="true" />
  </interface.cpp>
</service>
```

**Snippet A-10: Example of @Callback Annotation**

### A.2.4 @OneWay

Annotation on an interface member function to indicate the member function is one way. The @OneWay annotation also affects the representation of a service in WSDL, see @OneWay.

Corresponds to: @oneWay="true" attribute of function element of an interface.cpp element.

**Format:**

```cpp
// @OneWay
```

**Snippet A-11: @OneWay Annotation Format**

The default is false (not OneWay).

**Applies to:** Member function

Example:

**Interface header:**

```cpp
class LoanService {
  public:
    // @OneWay
    virtual void reportEvent(int eventId) = 0;
    ...
};
```

**Service definition:**

```xml
<service name="LoanService">
  <interface.cpp header="LoanService.h">
    <function name="reportEvent" oneWay="true" />
  </interface.cpp>
</service>
```
A.2.5 @Function

Annotation on a interface member function to modify its representation in an SCA interface. An SCA implementation MUST treat a member function with a @WebFunction annotation specified as if @Function was specified with the operationName value of the @WebFunction annotation used as the name value of the @Function annotation and the exclude value of the @WebFunction annotation used as the exclude valued of the @Function annotation. [CPPA0004]

Corresponds to: function or callbackFunction element of an interface.cpp element. If the class the function is a member of is being processed because it was identified via either a combination of interface.cpp/@callbackHeader and interface.cpp/@callbackClass or a @Callback annotation, then the @Function annotation corresponds to a callbackFunction element, otherwise it corresponds to a function element.

Format:

```cpp
// @Function(name="operationName", exclude="true")
```

A.3 Implementation Header Annotations

This section lists the annotations that can be used in the header file that defines a service implementation.

A.3.1 @ComponentType

Annotation used to indicate which class implements a componentType when multiple classes exist in an implementation file.
Corresponds to: `@class` attribute of an `implementation.cpp` element.

**Format:**

```cpp
// @ComponentType
```

**Snippet A-15: @ComponentType Annotation Format**

**Applies to:** Class

**Example:**

Implementation header:

```cpp
// @ComponentType
class LoanServiceImpl: public LoanService {
  ...
};
```

Component definition:

```xml
<component name="LoanService">
  <implementation.cpp library="loan" class="LoanServiceImpl" />
</component>
```

**Snippet A-16: Example of @ComponentType Annotation**

### A.3.2 @Scope

Annotation on a service implementation class to indicate the scope of the service.

Corresponds to: `@scope` attribute of an `implementation.cpp` element.

**Format:**

```cpp
// @Scope("value")
```

**Snippet A-17: @Scope Annotation Format**

where

- **value**: `[stateless | composite] (1..1)` – specifies the scope of the implementation. The default value is `stateless`.

**Applies to:** Class

**Example:**

Implementation header:

```cpp
// @Scope("composite")
class LoanServiceImpl: public LoanService {
  ...
};
```

Component definition:

```xml
<component name="LoanService">
  <implementation.cpp library="loan" class="LoanServiceImpl"
    scope="composite" />  
</component>
```

**Snippet A-18: Example of @Scope Annotation**

### A.3.3 @EagerInit

Annotation on a service implementation class to indicate the implantation is to be instantiated when its containing component is started.

**Corresponds to:** `@eagerInit="true"` attribute of an `implementation.cpp` element.
A.3.4 @AllowsPassByReference

Annotation on service implementation class or member function to indicate that a service or member function allows pass by reference semantics.

Corresponds to: @allowsPassByReference="true" attribute of an implementation.cpp element or a function child element of an implementation.cpp element.

Format:

// @AllowsPassByReference

Snippet A-21: @AllowsPassByReference Annotation Format

The default is false (the service does not allow by reference parameters).

Applies to: Class or Member function

Example:

Implementation header:

// @AllowsPassByReference
class LoanService { ...
};

Component definition:

<component name="LoanService">
  <implementation.cpp library="loan" class="LoanServiceImpl"
    allowsPassByReference="true" />
</component>

Snippet A-22: Example of @AllowsPassByReference Annotation

A.3.5 @Property

Annotation on a service implementation class data member to define a property of the service.

Corresponds to: property element of a componentType element.
A.3.6 @Reference

Annotation on a service implementation class data member to define a reference of the service.  
Corresponds to: reference element of a componentType element.

Where

- **name : NCName (0..1)** - specifies the name of the reference. If name is not specified the reference name is taken from the name of the following data member.
- **interfaceHeader : Name (1..1)** - specifies the C++ header defining the interface for the reference.
- **interfaceClass : Name (0..1)** - specifies the C++ class defining the interface for the reference. If not specified the class is derived from the type of the annotated data member.
- **required : boolean (0..1)** - specifies whether a value has to be set for this reference. Default is **true**.

If the annotated data member is a std::vector then the implied component type has a reference with a multiplicity of either 0..n or 1..n depending on the value of the @Reference **required** attribute – 1..n applies if **required=true**. Otherwise a multiplicity of 0..1 or 1..1 is implied.

Applies to: Data Member

Example:
Implementation:

```cpp
// @Reference(interfaceHeader="LoanService.h" required="true")
LoanServiceProxyPtr loanService;

// @Reference(interfaceHeader="LoanService.h" required="false")
std::vector<LoanServiceProxyPtr> loanServices;
```

Component Type definition:

```xml
<componentType ... >
  <service ... />
  <reference name="loanService" multiplicity="1..1">
    <interface.cpp header="LoanService.h" class="LoanService" />
  </reference>
  <reference name="loanServices" multiplicity="0..n">
    <interface.cpp header="LoanService.h" class="LoanService" />
  </reference>
</componentType>
```

Snippet A-26: Example of @Reference Annotation

A.4 Base Annotation Grammar

```xml
<annotation> ::= // @<baseAnnotation>
<baseAnnotation> ::= <name> [(<params>)]
<params> ::= <paramNameValue>, <paramNameValue>]* |
          <paramValue>, <paramValue>]*
<paramNameValue> ::= <name>="<value>"
<paramValue> ::= "<value>"
<name> ::= NCName
<value> ::= string
```

Snippet A-27: Base Annotation Grammar

- Adjacent string constants are concatenated
- NCName is as defined by XML schema [XSD]
- Whitespace including newlines between tokens is ignored.
- Annotations with parameters can span multiple lines within a comment, and are considered complete when the terminating "\)" is reached.
B  C++ SCA Policy Annotations

SCA provides facilities for the attachment of policy-related metadata to SCA assemblies, which influence how implementations, services and references behave at runtime. The policy facilities are described in [POLICY]. In particular, the facilities include Intents and Policy Sets, where intents express abstract, high-level policy requirements and policy sets express low-level detailed concrete policies.

Policy metadata can be added to SCA assemblies through the means of declarative statements placed into Composite documents and into Component Type documents. These annotations are completely independent of implementation code, allowing policy to be applied during the assembly and deployment phases of application development.

However, it can be useful and more natural to attach policy metadata directly to the code of implementations. This is particularly important where the policies concerned are relied on by the code itself. An example of this from the Security domain is where the implementation code expects to run under a specific security Role and where any service operations invoked on the implementation have to be authorized to ensure that the client has the correct rights to use the operations concerned. By annotating the code with appropriate policy metadata, the developer can rest assured that this metadata is not lost or forgotten during the assembly and deployment phases.

The SCA C++ policy annotations provide the capability for the developer to attach policy information to C++ implementation code. The annotations provide both general facilities for attaching SCA Intents and Policy Sets to C++ code and annotations that deal with specific policy intents. Policy annotation can be used in header files for service interfaces or implementations.

B.1 General Intent Annotations

SCA provides the annotation @Requires for the attachment of any intent to a C++ class, to a C++ interface or to elements within classes and interfaces such as member functions and data members.

The @Requires annotation can attach one or multiple intents in a single statement. Each intent is expressed as a string. Intents are XML QNames, which consist of a Namespace URI followed by the name of the Intent. The precise form used is:

\[ "{\text{Namespace URI}} + " + \text{intentname} \]

Snippet B-1: Intent Format

Intents can be qualified, in which case the string consists of the base intent name, followed by a ",", followed by the name of the qualifier. There can also be multiple levels of qualification.

This representation is quite verbose, so we expect that reusable constants will be defined for the namespace part of this string, as well as for each intent that is used by C++ code. SCA defines constants for intents such as the following:

```
// @Define SCA_PREFIX "{http://docs.oasis-open.org/ns/opencsa/sca/200912}"
// @Define CONFIDENTIALITY SCA_PREFIX ## "confidentiality"
// @Define CONFIDENTIALITY_MESSAGE CONFIDENTIALITY ## ",.message"
```

Snippet B-2: Example Intent Constants

Notice that, by convention, qualified intents include the qualifier as part of the name of the constant, separated by an underscore. These intent constants are defined in the file that defines an annotation for the intent (annotations for intents, and the formal definition of these constants, are covered in a following section).
Multiple intents (qualified or not) are expressed as separate strings within an array declaration.

Corresponds to: @requires attribute of an interface.cpp, implementation.cpp, function or callbackFunction element.

Format:

```cpp
// @Requires("qualifiedIntent" | "qualifiedIntent" ["qualifiedIntent"])
```

where

```cpp
qualifiedIntent ::= QName | QName.qualifier | QName.qualifier1.qualifier2
```

Snippet B-3: @Requires Annotation Format

Applies to: Class, Member Function

Examples:

Attaching the intents "confidentiality.message" and "integrity.message".
```
// @Requires({CONFIDENTIALITY_MESSAGE, INTEGRITY_MESSAGE})
```

Snippet B-4: Example @Requires Annotation

A reference requiring support for confidentiality:
```
class Foo {
  ...
  // @Requires(CONFIDENTIALITY)
  // @Reference(interfaceHeader="SetBar.h")
  void setBar(Bar* bar);
  ...
}
```

Snippet B-5: @Requires Annotation applied with an @Reference Annotation

Users can also choose to only use constants for the namespace part of the QName, so that they can add new intents without having to define new constants. In that case, this definition would instead look like this:
```
class Foo {
  ...
  // @Requires(SCA_PREFIX "confidentiality ")
  // @Reference(interfaceHeader="SetBar.h")
  void setBar(Bar* bar);
  ...
}
```

Snippet B-6: @Requires Annotation Using Mixed Constants and Literals

### B.2 Specific Intent Annotations

In addition to the general intent annotation supplied by the @Requires annotation described above, there are C++ annotations that correspond to specific policy intents. The general form of these specific intent annotations is an annotation with a name derived from the name of the intent itself. If the intent is a qualified intent, qualifiers are supplied as an attribute to the annotation in the form of a string or an array of strings.

For example, the SCA confidentiality intent described in General Intent Annotations using the @Requires(CONFIDENTIALITY) intent can also be specified with the specific @Confidentiality intent annotation. The specific intent annotation for the "integrity" security intent is:
```
// @Integrity
Corresponds to: @requires="<Intent>"> attribute of an interface.cpp, implementation.cpp, function or callbackFunction element.

Format:

```
// @<Intent>[(qualifiers)]
```

where Intent is an NCName that denotes a particular type of intent.

```
Intent ::= NCName
qualifiers ::= "qualifier " | {"qualifier" [, "qualifier"] } 
qualifier ::= NCName | NCName/qualifier
```

Snippets B-7 to B-9: @<Intent> Annotation Format

Applies to: Class, Member Function – but see specific intents for restrictions

Example:

```
// @ClientAuthentication( {"message", "transport"} )
```

These three intents can be qualified with

- transport
- message

### B.2.1 Security Interaction

<table>
<thead>
<tr>
<th>Intent</th>
<th>Annotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>clientAuthentication</td>
<td>@ClientAuthentication</td>
</tr>
<tr>
<td>serverAuthentication</td>
<td>@ServerAuthentication</td>
</tr>
<tr>
<td>mutualAuthentication</td>
<td>@MutualAuthentication</td>
</tr>
<tr>
<td>confidentiality</td>
<td>@Confidentiality</td>
</tr>
<tr>
<td>integrity</td>
<td>@Integrity</td>
</tr>
</tbody>
</table>

Table B-1: Security Interaction Intent Annotations

These three intents can be qualified with

- transport
- message

### B.2.2 Security Implementation

<table>
<thead>
<tr>
<th>Intent</th>
<th>Annotation</th>
<th>Qualifiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>authorization</td>
<td>@Authorization</td>
<td>fine_grain</td>
</tr>
</tbody>
</table>

Table B-2: Security Implementation Intent Annotations
B.2.3 Reliable Messaging

<table>
<thead>
<tr>
<th>Intent</th>
<th>Annotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>atLeastOnce</td>
<td>@AtLeastOnce</td>
</tr>
<tr>
<td>atMostOnce</td>
<td>@AtMostOnce</td>
</tr>
<tr>
<td>ordered</td>
<td>@Ordered</td>
</tr>
<tr>
<td>exactlyOnce</td>
<td>@ExactlyOnce</td>
</tr>
</tbody>
</table>

Table B-3: Reliable Messaging Intent Annotations

B.2.4 Transactions

<table>
<thead>
<tr>
<th>Intent</th>
<th>Annotation</th>
<th>Qualifiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>managedTransaction</td>
<td>@ManagedTransaction</td>
<td>local</td>
</tr>
<tr>
<td></td>
<td></td>
<td>global</td>
</tr>
<tr>
<td>noManagedTransaction</td>
<td>@NoManagedTransaction</td>
<td></td>
</tr>
<tr>
<td>transactedOneWay</td>
<td>@TransactedOneWay</td>
<td></td>
</tr>
<tr>
<td>immediateOneWay</td>
<td>@ImmediateOneWay</td>
<td></td>
</tr>
<tr>
<td>propagates Transaction</td>
<td>@PropagatesTransaction</td>
<td></td>
</tr>
<tr>
<td>suspendsTransaction</td>
<td>@SuspendsTransaction</td>
<td></td>
</tr>
</tbody>
</table>

Table B-4: Transaction Intent Annotations

B.2.5 Miscellaneous

<table>
<thead>
<tr>
<th>Intent</th>
<th>Annotation</th>
<th>Qualifiers</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOAP</td>
<td>@SOAP</td>
<td>v1_1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>v1_2</td>
</tr>
</tbody>
</table>

Table B-5: Miscellaneous Intent Annotations

B.3 Policy Set Annotations

The SCA Policy Framework uses Policy Sets to capture detailed low-level concrete policies (for example, a concrete policy is the specific encryption algorithm to use when encrypting messages when using a specific communication protocol to link a reference to a service). Policy Sets can be applied directly to C++ implementations using the @PolicySets annotation. The PolicySets annotation either takes the QName of a single policy set as a string or the name of two or more policy sets as an array of strings.

Corresponds to: @policySets attribute of an interface.cpp, implementation.cpp, function or callbackFuncion element.

Format:

```
// @PolicySets("<policy set QName>") |
// { "<policy set QName>", "<policy set QName>" } }
```

Snippet B-10: @PolicySets Annotation Format

As for intents, PolicySet names are QNames – in the form of "{Namespace-URI}localPart".
Applies to: Class, Member Function,
Example:

```cpp
// @Reference(name="helloService", interfaceHeader="helloService.h",
//            required="true")
// @PolicySets({ MY_NS "WS_Encryption_Policy",
//               MY_NS "WS_Authentication_Policy"})
HelloService* helloService;
```

Snippet B-11: Example @PolicySets Annotation

In this case, the Policy Sets WS_Encryption_Policy and WS_Authentication_Policy are applied, both using the namespace defined for the constant MY_NS.

PolicySets satisfy intents expressed for the implementation when both are present, according to the rules defined in [POLICY].

B.4 Policy Annotation Grammar Additions

```xml
<annotation> ::= // @<baseAnnotation> | @<requiresAnnotation> | 
                @<intentAnnotation> | @<policySetAnnotation>
<requiresAnnotation> ::= Requires(<intents>)
<intents> ::= "<qualifiedIntent>" | 
              {"<qualifiedIntent>"[ , "<qualifiedIntent>"]*}
<qualifiedIntent> ::= <intentName> | <intentName>.<qualifier> | 
                   <intentName>.<qualifier>.qualifier
<intentName> ::= {aAnyURI}NCName
<intentAnnotation> ::= <intent>[{<qualifiers>}]
<intent> ::= NCName [(param)]
<qualifiers> ::= "<qualifier>" | ["<qualifier>"[ , "<qualifier>"]*]
<qualifier> ::= NCName | NCName/<qualifier>
<policySetAnnotation> ::= policySets(<policysets>)
<policySets> ::= "<policySetName>" | ["<policySetName>"[ , "<policySetName>"]*]
<policySetName> ::= {aAnyURI}NCName
```

Snippet B-12: Annotation Grammar Additions for Policy Annotations

- anyURI is as defined by XML schema [XSD]

B.5 Annotation Constants

```xml
<annotationConstant> ::= // @Define <identifier> <token string>
<identifier> ::= token
<token string> ::= "string" | "string"[ #<token string>]
```

Snippet B-13: Annotation Constants Grammar

- Constants are immediately expanded
C++ WSDL Mapping Annotations

To allow developers to control the mapping of C++ to WSDL, a set of annotations is defined. If WSDL mapping annotations are supported by an implementation, the annotations defined here MUST be supported and MUST be mapped to WSDL as described. [CPPC0001]

C.1 Interface Header Annotations

C.1.1 @WebService

Annotation on a C++ class indicating that it represents a web service. An SCA implementation MUST treat any instance of a @Remotable annotation and without an explicit @WebService annotation as if a @WebService annotation with no parameters was specified. [CPPC0002]

Corresponds to: javax.jws.WebService annotation in the JAX-WS specification (7.11.1)

Format:

```cpp
// @WebService(name="portTypeName", targetNamespace="namespaceURI", // serviceName="WSDLServiceName", portName="WSDLPortName")
```

Snippet C-1: @WebService Annotation Format

where:

- **name**: NCName (0..1) – specifies the name of the web service portType. The default is the name of the C++ class the annotation is applied to. The name of the associated binding is also determined by the portType. The binding name is the name of the portType suffixed with “Binding”.

- **targetNamespace**: anyURI (0..1) – specifies the target namespace for the web service. The default namespace is determined by the implementation.

- **serviceName**: NCName (0..1) – specifies the target name for the associated service. The default service name is the name of the C++ class suffixed with “Service”.

- **portName**: NCName (0..1) – specifies the name to be used for the associated WSDL port for the service. If portName is not specified, the name of the WSDL port is the name of the portType suffixed with “Port”. See [CPPF0042]

Applies to: Class

Example:

Input C++ source file:

```cpp
// @WebService(name="StockQuote", targetNamespace="http://www.example.org/", // serviceName="StockQuoteService")
class StockQuoteService {
};
```

Generated WSDL file:

```xml
<definitions xmlns="http://schemas.xmlsoap.org/wsdl/
xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
xmlns:xtn="http://www.example.org/
xmlns:cpp="http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/cpp/200901"
targetNamespace="http://www.example.org/">
  <portType name="StockQuote">
    <cpp:bindings>
      <cpp:class name="StockQuoteService"/>
    </cpp:bindings>
  </portType>
</definitions>
```
<binding name="StockQuoteServiceSoapBinding">
  <soap:binding style="document">
    <transport>http://schemas.xmlsoap.org/soap/http</transport>
  </soap:binding>
</binding>

<service name="StockQuoteService">
  <port name="StockQuotePort" binding="tns:StockQuoteServiceSoapBinding">
    <soap:address location="REPLACE_WITH_ACTUAL_URL"/>
  </port>
</service>

</definitions>

Snippet C-2: Example @WebService Annotation

C.1.2 @WebFunction

Annotation on a C++ member function indicating that it represents a web service operation. An SCA implementation MUST treat a member function annotated with an @Function annotation and without an explicit @WebFunction annotation as if a @WebFunction annotation with with an operationName value equal to the name value of the @Function annotation, an exclude value equal to the exclude value of the @Operation annotation and no other parameters was specified. [CPPC0009]

Corresponds to: javax.jws.WebMethod annotation in the JAX-WS specification (7.11.2)

Format:

```c++
// @WebFunction(operationName="operation", action="SOAPAction",
//                exclude="false")
```

Snippet C-3: @WebFunction Annotation Format

where:

- **operationName**: NCName (0..1) – specifies the name of the WSDL operation to associate with this function. The default is the name of the C++ member function the annotation is applied to.
- **action**: string (0..1) – specifies the value associated with the soap:operation/@soapAction attribute in the resulting code. The default value is an empty string.
- **exclude**: boolean (0..1) – specifies whether this member function is included in the web service interface. The default value is "false".

Applies to: Member function.

Example:

Input C++ source file:

```c++
// @WebService(name="StockQuote", targetNamespace="http://www.example.org/"
//             serviceName="StockQuoteService")
class StockQuoteService {

  // @WebFunction(operationName="GetLastTradePrice",
  //                action="urn:GetLastTradePrice")
  float getLastTradePrice(const std::string& tickerSymbol);

  // @WebFunction(exclude=true)
  void setLastTradePrice(const std::string& tickerSymbol, float value);
};
```

Generated WSDL file:

```xml
<definitions xmlns="http://schemas.xmlsoap.org/wsd1/"
             xmlns:soap="http://schemas.xmlsoap.org/wsd1/soap/"
             xmlns:tns="http://www.example.org/"
             xmlns:cpp="http://docs.oasis-open.org/ns/openca/sca-c-cpp/cpp/200901"
             targetNamespace="http://www.example.org/">
```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
    xmlns:tns="http://www.example.org/"
    attributeFormDefault="unqualified"
    elementFormDefault="unqualified"
    targetNamespace="http://www.example.org/">
  <xs:element name="GetLastTradePrice" type="tns:GetLastTradePrice"/>
  <xs:element name="GetLastTradePriceResponse" type="tns:GetLastTradePriceResponse"/>
  <xs:complexType name="GetLastTradePrice">
    <xs:sequence>
      <xs:element name="tickerSymbol" type="xs:string"/>
    </xs:sequence>
  </xs:complexType>
  <xs:complexType name="GetLastTradePriceResponse">
    <xs:sequence>
      <xs:element name="return" type="xs:float"/>
    </xs:sequence>
  </xs:complexType>
</xs:schema>

<message name="GetLastTradePrice">
  <part name="parameters" element="tns:GetLastTradePrice"/>
</message>

<message name="GetLastTradePriceResponse">
  <part name="parameters" element="tns:GetLastTradePriceResponse"/>
</message>

<portType name="StockQuote">
  <cpp:bindings>
    <cpp:class name="StockQuoteService"/>
  </cpp:bindings>
  <operation name="GetLastTradePrice">
    <cpp:bindings>
      <cpp:memberFunction name="getLastTradePrice"/>
    </cpp:bindings>
    <input name="GetLastTradePrice" message="tns:GetLastTradePrice"/>
    <output name="GetLastTradePriceResponse" message="tns:GetLastTradePriceResponse"/>
  </operation>
</portType>

<binding name="StockQuoteServiceSoapBinding">
  <soap:binding style="document"
    transport="http://schemas.xmlsoap.org/soap/http"/>
  <operation name="GetLastTradePrice">
    <soap:operation soapAction="urn:GetLastTradePrice" style="document"/>
    <input name="GetLastTradePrice" message="tns:GetLastTradePrice"/>
    <output name="GetLastTradePriceResponse" message="tns:GetLastTradePriceResponse"/>
  </operation>
</binding>

<service name="StockQuoteService">
  <port name="StockQuotePort" binding="tns:StockQuoteServiceSoapBinding">
    <soap:address location="REPLACE_WITH_ACTUAL_URL"/>
  </port>
</service>
C.1.3 @OneWay

Annotation on a C++ member function indicating that it represents a one-way request. The @OneWay annotation also affects the service interface, see @OneWay.

Corresponds to: javax.jws.OneWay annotation in the JAX-WS specification (7.11.3)

Format:

```
// @OneWay
```

Snippet C-5: @OneWay Annotation Format

Applies to: Member function.

Example:

**Input C++ source file:**

```cpp
// @WebService(name="StockQuote", targetNamespace="http://www.example.org/
//       serviceName="StockQuoteService")
class StockQuoteService {
    // @WebFunction(operationName="SetTradePrice",
    //       action="urn:SetTradePrice")
    // @OneWay
    void setTradePrice(const std::string& tickerSymbol, float price);
};
```

**Generated WSDL file:**

```xml
<definitions xmlns="http://schemas.xmlsoap.org/wsdl/
xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/
xmlns:tns="http://www.example.org/"
xmlns:cpp="http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/cpp/200901"
targetNamespace="http://www.example.org/">
    <xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
        xmlns:tns="http://www.example.org/"
        attributeFormDefault="unqualified"
        elementFormDefault="unqualified"
        targetNamespace="http://www.example.org/">
        <xs:element name="SetTradePrice" type="tns:SetTradePrice"/>
        <xs:complexType name="SetTradePrice">
            <xs:sequence>
                <xs:element name="tickerSymbol" type="xs:string"/>
                <xs:element name="price" type="xs:float"/>
            </xs:sequence>
        </xs:complexType>
    </xs:schema>
    <message name="SetTradePrice">
        <part name="parameters" element="tns:SetTradePrice"/>
    </message>
    <portType name="StockQuote">
        <cpp:bindings>
            <cpp:class name="StockQuoteService"/>
        </cpp:bindings>
        <operation name="SetTradePrice"/>
    </portType>
</definitions>
```
Snippet C-6: Example @OneWay Annotation

C.1.4 @WebParam

Annotation on a C++ member function indicating the mapping of a parameter to the associated input and output WSDL messages.

Corresponds to: javax.jws.WebParam annotation in the JAX-WS specification (7.11.4)

Format:

```
// @WebParam(paramName=<"parameter", name="WSDLElement", 
targetNamespace="namespaceURI", mode="IN","OUT","INOUT", 
header="false", partName="WSDLPart", type="xsdType")
```

Snippet C-7: @WebParam Annotation Format

where:

- **paramName : NCName (1..1)** – specifies the name of the parameter that this annotation applies to.
  - The value of the paramName of a @WebParam annotation MUST be the name of a parameter of the
    member function the annotation is applied to. [CPPC0004]

- **name : NCName (0..1)** – specifies the name of the associated WSDL part or element. The default
  value is the name of the parameter. If an @WebParam annotation is not present, and the parameter
  is unnamed, then a name of "argN", where N is an incrementing value from 1 indicating the position of
  the parameter in the argument list, will be used.

- **targetNamespace : string (0..1)** – specifies the target namespace for the part. The default
  namespace is the namespace of the associated @WebService. The targetNamespace attribute is
  ignored unless the binding style is document, and the binding parameterStyle is bare. See
  @SOAPBinding.

- **mode : token (0..1)** – specifies whether the parameter is associated with the input message, output
  message, or both. The default value is determined by the passing mechanism for the parameter, see
  Parameter and return type classification.

- **header : boolean (0..1)** – specifies whether this parameter is associated with a SOAP header
  element. The default value is “false”.

```
- **partName : NCName (0..1)** – specifies the name of the WSDL part associated with this item. The default value is the value of name.

- **type : NCName (0..1)** – specifies the XML Schema type of the WSDL part or element associated with this parameter. The value of the type property of a @WebParam annotation MUST be one of the simpleTypes defined in namespace http://www.w3.org/2001/XMLSchema.[CPPC0005] The default type is determined by the mapping defined in Simple Content Binding.

**Applies to:** Member function parameter.

**Example:**

Input C++ source file:

```cpp
// @WebService(name="StockQuote", targetNamespace="http://www.example.org/"
//    serviceName="StockQuoteService")
class StockQuoteService {

    // @WebFunction(operationName="GetLastTradePrice",
    //    action="urn:GetLastTradePrice")
    // @WebParam(paramName="tickerSymbol", name="symbol")
    float getLastTradePrice(const std::string& tickerSymbol);
};
```

Generated WSDL file:

```xml
<definitions xmlns="http://schemas.xmlsoap.org/wsdl/
xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/
xmlns:cpp="http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/cpp/
xmlns:tns="http://www.example.org/"
targetNamespace="http://www.example.org/">
    <xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
        xmlns:tns="http://www.example.org/"
        attributeFormDefault="unqualified"
        elementFormDefault="unqualified"
        targetNamespace="http://www.example.org/">
        <xs:element name="GetLastTradePrice" type="tns:GetLastTradePrice"/>
        <xs:element name="GetLastTradePriceResponse" type="tns:GetLastTradePriceResponse"/>
        <xs:complexType name="GetLastTradePrice">
            <xs:sequence>
                <xs:element name="symbol" type="xs:string"/>
            </xs:sequence>
        </xs:complexType>
        <xs:complexType name="GetLastTradePriceResponse">
            <xs:sequence>
                <xs:element name="return" type="xs:float"/>
            </xs:sequence>
        </xs:complexType>
    </xs:schema>
    <message name="GetLastTradePrice">
        <part name="parameters" element="tns:GetLastTradePrice"/>
    </message>
    <message name="GetLastTradePriceResponse">
        <part name="parameters" element="tns:GetLastTradePriceResponse"/>
    </message>
    <portType name="StockQuote">
        <cpp:bindings>
            <cpp:class name="StockQuoteService"/>
        </cpp:bindings>
    </portType>
</definitions>
```
<operation name="GetLastTradePrice">
  <cpp:bindings>
    <cpp:memberFunction name="getLastTradePrice"/>
    <cpp:parameter name="tickerSymbol" part="tns:GetLastTradePrice/parameter"
        childElementName="symbol"/>
  </cpp:bindings>
  <input name="GetLastTradePrice" message="tns:GetLastTradePrice"/>
  <output name="GetLastTradePriceResponse" message="tns:GetLastTradePriceResponse"/>
</operation>

<binding name="StockQuoteServiceSoapBinding">
  <soap:binding style="document"
      transport="http://schemas.xmlsoap.org/soap/http"/>
  <operation name="GetLastTradePrice">
    <soap:operation soapAction="urn:GetLastTradePrice" style="document"/>
    <input name="GetLastTradePrice">
      <soap:body use="literal"/>
    </input>
    <output name="GetLastTradePriceResponse">
      <soap:body use="literal"/>
    </output>
  </operation>
</binding>

<service name="StockQuoteService">
  <port name="StockQuotePort" binding="tns:StockQuoteServiceSoapBinding">
    <soap:address location="REPLACE_WITH_ACTUAL_URL"/>
  </port>
</service>

<definitions>

Snippet C-8: Example @WebParam Annotation

C.1.5 @WebResult

Annotation on a C++ member function indicating the mapping of the member function’s return type to the associated output WSDL message.

Corresponds to: javax.jws@WebResult annotation in the JAX-WS specification (7.11.5)

Format:

```c
// @WebResult(name="WSDLElement", targetNamespace="namespaceURI",
// header=false, partName="WSDLPart", type="xsdType")
```

Snippet C-9: @WebResult Annotation Format

where:

- **name : NCName (0..1)** – specifies the name of the associated WSDL part or element. The default value is “return”.
- **targetNamespace : string (0..1)** – specifies the target namespace for the part. The default namespace is the namespace of the associated @WebService. The targetNamespace attribute is ignored unless the binding style is document, and the binding parameterStyle is bare. See @SOAPBinding.
- **header : boolean (0..1)** – specifies whether the result is associated with a SOAP header element. The default value is “false”.
- **partName : NCName (0..1)** – specifies the name of the WSDL part associated with this item. The default value is the value of name.
**type : NCName (0..1)** – specifies the XML Schema type of the WSDL part or element associated with this parameter. The value of the type property of a @WebResult annotation MUST be one of the simpleTypes defined in namespace http://www.w3.org/2001/XMLSchema. [CPPC0006] The default type is determined by the mapping defined in Simple Content Binding.

**Applies to:** Member function return value.

**Example:**

Input C++ source file:
```cpp
// @WebService(name="StockQuote", targetNamespace="http://www.example.org/
//       serviceName="StockQuoteService")
class StockQuoteService {

// @WebFunction(operationName="GetLastTradePrice",
//       action="urn:GetLastTradePrice")
// @WebResult(name="price")
float getLastTradePrice(const std::string& tickerSymbol);
};
```

Generated WSDL file:
```xml
<definitions xmlns="http://schemas.xmlsoap.org/wsdl/
xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/
xmlns:tns="http://www.example.org/
xmlns:cpp="http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/cpp/
xmlns:cpp="http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/cpp/
targetNamespace="http://www.example.org/">
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
xmlns:tns="http://www.example.org/
attributeFormDefault="unqualified"
elementFormDefault="unqualified"
targetNamespace="http://www.example.org/">
<xs:element name="GetLastTradePrice" type="tns:GetLastTradePrice"/>
<xs:element name="GetLastTradePriceResponse" type="tns:GetLastTradePriceResponse"/>
<xs:complexType name="GetLastTradePrice">
<xs:sequence>
<xs:element name="tickerSymbol" type="xs:string"/>
</xs:sequence>
</xs:complexType>
<xs:complexType name="GetLastTradePriceResponse">
<xs:sequence>
<xs:element name="price" type="xs:float"/>
</xs:sequence>
</xs:complexType>
</xs:schema>
<message name="GetLastTradePrice">
<part name="parameters" element="tns:GetLastTradePrice"/>
</message>
<message name="GetLastTradePriceResponse">
<part name="parameters" element="tns:GetLastTradePriceResponse"/>
</message>
<portType name="StockQuote">
<cpp:bindings>
<cpp:class name="StockQuoteService"/>
</cpp:bindings>
</portType>
```
<cpp:memberFunction name="getLastTradePrice"/>
</cpp:bindings>
<input name="GetLastTradePrice" message="tns:GetLastTradePrice">
<output name="GetLastTradePriceResponse" message="tns:GetLastTradePriceResponse">
</operation>
</portType>

<binding name="StockQuoteServiceSoapBinding">
<soap:binding style="document"
    transport="http://schemas.xmlsoap.org/soap/http"/>
<operation name="GetLastTradePrice">
<soap:operation soapAction="urn:GetLastTradePrice" style="document"/>
<input name="GetLastTradePrice">
<soap:body use="literal"/>
</input>
<output name="GetLastTradePriceResponse">
<soap:body use="literal"/>
</output>
</operation>
</binding>

<service name="StockQuoteService">
<port name="StockQuotePort" binding="tns:StockQuoteServiceSoapBinding">
<soap:address location="REPLACE_WITH_ACTUAL_URL"/>
</port>
</service>
</definitions>

Snippet C-10: Example @WebResult Annotation

C.1.6 @SOAPBinding

Annotation on a C++ member function indicating that it represents a web service operation.

Corresponds to: javax.jws.SOAPBinding annotation in the JAX-WS specification (7.11.6)

Format:

```cpp
// @SOAPBinding(style="DOCUMENT"|"RPC", use="LITERAL"|"ENCODED",
parameterStyle="BARE"|"WRAPPED")
```

Snippet C-11: @SOAPBinding Annotation Format

where:

- **style : token (0..1)** – specifies the WSDL binding style. The default value is "DOCUMENT".
- **use : token (0..1)** – specifies the WSDL binding use. The default value is "LITERAL".
- **parameterStyle : token (0..1)** – specifies the WSDL parameter style. The default value is "WRAPPED".

Applies to: Class, Member function.

Example:

Input C++ source file:

```cpp
// @WebService(name="StockQuote", targetNamespace="http://www.example.org/"
//    serviceName="StockQuoteService")
// @SOAPBinding(style="RPC")
class StockQuoteService {
};
```

Generated WSDL file:
C.1.7 @WebFault

Annotation on a C++ exception class indicating that it might be thrown as a fault by a web service function. A C++ class with a @WebFault annotation MUST provide a constructor that takes two parameters, a std::string and a type representing the fault information. Additionally, the class MUST provide a const member function “getFaultInfo” that takes no parameters, and returns the same type as defined in the constructor. [CPPC0007]

Corresponds to: javax.xml.ws.WebFault annotation in the JAX-WS specification (7.2)

Format:

```
// @WebFault(name="WSDLElement", targetNamespace="namespaceURI")
```

where:

- **name**: NCName (1..1) – specifies local name of the global element mapped to this fault.
- **targetNamespace**: string (0..1) – specifies the namespace of the global element mapped to this fault. The default namespace is determined by the implementation.

Applies to: Class.

Example:

Input C++ source file:

```
// @WebFault(name="UnknownSymbolFault", targetNamespace="http://www.example.org/")
class UnknownSymbol {
    UnknownSymbol(const char* message,
                  const std::string& faultInfo);
    std::string getFaultInfo() const;
};
```

```
// @WebService(name="StockQuote", targetNamespace="http://www.example.org/")
class StockQuoteService {
```
// @WebFunction(operationName="GetLastTradePrice",
// action="urn:GetLastTradePrice")
// @WebThrows(faults="UnknownSymbol")
float getLastTradePrice(const std::string& tickerSymbol);

Generated WSDL file:

<definitions xmlns="http://schemas.xmlsoap.org/wsdl/
xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/
xmlns:tns="http://www.example.org/
xmlns:cpp="http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/cpp/200901"
targetNamespace="http://www.example.org/">
<x:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
xmlns:tns="http://www.example.org/
attributeFormDefault="unqualified"
elementFormDefault="unqualified"
targetNamespace="http://www.example.org/">
<x:element name="GetLastTradePrice" type="tns:GetLastTradePrice"/>
<x:element name="GetLastTradePriceResponse" type="tns:GetLastTradePriceResponse"/>
<x:complexType name="GetLastTradePrice">
<x:sequence>
<x:element name="tickerSymbol" type="xs:string"/>
</x:sequence>
</xs:complexType>
<x:complexType name="GetLastTradePriceResponse">
<x:sequence>
<x:element name="return" type="xs:float"/>
</x:sequence>
</xs:complexType>
<x:element name="UnknownSymbolFault" type="xs:string"/>
</xs:schema>
<message name="GetLastTradePrice">
<part name="parameters" element="tns:GetLastTradePrice"/>
</message>
<message name="GetLastTradePriceResponse">
<part name="parameters" element="tns:GetLastTradePriceResponse"/>
</message>
<message name="UnknownSymbol">
<part name="parameters" element="tns:UnknownSymbolFault"/>
</message>
<portType name="StockQuote">
<cpp:bindings>
<cpp:class name="StockQuoteService"/>
</cpp:bindings>
<operation name="GetLastTradePrice">
<cpp:bindings>
<cpp:memberFunction name="getLastTradePrice"/>
</cpp:bindings>
</operation>
<input name="GetLastTradePrice" message="tns:GetLastTradePrice"/>
</input>
<output name="GetLastTradePriceResponse" message="tns:GetLastTradePriceResponse"/>
</output>
<fault name="UnknownSymbol" message="tns:UnknownSymbol"/>
</fault>
</operation>
</portType>

(binding name="StockQuoteServiceSoapBinding">
<soap:binding style="document"
transport="http://schemas.xmlsoap.org/soap/http"/>
<operation name="GetLastTradePrice">
<soap:operation soapAction="urn:GetLastTradePrice" style="document"/>
<input name="GetLastTradePrice">
<soap:body use="literal"/>
</input>
<output name="GetLastTradePriceResponse">
<soap:body use="literal"/>
</output>
<fault>
<soap:_fault name="UnknownSymbol" use="literal"/>
</fault>
</operation>
</binding>

<service name="StockQuoteService">
<port name="StockQuotePort" binding="tns:StockQuoteServiceSoapBinding">
<soap:address location="REPLACE_WITH_ACTUAL_URL"/>
</port>
</service>
</definitions>

Snippet C-14: Example @WebFault Annotation

C.1.8 @WebThrows

Annotation on a C++ class indicating which faults might be thrown by this class.

Corresponds to: No equivalent in JAX-WS.

Format:

```c++
// @WebThrows(faults="faultMsg1", "faultMsgn")
```

Snippet C-15: @WebThrows Annotation Format

where:

- **faults**: `NMTOKEN{1..n}`—specifies the names of all faults that might be thrown by this member function. The name of the fault is the name of its associated C++ class name. A C++ class that is listed in a @WebThrows annotation MUST itself have a @WebFault annotation. [CPPC0008]

Applies to: Member function.

Example:

See @WebFault.
D  WSDL C++ Mapping Extensions

A set of WSDL extensions are used to augment the conversion process from WSDL to C++. All of these extensions are defined in the namespace http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/cpp/200901. For brevity, all definitions of these extensions will be fully qualified, and all references to the "cpp" prefix are associated with the namespace above. If WSDL extensions are supported by an implementation, all the extensions defined here MUST be supported and MUST be mapped to C++ as described.

[CPPD0001]

D.1 <cpp:bindings>

<cpp:bindings> is a container type which can be used as a WSDL extension. All other SCA wsdl extensions will be specified as children of a <cpp:bindings> element. A <cpp:bindings> element can be used as an extension to any WSDL type that accepts extensions.

D.2 <cpp:class>

<cpp:class> provides a mechanism for defining an alternate C++ class name for a WSDL construct.

Format:

```xml
<cpp:class name="xsd:string"/>
```

Snippet D-1: <cpp:class> Element Format

where:

- **class/@name : NCName (1..1)** – specifies the name of the C++ class associated with this WSDL element.

Applicable WSDL element(s):

- `wsdl:portType`
- `wsdl:fault`

A <cpp:bindings/> element MUST NOT have more than one <cpp:class/> child element. [CPPD0002]

Example:

Input WSDL file:

```xml
<definitions xmlns="http://schemas.xmlsoap.org/wsd1/"
    xmlns:soap="http://schemas.xmlsoap.org/wsd1/soap/"
    xmlns:tns="http://www.example.org/
    xmlns:cpp="http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/cpp/200901"
    targetNamespace="http://www.example.org/">
    <portType name="StockQuote">
        <cpp:bindings>
            <cpp:class name="StockQuoteService"/>
        </cpp:bindings>
    </portType>
</definitions>
```

Generated C++ file:

```cpp
// @WebService(name="StockQuote", targetNamespace="http://www.example.org/
//      serviceName="StockQuoteService")
class StockQuoteService {
};
```

Snippet D-2: Example <cpp:class> Element
D.3 <cpp:enableWrapperStyle>

<cpp:enableWrapperStyle> indicates whether or not the wrapper style for messages is applied, when otherwise applicable. If false, the wrapper style will never be applied.

Format:

```
<cpp:enableWrapperStyle>value</cpp:enableWrapperStyle>
```

**Snippet D-3: <cpp:enableWrapperStyle> Element Format**

where:

- `enableWrapperStyle/text() : boolean (1..1)` – specifies whether wrapper style is enabled or disabled for this element and any of its children. The default value is “true”.

**Applicable WSDL element(s):**

- `wsdl:definitions`
- `wsdl:portType` – overrides a binding applied to `wsdl:definitions`
- `wsdl:portType.wsdl:operation` – overrides a binding applied to `wsdl:definitions` or the enclosing `wsdl:portType`

A `<cpp:bindings/>` element MUST NOT have more than one `<cpp:enableWrapperStyle/>` child element. [CPPD0003]

**Example:**

Input WSDL file:

```xml
<definitions xmlns="http://schemas.xmlsoap.org/wsd1/">
  xmlns:soap="http://schemas.xmlsoap.org/wsd1/soap/
  xmlns:tns="http://www.example.org/
  xmlns:cpp="http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/cpp/200901"
  targetNamespace="http://www.example.org/">
  <xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
    xmlns:tns="http://www.example.org/"
    attributeFormDefault="unqualified"
    elementFormDefault="unqualified"
    targetNamespace="http://www.example.org/">
    <xs:element name="GetLastTradePrice" type="tns:GetLastTradePrice"/>
    <xs:element name="GetLastTradePriceResponse" type="tns:GetLastTradePriceResponse"/>
    <xs:complexType name="GetLastTradePrice">
      <xs:sequence>
        <xs:element name="tickerSymbol" type="xs:string"/>
      </xs:sequence>
    </xs:complexType>
    <xs:complexType name="GetLastTradePriceResponse">
      <xs:sequence>
        <xs:element name="return" type="xs:float"/>
      </xs:sequence>
    </xs:complexType>
  </xs:schema>
</definitions>
```
<cpp:bindings>
  <cpp:class name="StockQuoteService"/>
  <cpp:enableWrapperStyle>false</cpp:enableWrapperStyle>
  <cpp:bindings>
    <cpp:memberFunction name="getLastTradePrice"/>
  </cpp:bindings>
  <operation name="GetLastTradePrice">
    <cpp:bindings>
      <cpp:memberFunction name="getLastTradePrice"/>
    </cpp:bindings>
    <input name="GetLastTradePrice" message="tns:GetLastTradePrice">
    </input>
    <output name="GetLastTradePriceResponse" message="tns:GetLastTradePriceResponse">
    </output>
  </operation>
</portType>
</definitions>

Generated C++ file:

```cpp
// @WebService(name="StockQuote", targetNamespace="http://www.example.org/
//       serviceName="StockQuoteService")
class StockQuoteService {
    // @WebFunction(operationName="GetLastTradePrice",
    //       action="urn:GetLastTradePrice")
    commonj::sdo::DataObjectPtr getLastTradePrice(commonj::sdo::DataObjectPtr parameters);
};
```

**Snippet D-4: Example `<cpp:enableWrapperStyle>` Element**

**D.4 `<cpp:namespace>`**

`<cpp:namespace>` specifies the name of the C++ namespace that the associated WSDL element (and any of its children) are created in.

**Format:**

```
<cpp:namespace name="namespaceURI"/>
```

**Snippet D-5: `<cpp:namespace>` Element Format**

where:

- `namespace/@name : anyURI (1..1)` – specifies the name of the C++ namespace associated with this WSDL element.

**Applicable WSDL element(s):**

- `wsdl:definitions`

**A `<cpp:bindings/>` element MUST NOT have more than one `<cpp:namespace/>` child element.**

**[CPPD0004]**

**Example:**

Input WSDL file:

```xml
<definitions xmlns="http://schemas.xmlsoap.org/wwsdl/
    xmlns:soap="http://schemas.xmlsoap.org/wwsdl/soap/
    xmlns:tns="http://www.example.org/"
    xmlns:cpp="http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/200901"
    targetNamespace="http://www.example.org/">
  <cpp:bindings>
    <cpp:namespace name="stock"/>
  </cpp:bindings>
</portType name="StockQuote"/>
```
<cpp:bindings>
<cpp:class name="StockQuoteService"/>
</cpp:bindings>
</portType>
</definitions>

Generated C++ file:

```cpp
namespace stock {
    // @WebService(name="StockQuote", targetNamespace="http://www.example.org/"
    //       serviceName="StockQuoteService")
    // @WebService(name="StockQuote",
    class StockQuoteService {
    
    }
}
```

**Snippet D-6: Example `<cpp:namespace>` Element**

**D.5 `<cpp:memberFunction>`**

`<cpp:memberFunction>` specifies the name of the C++ member function that the associated WSDL operation is associated with.

**Format:**

```cpp
<cpp:memberFunction name="myFunction"/>
```

**Snippet D-7: `<cpp:memberFunction>` Element Format**

where:

- **`memberFunction/@name : NCName (1..1)`** – specifies the name of the C++ member function associated with this WSDL operation.

**Applicable WSDL element(s):**

- `wsdl:portType/wsdl:operation`

A `<cpp:bindings/>` element MUST NOT have more than one `<cpp:memberFunction/>` child element.

**Example:**

**Input WSDL file:**

```xml
<definitions xmlns="http://schemas.xmlsoap.org/wsdl/
xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/
xmlns:xns="http://www.example.org/
xmlns:cpp="http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/cpp/200901"
targetNamespace="http://www.example.org/">
    <xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
xmlns:xns="http://www.example.org/
attributeFormDefault="unqualified"
elementFormDefault="unqualified"
targetNamespace="http://www.example.org/>
    <xs:element name="GetLastTradePrice" type="xns:GetLastTradePrice"/>
    <xs:element name="GetLastTradePriceResponse" type="xns:GetLastTradePriceResponse"/>
    <xs:complexType name="GetLastTradePrice">
        <xs:sequence>
            <xs:element name="tickerSymbol" type="xs:string"/>
        </xs:sequence>
    </xs:complexType>
    <xs:complexType name="GetLastTradePriceResponse">
        <xs:sequence>
            <xs:element name="tickerSymbol" type="xs:string"/>
        </xs:sequence>
    </xs:complexType>
</definitions>
```
<message name="GetLastTradePrice">
    <part name="parameters" element="tns:GetLastTradePrice"/>
</message>

<message name="GetLastTradePriceResponse">
    <part name="parameters" element="tns:GetLastTradePriceResponse"/>
</message>

<portType name="StockQuote">
    <cpp:bindings>
        <cpp:class name="StockQuoteService"/>
    </cpp:bindings>
    <operation name="GetLastTradePrice">
        <cpp:bindings>
            <cpp:memberFunction name="getTradePrice"/>
        </cpp:bindings>
        <input name="GetLastTradePrice" message="tns:GetLastTradePrice"/>
        <output name="GetLastTradePriceResponse" message="tns:GetLastTradePriceResponse"/>
    </operation>
</portType>
</definitions>

Generated C++ file:

```cpp
// @WebService(name="StockQuote", targetNamespace="http://www.example.org/"
//       serviceName="StockQuoteService")
class StockQuoteService {
    // @WebFunction(operationName="GetLastTradePrice",
    //       action="urn:GetLastTradePrice")
    float getTradePrice(const std::string& tickerSymbol);
};
```

**Snippet D-8: Example `<cpp:memberFunction>` Element**

**D.6 `<cpp:parameter>`**

`<cpp:parameter>` specifies the name of the C++ member function parameter associated with a specific WSDL message part or wrapper child element.

**Format:**

```xml
<cpp:parameter name="CPPParameter" part="WSDLPart"
    childElementName="WSDLElement" type="CPPType"/>
```

**Snippet D-9: `<cpp:parameter>` Element Format**

where:

- `parameter/@name : NCName (1..1)` – specifies the name of the C++ member function parameter associated with this WSDL operation. "return" is used to denote the return value.
- `parameter/@part : string (1..1)` - an XPath expression identifying the wsdl:part of a wsdl:message.
- `parameter/@childElementName : QName (1..1)` – specifies the qualified name of a child element of the global element identified by parameter/@part.
- `parameter/@type : string (0..1)` – specifies the type of the parameter or struct member or return type. The `@type` attribute of a `<cpp:parameter/>` element MUST be a C++ type specified in Simple Content Binding. [CPPD0006] The default type is determined by the mapping defined in Simple Content Binding.

**Applicable WSDL element(s):**

- `wsdl:portType/wsdl:operation`

Example:

```
Input WSDL file:

```xml
<definitions xmlns="http://schemas.xmlsoap.org/wsdl/
xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/
xmlns:tns="http://www.example.org/
xmlns:cpp="http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/cpp/200901"
targetNamespace="http://www.example.org/">
  <xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
    xmlns:tns="http://www.example.org/"
    attributeFormDefault="unqualified"
    elementFormDefault="unqualified"
    targetNamespace="http://www.example.org/">
    <xs:element name="GetLastTradePrice" type="tns:GetLastTradePrice"/>
    <xs:element name="GetLastTradePriceResponse" type="tns:GetLastTradePriceResponse"/>
    <xs:complexType name="GetLastTradePrice">
      <xs:sequence>
        <xs:element name="symbol" type="xs:string"/>
      </xs:sequence>
    </xs:complexType>
    <xs:complexType name="GetLastTradePriceResponse">
      <xs:sequence>
        <xs:element name="return" type="xs:float"/>
      </xs:sequence>
    </xs:complexType>
  </xs:schema>
  <message name="GetLastTradePrice">
    <part name="parameters" element="tns:GetLastTradePrice"/>
  </message>
  <message name="GetLastTradePriceResponse">
    <part name="parameters" element="tns:GetLastTradePriceResponse"/>
  </message>
  <portType name="StockQuote">
    <cpp:bindings>
      <cpp:class name="StockQuoteService"/>
    </cpp:bindings>
    <operation name="GetLastTradePrice">
      <cpp:bindings>
        <cpp:memberFunction name="getLastTradePrice"/>
        <cpp:parameter name="tickerSymbol" part="tns:GetLastTradePrice/parameter"
          childElementName="symbol"/>
      </cpp:bindings>
      <input name="GetLastTradePrice" message="tns:GetLastTradePrice"/>
      <output name="GetLastTradePriceResponse" message="tns:GetLastTradePriceResponse"/>
    </operation>
  </portType>
</definitions>
```
<portType>

<binding name="StockQuoteServiceSoapBinding">
   <soap:binding style="document"
   transport="http://schemas.xmlsoap.org/soap/http"/>
   <operation name="GetLastTradePrice">
      <soap:operation soapAction="urn:GetLastTradePrice" style="document"/>
      <input name="GetLastTradePrice"/>
      <output name="GetLastTradePriceResponse"/>
   </operation>
</binding>

<service name="StockQuoteService">
   <port name="StockQuotePort" binding="tns:StockQuoteServiceSoapBinding">
      <soap:address location="REPLACE_WITH_ACTUAL_URL"/>
   </port>
</service>
</definitions>

Generated C++ file:

// @WebService(name="StockQuote", targetNamespace="http://www.example.org/
//       serviceName="StockQuoteService")
class StockQuoteService {

   // @WebFunction(operationName="GetLastTradePrice",
   //       action="urn:GetLastTradePrice")
   // @WebParam(paramName="tickerSymbol", name="symbol")
   float getLastTradePrice(const std::string& tickerSymbol);
};

Snippet D-10: Example <cpp:parameter> Element

D.7 JAX-WS WSDL Extensions

An SCA implementation MAY support the reading and interpretation of JAX-WS defined WSDL
extensions; however it MUST give precedence to the corresponding SCA WSDL extension if present.
Table D-1 is a list of JAX-WS WSDL extensions that MAY be interpreted and their corresponding SCA
WSDL extensions. [CPPD0007]

<table>
<thead>
<tr>
<th>JAX-WS Extension</th>
<th>SCA Extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>jaxws:bindings</td>
<td>cpp:bindings</td>
</tr>
<tr>
<td>jaxws:class</td>
<td>cpp:class</td>
</tr>
<tr>
<td>jaxws:method</td>
<td>cpp:memberFunction</td>
</tr>
<tr>
<td>jaxws:parameter</td>
<td>cpp:parameter</td>
</tr>
<tr>
<td>jaxws:enableWrapperStyle</td>
<td>cpp:enableWrapperStyle</td>
</tr>
</tbody>
</table>

Table D-1: Allowed JAX-WS Extensions

D.8 sca-wsdlext-cpp-1.1.xsd
```xml
<schema xmlns="http://www.w3.org/2001/XMLSchema"

targetNamespace="http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/cpp/200901"

xmllns:cpp="http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/cpp/200901"
xmllns:xsd="http://www.w3.org/2001/XMLSchema"

elementFormDefault="qualified">

  <element name="bindings" type="cpp:BindingsType" />

  <complexType name="BindingsType">
    <choice minOccurs="0" maxOccurs="unbounded">
      <element ref="cpp:namespace" />
      <element ref="cpp:class" />
      <element ref="cpp:enableWrapperStyle" />
      <element ref="cpp:memberFunction" />
      <element ref="cpp:parameter" />
    </choice>
  </complexType>

  <element name="namespace" type="cpp:NamespaceType" />
  <complexType name="NamespaceType">
    <attribute name="name" type="xsd:anyURI" use="required" />
  </complexType>

  <element name="class" type="cpp:ClassType" />
  <complexType name="ClassType">
    <attribute name="name" type="xsd:NCName" use="required" />
  </complexType>

  <element name="memberFunction" type="cpp:MemberFunctionType" />
  <complexType name="MemberFunctionType">
    <attribute name="name" type="xsd:NCName" use="required" />
  </complexType>

  <element name="parameter" type="cpp:ParameterType" />
  <complexType name="ParameterType">
    <attribute name="part" type="xsd:string" use="required" />
    <attribute name="childElementName" type="xsd:QName" use="required" />
    <attribute name="name" type="xsd:NCName" use="required" />
    <attribute name="type" type="xsd:string" use="optional" />
  </complexType>

  <element name="enableWrapperStyle" type="xsd:boolean" />
</schema>
```

**Snippet D-11: SCA C++ WSDL Extension Schema**
E XML Schemas

E.1 sca-interface-cpp-1.1.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema xmlns="http://www.w3.org/2001/XMLSchema"

targetNamespace="http://docs.oasis-open.org/ns/opencsa/sca/200912"
xmlns:sca="http://docs.oasis-open.org/ns/opencsa/sca/200912"
elementFormDefault="qualified">
<include schemaLocation="sca-core.xsd"/>
<element name="interface.cpp" type="sca:CPPInterface"
substitutionGroup="sca:interface"/>
<complexType name="CPPInterface">
<complexContent>
<extension base="sca:Interface">
<sequence>
<element name="function" type="sca:CPPFunction"
minOccurs="0" maxOccurs="unbounded" />
<element name="callbackFunction" type="sca:CPPFunction"
minOccurs="0" maxOccurs="unbounded" />
<any namespace="##other" processContents="lax"
minOccurs="0" maxOccurs="unbounded"/>
</sequence>
<attribute name="header" type="string" use="required"/>
<attribute name="class" type="Name" use="required"/>
<attribute name="callbackHeader" type="string" use="optional"/>
<attribute name="callbackClass" type="Name" use="optional"/>
</extension>
</complexContent>
</complexType>
<complexType name="CPPFunction">
<sequence>
<choice minOccurs="0" maxOccurs="unbounded">
<element ref="sca:requires"/>
<element ref="sca:policySetAttachment"/>
</choice>
<any namespace="##other" processContents="lax"
minOccurs="0" maxOccurs="unbounded"/>
<attribute name="name" type="NCName" use="required"/>
<attribute name="requires" type="sca:listOfQNames" use="optional"/>
<attribute name="policySets" type="sca:listOfQNames" use="optional"/>
<attribute name="oneWay" type="boolean" use="optional"/>
<attribute name="exclude" type="boolean" use="optional"/>
<anyAttribute namespace="##other" processContents="lax"/>
</sequence>
</complexType>
</schema>
```

Snippet E-1: SCA <interface.cpp> Schema

E.2 sca-implementation-cpp-1.1.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema xmlns="http://www.w3.org/2001/XMLSchema"

targetNamespace="http://docs.oasis-open.org/ns/opencsa/sca/200912"
```
Snippet E-2: SCA <implementation.cpp> Schema

E.3 sca-contribution-cpp-1.1.xsd
Snippet E-3: SCA <export.cpp> and <import.cpp> Schema
### F Normative Statement Summary

This section contains a list of normative statements for this specification.

<table>
<thead>
<tr>
<th>Conformance ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[CPP20001]</td>
<td>A C++ implementation MUST implement all of the operation(s) of the service interface(s) of its componentType.</td>
</tr>
<tr>
<td>[CPP20003]</td>
<td>An SCA runtime MUST support these scopes; <strong>stateless</strong> and <strong>composite</strong>. Additional scopes MAY be provided by SCA runtimes.</td>
</tr>
<tr>
<td>[CPP20005]</td>
<td>If the header file identified by the <code>@header</code> attribute of an <code>&lt;interface.cpp/&gt;</code> element contains more than one class, then the <code>@class</code> attribute MUST be specified for the <code>&lt;interface.cpp/&gt;</code> element.</td>
</tr>
<tr>
<td>[CPP20006]</td>
<td>If the header file identified by the <code>@callbackHeader</code> attribute of an <code>&lt;interface.cpp/&gt;</code> element contains more than one class, then the <code>@callbackClass</code> attribute MUST be specified for the <code>&lt;interface.cpp/&gt;</code> element.</td>
</tr>
<tr>
<td>[CPP20007]</td>
<td>The <code>@name</code> attribute of a <code>&lt;function/&gt;</code> child element of a <code>&lt;interface.cpp/&gt;</code> MUST be unique amongst the <code>&lt;function/&gt;</code> elements of that <code>&lt;interface.cpp/&gt;</code>.</td>
</tr>
<tr>
<td>[CPP20008]</td>
<td>The <code>@name</code> attribute of a <code>&lt;callbackFunction/&gt;</code> child element of a <code>&lt;interface.cpp/&gt;</code> MUST be unique amongst the <code>&lt;callbackFunction/&gt;</code> elements of that <code>&lt;interface.cpp/&gt;</code>.</td>
</tr>
<tr>
<td>[CPP20009]</td>
<td>The name of the componentType file for a C++ implementation MUST match the class name (excluding any namespace definition) of the implementations as defined by the <code>@class</code> attribute of the <code>&lt;implementation.cpp/&gt;</code> element.</td>
</tr>
<tr>
<td>[CPP20010]</td>
<td>The <code>@name</code> attribute of a <code>&lt;function/&gt;</code> child element of a <code>&lt;implementation.cpp/&gt;</code> MUST be unique amongst the <code>&lt;function/&gt;</code> elements of that <code>&lt;implementation.cpp/&gt;</code>.</td>
</tr>
<tr>
<td>[CPP20011]</td>
<td>A C++ implementation class MUST be default constructable by the SCA runtime to instantiate the component.</td>
</tr>
<tr>
<td>[CPP20012]</td>
<td>An SCA runtime MUST ensure that a stateless scoped implementation instance object is only ever dispatched on one thread at any one time. In addition, within the SCA lifecycle of an instance, an SCA runtime MUST only make a single invocation of one business member function.</td>
</tr>
<tr>
<td>[CPP20013]</td>
<td>An SCA runtime MAY run multiple threads in a single composite scoped implementation instance object.</td>
</tr>
<tr>
<td>[CPP20014]</td>
<td>The SCA runtime MAY use by-reference semantics when passing input parameters, return values or exceptions on calls to remtatable services within the same system address space if both the service member function implementation and the client are marked “allows pass by reference”.</td>
</tr>
<tr>
<td>[CPP20015]</td>
<td>The SCA runtime MUST use by-value semantics when passing input parameters, return values and exceptions on calls to remtatable services within the same system address space if the service member function implementation is not marked “allows pass by reference” or the client is not marked “allows pass by reference”.</td>
</tr>
<tr>
<td>Conformance ID</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------</td>
</tr>
<tr>
<td>[CPP20016]</td>
<td>If the header file identified by the @header attribute of an <code>&lt;interface.cpp/&gt;</code> element contains function declarations that are not operations of the interface, then the functions that are not operations of the interface MUST be excluded using <code>&lt;function/&gt;</code> child elements of the <code>&lt;interface.cpp/&gt;</code> element with @exclude=&quot;true&quot;.</td>
</tr>
<tr>
<td>[CPP20017]</td>
<td>If the header file identified by the @callbackHeader attribute of an <code>&lt;interface.cpp/&gt;</code> element contains function declarations that are not operations of the callback interface, then the functions that are not operations of the callback interface MUST be excluded using <code>&lt;callbackFunction/&gt;</code> child elements of the <code>&lt;interface.cpp/&gt;</code> element with @exclude=&quot;true&quot;.</td>
</tr>
<tr>
<td>[CPP20018]</td>
<td>An SCA runtime MUST NOT perform any synchronization of access to component implementations.</td>
</tr>
<tr>
<td>[CPP30001]</td>
<td>If a remotable interface is defined with a C++ class, an SCA implementation SHOULD map the interface definition to WSDL before generating the proxy for the interface.</td>
</tr>
<tr>
<td>[CPP30002]</td>
<td>For each reference of a component, an SCA implementation MUST generate a service proxy derived from ServiceProxy that contains the operations of the reference’s interface definition.</td>
</tr>
<tr>
<td>[CPP30003]</td>
<td>An SCA runtime MUST include an asynchronous invocation member function for every operation of a reference interface with a @requires=&quot;asyncInvocation&quot; intent applied either to the operation or the reference as a whole.</td>
</tr>
<tr>
<td>[CPP30004]</td>
<td>An SCA runtime MUST include a response class for every response message of a reference interface that can be returned by an operation of the interface with a @requires=&quot;asyncInvocation&quot; intent applied either to the operation of the reference as a whole.</td>
</tr>
<tr>
<td>[CPP40001]</td>
<td>An operation marked as oneWay is considered non-blocking and the SCA runtime MAY use a binding that buffers the requests to the member function and sends them at some time after they are made.</td>
</tr>
<tr>
<td>[CPP40002]</td>
<td>For each service of a component that includes a bidirectional interface, an SCA implementation MUST generate a service proxy derived from ServiceProxy that contains the operations of the reference’s callback interface definition.</td>
</tr>
<tr>
<td>[CPP40003]</td>
<td>If a service of a component that has a callback interface contains operations with a @requires=&quot;asyncInvocation&quot; intent applied either to the operation of the reference as a whole, an SCA implementation MUST include asynchronous invocation member functions and response classes as described in Long Running Request-Response Operations.</td>
</tr>
<tr>
<td>[CPP70001]</td>
<td>The @name attribute of a <code>&lt;export.cpp/&gt;</code> element MUST be unique amongst the <code>&lt;export.cpp/&gt;</code> elements in a domain.</td>
</tr>
<tr>
<td>[CPP70002]</td>
<td>The @name attribute of a <code>&lt;import.cpp/&gt;</code> child element of a <code>&lt;contribution/&gt;</code> MUST be unique amongst the <code>&lt;import.cpp/&gt;</code> elements in of that contribution.</td>
</tr>
<tr>
<td>[CPP80001]</td>
<td>An SCA implementation MUST translate a class to tokens as part of conversion to WSDL or compatibility testing.</td>
</tr>
<tr>
<td>Conformance ID</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------</td>
</tr>
<tr>
<td>[CPP80002]</td>
<td>The return type and types of the parameters of a member function of a remotable service interface MUST be one of:</td>
</tr>
<tr>
<td></td>
<td>• Any of the C++ types specified in Simple Content Binding. These types may be passed by-value, by-reference, or by-pointer and may be contained in an array, an std::vector, std::list or one of the variations of an std::deque. Unless the member function and client indicate that they allow by-reference semantics (see AllowsPassByReference), a copy will be explicitly created by the runtime for any parameters passed by-reference or by-pointer.</td>
</tr>
<tr>
<td></td>
<td>• An SDO DataObjectPtr instance. This type may be passed by-value, by-reference, or by-pointer and may be contained in an array, an std::vector, std::list or one of the variations of an std::deque. Unless the member function and client indicate that they allow by-reference semantics (see AllowsPassByReference), a deep-copy of the DataObjectPtr will be created by the runtime for any parameters passed by-value, by-reference, or by-pointer. When by-reference semantics are allowed, the DataObjectPtr itself will be passed.</td>
</tr>
<tr>
<td>[CPP80003]</td>
<td>A C++ header file used to define an interface MUST declare at least one class with:</td>
</tr>
<tr>
<td></td>
<td>• At least one public member function.</td>
</tr>
<tr>
<td></td>
<td>• All public member functions are pure virtual.</td>
</tr>
<tr>
<td>[CPP100001]</td>
<td>A WSDL file might define a namespace using the <a href="">sca:namespace</a> WSDL extension, otherwise all C++ classes MUST be placed in a default namespace as determined by the implementation. Implementations SHOULD provide a mechanism for overriding the default namespace.</td>
</tr>
<tr>
<td>[CPP100002]</td>
<td>If multiple operations within the same portType indicate that they throw faults that reference the same global element, an SCA implementation MUST generate a single C++ exception class with each C++ member function referencing this class in its @WebThrows annotation.</td>
</tr>
<tr>
<td>[CPP100003]</td>
<td>• For unwrapped messages, an SCA implementation MUST map:</td>
</tr>
<tr>
<td></td>
<td>– <strong>in</strong> - the message part to a member function parameter, passed by const-reference.</td>
</tr>
<tr>
<td></td>
<td>– <strong>out</strong> - the message part to a member function parameter, passed by reference, or to the member function return type, returned by-value.</td>
</tr>
<tr>
<td></td>
<td>– <strong>in/out</strong> - the message part to a member function parameter, passed by reference.</td>
</tr>
<tr>
<td>[CPP100004]</td>
<td>• For wrapped messages, an SCA implementation MUST map:</td>
</tr>
<tr>
<td></td>
<td>– <strong>in</strong> - the wrapper child to a member function parameter, passed by const-reference.</td>
</tr>
<tr>
<td></td>
<td>– <strong>out</strong> - the wrapper child to a member function parameter, passed by reference, or to the member function return type, returned by-value.</td>
</tr>
<tr>
<td></td>
<td>– <strong>in/out</strong> - the wrapper child to a member function parameter, passed by reference.</td>
</tr>
<tr>
<td>[CPP100005]</td>
<td>An SCA implementation SHOULD provide a mechanism for overriding the default targetNamespace.</td>
</tr>
</tbody>
</table>
An SCA implementation MUST map a method’s return type as an out parameter, a parameter passed by-reference or by-pointer as an inout parameter, and all other parameters, including those passed by-const-reference as in parameters.

An SCA implementation MUST map simple types as defined in Table 9-1 and Table 9-2 by default.

An SCA implementation MUST map a WSDL portType to a remotable C++ interface definition.

An SCA implementation MUST map a C++ interface definition to WSDL as if it has a @WebService annotation with all default values on the class.

An SCA implementation MUST reject a composite file that does not conform to http://docs.oasis-open.org/opencsa/sca/200912/sca-interface-cpp-1.1.xsd or http://docs.oasis-open.org/opencsa/sca/200912/sca-implementation-cpp-1.1.xsd.

An SCA implementation MUST reject a componentType file that does not conform to http://docs.oasis-open.org/opencsa/sca/200912/sca-interface-cpp-1.1.xsd.

An SCA implementation MUST reject a contribution file that does not conform to http://docs.oasis-open.org/opencsa/sca/200912/sca-contribution-cpp-1.1.xsd.

An SCA implementation MUST reject a WSDL file that does not conform to http://docs.oasis-open.org/opencsa/sca-c-cpp/cpp/200901/sca-wsdl-ext-cpp-1.1.xsd.

This section contains a list of normative statements related to source file annotations for this specification.

If annotations are supported by an implementation, the annotations defined here MUST be supported and MUST be mapped to SC DL as described. The SCA runtime MUST only process the SC DL files and not the annotations.

If multiple annotations apply to a program element, all of the annotations SHOULD be in the same comment block.

An SCA implementation MUST treat a class with an@WebService annotation specified as if a @Remotable annotation was specified.

An SCA implementation MUST treat a member function with a@WebFunction annotation specified as if @Function was specified with the operationName value of the@WebFunction annotation used as the name value of the @Function annotation and the exclude value of the@WebFunction annotation used as the exclude valued of the @Function annotation.

If WSDL mapping annotations are supported by an implementation, the annotations defined here MUST be supported and MUST be mapped to WSDL as described.
Table D-1: JAX-WS Defined WSDL Extensions

<table>
<thead>
<tr>
<th>Conformance ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[CPPD0001]</td>
<td>An SCA implementation MUST treat all the bindings defined in the WSDL file as described.</td>
</tr>
<tr>
<td>[CPPD0002]</td>
<td>An SCA implementation MUST treat all the bindings defined in the WSDL file as described.</td>
</tr>
<tr>
<td>[CPPD0003]</td>
<td>An SCA implementation MUST treat all the bindings defined in the WSDL file as described.</td>
</tr>
<tr>
<td>[CPPD0004]</td>
<td>An SCA implementation MUST treat all the bindings defined in the WSDL file as described.</td>
</tr>
<tr>
<td>[CPPD0005]</td>
<td>An SCA implementation MUST treat all the bindings defined in the WSDL file as described.</td>
</tr>
<tr>
<td>[CPPD0006]</td>
<td>An SCA implementation MAY support the reading and interpretation of JAX-WS defined WSDL extensions; however it MUST give precedence to the corresponding SCA WSDL extension if present. Table D-1 is a list of JAX-WS defined WSDL extensions.</td>
</tr>
</tbody>
</table>
WSDL extensions that MAY be interpreted and their corresponding SCA WSDL extensions.

Table F-3 SCA C++ WSDL Extension Normative Statements

F.3 JAX-WS Normative Statements

The JAX-WS 2.1 specification [JAXWS21] defines normative statements for various requirements defined by that specification. Table F-4 outlines those normative statements which apply to the WSDL mapping described in this specification.

<table>
<thead>
<tr>
<th>Number</th>
<th>Conformance Point</th>
<th>Notes</th>
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3504 [A] All references to Java in the conformance point are treated as references to C++.

3505 [B] Annotation generation is only necessary if annotations are supported by an SCA implementation.

3506 Table F-4: JAX-WS Normative Statements that are Applicable to SCA C++

3507 F.3.1 Ignored Normative Statements

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<td>use of JAXB annotations</td>
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<td>Using javax.xml.ws.RequestWrapper</td>
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<td>Using javax.xml.ws.ResponseWrapper</td>
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<td>Use of Holder</td>
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Table F-5: JAX-WS Normative Statements that Are Not Applicable to SCA C++
G Migration

To aid migration of an implementation or clients using an implementation based the version of the Service Component Architecture for C++ defined in OSOA SCA C++ Client and Implementation V1.00, this appendix identifies the relevant changes to APIs, annotations, or behavior defined in V1.00.

G.1 Method child elements of interface.cpp and implementation.cpp

The `<method/>` child element of `<interface.cpp/>` and the `<method/>` child element of `<implementation.cpp/>` have both been renamed to `<function/>` to be consistent with C++ terminology.
## Acknowledgements

The following individuals have participated in the creation of this specification and are gratefully acknowledged:

### Participants:

<table>
<thead>
<tr>
<th>Participant Name</th>
<th>Affiliation</th>
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<tr>
<td>Bryan Aupperle</td>
<td>IBM</td>
</tr>
<tr>
<td>Andrew Borley</td>
<td>IBM</td>
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<td>Jean-Sebastien Delfino</td>
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<td>David Haney</td>
<td>Individual</td>
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<td>Mark Little</td>
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<td>Jeff Mischkinsky</td>
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## Revision History

[optional; should not be included in OASIS Standards]

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