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

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- OASIS SCA Policy Framework Version 1.1
- OASIS Service Component Architecture Web Service Binding Specification Version 1.1

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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:

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Table of Contents

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 1-1 Prefixes and Namespaces used in this specification

Prefix	***Namespace***	***Notes***
xs	"http://www.w3.org/2001/XMLSchema"	Defined by XML Schema 1.0 specification
sca	"http://docs.oasis-open.org/ns/opencsa/sca/200903"	Defined by the SCA specifications
cpp	"http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/cpp/200901"	

1.2 Normative References

[RFC2119] S. Bradner, *Key words for use in RFCs to Indicate Requirement Levels*, IETF RFC 2119, March 1997. http://www.ietf.org/rfc/rfc2119.txt

[ASSEMBLY] OASIS Committee Draft 03, *Service Component Architecture Assembly Model Specification Version 1.1*, March 2009. http://docs.oasis-open.org/opencsa/sca-assembly/sca-assembly-1.1-spec-cd03.pdf

[POLICY] OASIS Commmittee Draft 02, *SCA Policy Framework Version 1.1*, March 2009. http://docs.oasis-open.org/opencsa/sca-policy/sca-policy-1.1-spec.pdf

[SDO21] OSOA, *Service Data Objects For C++ Specification*, December 2006. http://www.osoa.org/download/attachments/36/CPP-SDO-Spec-v2.1.0-FINAL.pdf

[WSDL11] World Wide Web Consortium, *Web Service Description Language (WSDL)*, March 2001. http://www.w3.org/TR/wsdl

[XSD] World Wide Web Consortium, *XML Schema Part 2: Datatypes Second Edition*, October 2004. http://www.w3.org/TR/xmlschema-2/

[JAXWS21] Doug. Kohlert and Arun Gupta, *The Java API for XML-Based Web Services (JAX-WS) 2.1*, JSR, JCP, May 2007. http://jcp.org/aboutJava/communityprocess/mrel/jsr224/index2.html

1.3 Conventions

1.3.1 Naming Conventions

This specification follows some naming conventions for artifacts defined by the specification, as follows:

- 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.

1.3.2 Typographic Conventions

This specification follows some typographic conventions for some specific constructs

- 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]

The following snippets show the C++ service interface and the C++ implementation class of a C++ implementation.

Service interface.

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

Implementation declaration header file.

```
class LoanServiceImpl : public LoanService {
public:
   LoanServiceImpl();
   virtual ~LoanServiceImpl();

   virtual bool approveLoan(unsigned long customerNumber,
                            unsigned long loanAmount);
};
```

Implementation.

```
#include "LoanServiceImpl.h"

LoanServiceImpl::LoanServiceImpl()
{
   …
}

LoanServiceImpl::~LoanServiceImpl()
```

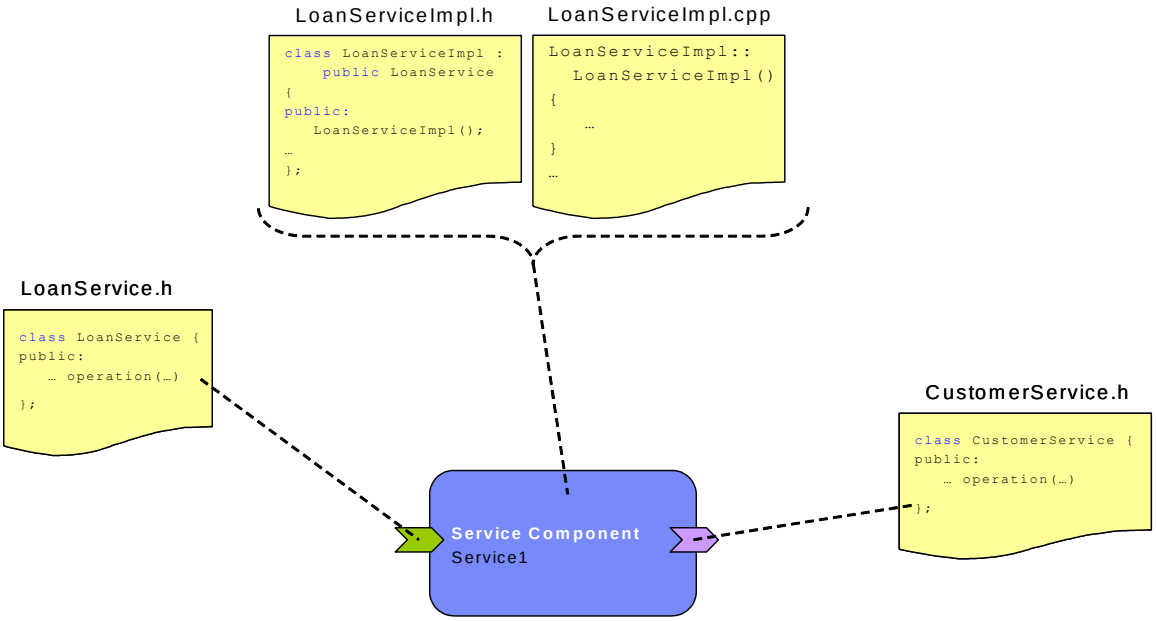
```
{
   …
}

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

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

```
<?xml version="1.0" encoding="ASCII"?>
<componentType xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200903">
   <service name="LoanService">
      <interface.cpp header="LoanService.h"/>
   </service>
</componentType>
```

The following picture 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]**. The following snippet shows the component type for a remotable service:

```
<?xml version="1.0" encoding="ASCII"?>
<componentType xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200903">
   <service name="LoanService">
      <interface.cpp header="LoanService.h" remotable="true"/>
   </service>
</componentType>
```

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 implemementation. 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 (see below) for any callbacks that it makes.

Marking a client as "allows pass by reference" asserts that the client observe the following restrictions for all references' member functions:

- 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

Component implementations can either manage their own state or allow the SCA runtime to do so. In the latter case, SCA defines the concept of implementation scope, which specifies the visibility and 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]

The following snippet shows the component type for a composite scoped component:

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

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 method. [CPP20012]

2.2.2 Composite scope

All service requests are dispatched to the same implementation instance for the lifetime of the containing composite. The lifetime of the containing composite is defined as the time it becomes active in the runtime to the time it is deactivated, 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 composite scoped instance will be created when its containing component is started.

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 and it MUST NOT perform any synchronization. [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.

The following code extract shows how to get the property values.

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

void clientFunction()
{
   …
```

```
   ComponentContext context = ComponentContext::getCurrent();

   DataObjectPtr properties = context.getProperties();

   long loanRating = properties->getInteger("maxLoanValue");

   …
}
```

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 below.

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.

The following snippets show the C++ service interface and the C++ implementation class of a C++ service.

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

Implementation declaration header file.

```
class LoanServiceImpl : public LoanService {
public:
   LoanServiceImpl();
   virtual ~LoanServiceImpl();

   virtual bool approveLoan(unsigned long customerNumber,
                            unsigned long loanAmount);
};
```

Implementation.

```
#include "LoanServiceImpl.h"

// Construction/Destruction

LoanServiceImpl::LoanServiceImpl()
{
   …
}
LoanServiceImpl::~LoanServiceImpl()
{
   …
}
// Implementation

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

```
    …
}
```

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

```
<?xml version="1.0" encoding="ASCII"?>
<componentType xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200903">
   <service name="LoanService">
      <interface.cpp header="LoanService.h"/>
   </service>
</componentType>
```

The following snippet shows the component using the implementation.

```
<?xml version="1.0" encoding="ASCII"?>
<composite xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200903"
      name="LoanComposite" >
   …

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

2.4.1 Interface.cpp

The following snippet shows the schema for the C++ interface element used to type services and references of component types.

```
<?xml version="1.0" encoding="ASCII"?>
<!-- interface.cpp schema snippet -->
<interface.cpp xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200903"
      header="string" class="Name"? remotable="boolean"?
      callbackHeader="string" callbackClass="Name"? >

   <function … />*
   <callbackFunction … />*

</interface.cpp>
```

The ***interface.cpp*** element has the following ***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

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

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

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

2.4.2 Function and CallbackFunction

Some member functions of an interface have behavioral characteristics, which will be described later, that need to be identified. This is done using a *function* or *callbackFunction* child element of *interface.cpp*

The following snippet shows the *interface.cpp* schema with the schema for the *function* and *callbackFunction* child elements:

```
<?xml version="1.0" encoding="ASCII"?>
<!-- Function schema snippet -->
<interface.cpp xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200903" … >

   <function name="NCName" requires="listOfQNames"? oneWay="Boolean"? />*
   <callbackFunction name="NCName" requires="listOfQNames"?
         oneWay="Boolean"? />*

</interface.cpp>
```

The ***function*** and ***callbackFunction*** elements have the following ***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]

  The *@name* attribute of a *<callbackFunction/>* child element of a *<interface.cpp/>* MUST be unique amongst the <callbackFunction/> elements of *that <interface.*cpp/>. [CPP20008]

- ***requires : listOfQNames (0..1)*** – list of intents **[POLICY]** needed by this member function.
- ***oneWay : boolean (0..1) –*** see Non-blocking Calls

2.4.3 Implementation.cpp

The following snippet shows the schema for the C++ implementation element used to define the implementation of a component.

```
<?xml version="1.0" encoding="ASCII"?>
<!-- implementation.cpp schema snippet -->
<implementation.cpp xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200903"
      library="NCName" path="string"? class="Name"
      scope="scope"? componentType="string"? allowsPassByReference="Boolean"?
      eagerInit="boolean"? >

   <method … />*

</implementation.cpp>
```

The ***implementation.cpp*** element has the following ***attributes***:

- ***library : NCName (1..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 (1..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. [CPP20009] 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 sematics 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

The ***implementation.cpp*** element has the following ***child element***:

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

2.4.4 Implementation Function

Some member functions of an implementation have operational characteristics that need to be identified. This is done using a *function* child element of *implementation.cpp*

The following snippet shows the *implementation.cpp* schema with the schema for a *method* child element:

```
<?xml version="1.0" encoding="ASCII"?>
<!-- ImplementationFunction schema snippet -->
<implementation.cpp xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200903" … >

   <function name="NCName" requires="listOfQNames"?
         allowsPassByReference="boolean"? />*

</implementation.cpp>
```

The ***function*** element has the following ***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)*** – list of intents **[POLICY]** needed by this member function.
- ***allowsPassByReference : boolean (0..1) –*** indicates the member function allows pass by reference data exchange semantics. See AllowsPassByReference

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.

The following snippet shows the `ComponentContext` C++ class with its `getService()` member function.

```
namespace oasis {
   namespace sca {

      class ComponentContext {
      public:
         static ComponentContextPtr getCurrent();
         virtual ServiceProxyPtr getService(
                           const std::string& referenceName) const = 0;
         …
      }
   }
}
```

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.

The following shows 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.

```
#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:

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

A remotable interface is always mappable to 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:

```
<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="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">
      </part>
   </message>

   < message name="GetLastTradePriceResponse">
      <part name="parameters" element="tns:GetLastTradePriceResponse">
      </part>
   </ 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">
         </input>
         <output name="GetLastTradePriceResponse"
               message="tns:GetLastTradePriceResponse">
         </output>
      </operation>
   </portType>
</definitions>
```

The resulting abstract proxy class is:

```
// @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);
};
```

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:

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

The resulting proxy class is:

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

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.

The following shows a sample of how the `DomainContext` is used in non-SCA C++ code.

```
#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);

}
```

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()* 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

The previous sections show the various options for getting 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.

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. A client calling such an operation has to be prepared for any arbitrary delay between the time a request is made and the time the response is received. To support this kind of operation three invocation styles are available: asynchronous – the client provides a response handler, polling – the client will poll the SCA runtime to determine if a response is available, and synchronous – the SCA runtime handles suspension of the main thread, asynchronously receiving the response and resuming the main thread. The details of each of these styles are provided in the following sections.

For a service operation with signature

```
<return type> <function name>(<parameters>);
```

the asynchronous invocation style includes a member function in the interface proxy class

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

where `<response_message name>Response` is the response class for the operation as defined by 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]

The following shows a sample proxy class interface providing an asynchronous API.

```
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;
};
```

The following 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);
```

```
      // ...
   }

}
```

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. The following example 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 =
            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.

```
#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 (...) {
         // ...
      }
   }
}
```

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.

```
#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);

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

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.

```
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;
};
```

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.

Precondition	C++ component instance is running and has an outstanding asynchronous call	
Input Parameter		
Return	Response data for the operation.	
Throws	Any exceptions defined for the operation.	
Post Condition	The response object is marked as done.	

3.5.4.2 setCallback

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

Precondition	C++ component instance is running and has an outstanding asynchronous call	
Input Parameter	`callback`	A pointer to the callback object for the response
Return		
Post Condition	The response object is marked as done.	

3.5.4.3 isReady

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

Precondition	C++ component instance is running and has an outstanding polling call	
Input Parameter		
Return	True if the response is avaialble	
Post Condition	No change	

3.5.4.4 cancel

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

Precondition	C++ component instance is running and has an outstanding asynchronous call	
Input Parameter		
Return		
Post Condition	If a response is subsequently received for the operation, it will be discarded.	

3.5.4.5 isCancelled

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

Precondition	C++ component instance is running and has an outstanding asynchronous call	
Input Parameter		
Return	True if the operation has been cancelled	
Post Condition	No change	

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. Each of these topics is discussed in the following sections.

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]

The following snippet shows the component type for a service with the `reportEvent()` member fucntion declared as a one-way operation:

```
<componentType xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200903">
   <service name="LoanService">
      <interface.cpp header="LoanService.h">
         <function name="reportEvent" oneWay="true" />
      </interface.cpp>
   </service>
</componentType>
```

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. The following snippet 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/200903" >
   <service name="MyService">
      <interface.cpp header="MyService.h"
         callbackHeader="MyServiceCallback.h"/>
   </service>
</componentType>
```

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.

The following example shows 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.

```
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;
};
```

In this example, 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.

The following code snippet illustrates a possible implementation of the example service.

```
#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);
}
```

The code snippet below 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.

```
#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";
}
```

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 **Error! Reference source not found.**, 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 following SCA runtime exceptions are defined:

- `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 following descriptions 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.

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

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

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

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

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

The ***RefCountingPointer*** class has the following member functions:

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

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.

Precondition	C++ component instance is running and has a reference counting pointer
Return	
Throws	`SCANullPointerException` if the pointer is NULL
Post Condition	The underlying member functions has been processed.

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 */ }`.

Precondition	C++ component instance is running and has a reference counting pointer
Return	Zero if the underlying pointer is null, otherwise a non-zero value
Post Condition	No change

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 */ }`.

Precondition	C++ component instance is running and has a reference counting pointer
Return	A non-zero value if the underlying pointer is null, otherwise zero
Post Condition	No change

6.1.5 constCast

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

Precondition	C++ component instance is running and has a reference counting pointer
Return	A RefCountingPointer instance templatized on the target type.
Post Condition	No change

6.1.6 dynamicCast

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

Precondition	C++ component instance is running and has a reference counting pointer
Return	A RefCountingPointer instance templatized on the target type. This can return an invalid RefCountingPointer instance if the cast fails.
Post Condition	No change

6.1.7 reinterpretCast

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

Precondition	C++ component instance is running and has a reference counting pointer
Return	A RefCountingPointer instance templatized on the target type.
Post Condition	No change

6.1.8 staticCast

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

Precondition	C++ component instance is running and has a reference counting pointer
Return	A RefCountingPointer instance templatized on the target type.
Post Condition	No change

6.2 Component Context

The following shows the `ComponentContext` interface.

```
class ComponentContext {
public:
   static ComponentContextPtr getCurrent();

   virtual std::string getURI() const = 0;

   virtual ServiceProxyPtr getService(
                              const std::string& referenceName) const = 0;
   virtual std::list<ServiceProxyPtr> getServices(
                              const std::string& referenceName) const = 0;

   virtual ServiceReferencePtr getServiceReference(
                                 const std::string& referenceName) const = 0;
   virtual std::list<ServiceReferencePtr> getServiceReferences(
                                 const std::string& referenceName) const = 0;


   virtual DataObjectPtr getProperties() const = 0;
   virtual DataFactoryPtr getDataFactory() const = 0;

   virtual ServiceReferencePtr getSelfReference() const = 0;
   virtual ServiceReferencePtr getSelfReference(
                                 const std::string& serviceName)const = 0;
};
```

The ***ComponentContext*** C++ interface has the following member functions:

6.2.1 getCurrent

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

Precondition	C++ component instance is running

Input Parameter		
Return	`ComponentContext` for the current component	
Post Condition	The component instance has a valid context object to use for subsequent runtime calls.	

6.2.2 getURI

A C++ component implementation uses `getURI()` to get an absolute URI for itself.

Precondition	C++ component instance is running and has a `ComponentContext`	
Input Parameter		
Return	Absolute URI for the current component	
Post Condition	No change	

6.2.3 getService

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

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

6.2.4 getServices

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

Precondition	C++ component instance is running and has a `ComponentContext`	
Input Parameter	`referenceName`	Name of the Reference to get an interface object for
Return	List of pointers to `ServiceProxy` objects implementing the interface of the Reference. This list will be empty if `referenceName` is not defined for the component. Operations need to be invoked on each object in the list.	
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.

Precondition	C++ component instance is running and has a `ComponentContext`	
Input Parameter	`referenceName`	Name of the Reference to get a `ServiceReference` for
Return	`ServiceReference` for the Reference. This will be NULL if `referenceName` is not defined for the component.	
Throws	`MultipleServicesException` if the reference resolves to more than one service	
Post Condition	A `ServiceReference` for the Reference is constructed.	

6.2.6 getServiceReferences

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

Precondition	C++ component instance is running and has a `ComponentContext`	
Input Parameter	`referenceName`	Name of the Reference to get a list of `ServiceReferences` for
Return	List of `ServiceReference`s for the Reference. This will be empty if `referenceName` is not defined for the component.	
Post Condition	`ServiceReference`s for the Reference are constructed.	

6.2.7 getProperties

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

Precondition	C++ component instance is running and has a `ComponentContext`	
Input Parameter		
Return	An SDO **[SDO21]** from which all the properties defined in the componentType file can be retrieved.	
Post Condition	An SDO with the property values for the component instance is constructed.	

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	

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.	
Throws	`MultipleServicesException` if the component implements more than one Service	
Post Condition	A `ServiceReference` object is constructed	

and

Precondition	C++ component instance is running and has a `ComponentContext`	
Input Parameter	`serviceName`	Name of the Service to get a `ServiceReference` for
Return	A `ServiceReference` for the service provided by this component.	
Post Condition	A `ServiceReference` object is constructed	

6.3 ServiceReference

The following shows the `ServiceReference` interface.

```
class ServiceReference {
public:
   virtual ServiceProxyPtr getService() const = 0;

   virtual ServiceProxyPtr getCallback() const = 0;
};
```

6.4 The *ServiceReference* interface has the following member usage of these member functions is described in the section 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. A client calling such an operation has to be prepared for any arbitrary delay between the time a request is made and the time the response is received. To support this kind of operation three invocation styles are available: asynchronous – the client provides a response handler, polling – the client will poll the SCA runtime to determine if a response is available, and synchronous – the SCA runtime handles suspension of the main thread, asynchronously receiving the response and resuming the main thread. The details of each of these styles are provided in the following sections.

For a service operation with signature

```
<return type> <function name>(<parameters>);
```

the asynchronous invocation style includes a member function in the interface proxy class

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

where <response_message name>Response is the response class for the operation as defined by 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]

The following shows a sample proxy class interface providing an asynchronous API.

```
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;
};
```

The following 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);

     // ...
   }

}
```

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.

6.4.1 Response Callback

If a callback is specified on a response object, that callback will be invoked when the response is received by the runtime. The following example 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 =
            customerService->getCreditRatingAsync(1234);

      CustomerServiceProxy::getCreditRatingCallbackPtr callback =
            new CreditRatingCallback();

      response->setCallback(callback);

      // ...
   }
}
```

6.4.2 Response Polling

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

```
#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 (...) {
         // ...
      }
   }
}
```

6.4.3 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.

```
#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);

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

```
        catch (...) {
            // ...
        }
    }
}
```

6.4.4 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.

```
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;
};
```

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]

6.4.4.1 getReturn

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

Precondition	C++ component instance is running and has an outstanding asynchronous call	
Input Parameter		
Return	Response data for the operation.	
Throws	Any exceptions defined for the operation.	
Post Condition	The response object is marked as done.	

6.4.4.2 setCallback

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

Precondition	C++ component instance is running and has an outstanding asynchronous call	
Input Parameter	`callback`	A pointer to the callback object for the response
Return		
Post Condition	The response object is marked as done.	

6.4.4.3 isReady

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

Precondition	C++ component instance is running and has an outstanding polling call	
Input Parameter		
Return	True if the response is avaialble	
Post Condition	No change	

6.4.4.4 cancel

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

Precondition	C++ component instance is running and has an outstanding asynchronous call	
Input Parameter		
Return		
Post Condition	If a response is subsequently received for the operation, it will be discarded.	

6.4.4.5 isCancelled

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

Precondition	C++ component instance is running and has an outstanding asynchronous call	
Input Parameter		
Return	True if the operation has been cancelled	
Post Condition	No change	

Asynchronous Programming):

6.4.5 getService

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

Precondition	C++ component instance is running and has a `ServiceReference`	
Input Parameter		
Return	Pointer to a `ServiceProxy` implementing the interface of the `ServiceReference`.	
Post Condition	A `ServiceProxy` object for the `ServiceReference` is constructed.	

6.4.6 getCallback

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

Precondition	C++ component instance is running and has a `ServiceReference`	
Input Parameter		
Return	Pointer to a `ServiceProxy` implementing the callback interface of the `ServiceReference`. This will be NULL if no callback interface is defined.	

Post Condition	A `ServiceProxy` object for the callback interface of the `ServiceReference` is constructed.

6.5 DomainContext

The following shows the `DomainContext` interface.

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

6.5.1 getService

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

Precondition	None	
Input Parameter	`serviceURI`	URI of the Service to get an interface object for
Return	Pointer to a `ServiceProxy` object implementing the interface of the Service. This will be NULL if `serviceURI` is not defined in the domain.	
Post Condition	A `ServiceProxy` object for the Service is constructed.	

6.6 SCAException

The following shows the `SCAException` interface.

```
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;
};
```

The ***SCAException*** C++ interface has the following member functions (the details concerning this class and its derived types are described in the section **Error! Reference source not found.**):

6.6.1 getEClassName

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

Precondition	C++ component instance is running and has caught an SCA Exception	
Input Parameter		
Return	The type of the exception as a string. e.g. “ServiceUnavailableException”	
Post Condition	No change	

6.6.2 getMessageText

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

Precondition	C++ component instance is running and has caught an SCA Exception	
Input Parameter		
Return	The message which the SCA runtime attached to the exception	
Post Condition	No change	

6.6.3 getFileName

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

Precondition	C++ component instance is running and has caught an SCA Exception	
Input Parameter		
Return	The filename within which the exception occurred – Will be an empty string if the filename is not known	
Post Condition	No change	

6.6.4 getLineNumber

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

Precondition	C++ component instance is running and has caught an SCA Exception	
Input Parameter		
Return	The line number at which the exception occurred – Will 0 if the line number is not known	
Post Condition	No change	

6.6.5 getFunctionName

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

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

6.7 SCANullPointerException

The following shows the `SCANullPointerException` interface.

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

6.8 ServiceRuntimeException

The following shows the `ServiceRuntimeException` interface.

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

6.9 ServiceUnavailableException

The following shows the `ServiceUnavailableException` interface.

```
class ServiceUnavailablException : public ServiceRuntimeException {
};
```

6.10 MultipleServicesException

The following shows the `MultipleServicesException` interface.

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

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 here are some additional considerations for executable and componentType files discussed in the following sections.

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.

The following 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
```

The SCDL for the AutoInsuranceService component is:

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

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 the following snippet.

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

It is also possible to export only a subtree of a contribution. If a contribution contains the following:

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

An export of the form:

```
<contribution>
   <deployable composite="myNS:RateUtilities"
   <export.cpp name="contribNS:ratesbin" path="bin/" >
</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 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 MUST 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 the following snippet.

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

The SCDL for the UnderwritingService component is:

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

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 this snippet.

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

7.2 componentType files

As stated in section 2.5, 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 the following example.

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

The SCDL for the AutoInsuranceService component is:

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

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.

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

7.3 C++ Contribution Extensions

7.3.1 Export.cpp

The following snippet shows the schema for the C++ export element used to make an executable or componentType file visible outside of a contribution.

```
<?xml version="1.0" encoding="ASCII"?>
<!-- export.cpp schema snippet -->
<export.cpp xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200903"
      name="QName" path="string"? >
```

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

The following snippet shows the schema for the C++ import element used to reference an executable or componentType file that is outside of a contribution.

```
<?xml version="1.0" encoding="ASCII"?>
<!-- import.cpp schema snippet -->
<import.cpp xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200903"
      name="QName" location="string" >
```

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 Types Supported in Service Interfaces

A service interface can support a restricted set of the types available to a C++ programmer. This section summarizes the valid types that can be used.

8.1 Local service

The return type and types of the parameters of a member function of a local service interface MUST be one of:

- Any of the C++ primitive types (for example, `int`, `short`, `char`). In this case the data will be passed by value as is normal for C++.
- Pointers to any of the C++ primitive types (for example, `int *`, `short *`, `char *`).
- The `const` keyword can be used for any pointer to a C++ primitive type (for example `const char *`). If this is used on a parameter then the destination can not change the value.
- C++ `class`. The class will be passed by value as is normal for C++.
- Pointer to a C++ `class`. A pointer will be passed to the destination which can then modify the original contents.
- `DataObjectPtr`. An SDO pointer. This will be passed by reference.
- References to C++ classes (passed by reference). [CPP80001]

8.2 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++ primitive types (for example, `int`, `short`, `char`). This will be copied.
- `DataObjectPtr`. An SDO pointer. The SDO will be copied and passed to the destination. [CPP80002]

Unless the interface is marked as allowing pass by reference semantics, the behavior of the following are not defined:

- Pointers.
- References.

9 Restrictions on C++ header files

A C++ header file that is used to describe an interface has some restrictions.

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 MUST be pure virtual (virtual with no implementation) [CPP90001]

A C++ header file used to define an interface MUST NOT use the following constructs:

- Macros
- Inline member functions
- Friend classes [CPP90002]

10 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 Java-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-Java 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.

The following limitations apply:

- JAX-WS style external binding files are not supported. (See JAX-WS Sec. 2)
- MIME binding is not supported. (See JAX-WS Sec. 2.1.1)
- Holder classes are not supported. (See JAX-WS Sec. 2.3.3)
- Asynchronous mapping is not supported. (See JAX-WS Sec. 2.3.4)
- Generation of Service classes from WSDL is not supported. (See JAX-WS Sec. 2.7)
- Generation of WSDL from Service implementation classes is not supported (See JAX-WS Sec. 3.3)
- Templates are not supported when converting from C++ to WSDL (See JAX-WS Sec. 3.9)

The following general rules apply to 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.
- For the purposes of the C++-to-WSDL mapping algorithm, a C++ class with only pure-virtual functions and no state is treated as if it had a @WebService annotation on the class. All default values are assumed for the @WebService annotation.

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.

10.1 Augmentations for WSDL to C++ Mapping

10.1.1 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]

10.1.2 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 wsd:fault/wsdl:message/@part indicates.

```
FaultException(const char* message, const FaultInfo& faultInfo);
FaultInfo getFaultInfo() const;
```

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.

10.1.2.1 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]

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

C++ diverges from the JAX-WS specification in it's 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-value.
  - **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-value.
  - **in/out** - the wrapper child to a member function parameter, passed by reference. [CPP100004]

10.2 Augmentations for C++ to WSDL Mapping

10.2.1 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]

10.2.2 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.

10.2.3 C++ to WSDL Type Conversion

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

10.2.4 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. An SCA implementation MUST ensure each class that is referenced from an @WebThrows annotation MUST itself have a @WebFault annotation that associates the fault with a particular global element that will be associated with the fault message. [CPP100007]

10.3 SDO Data Binding

10.3.1 Simple Content Binding

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

XSD Schema Type →	***C++ Type***	***→ XSD Schema Type***
anySimpleType	std::string	string
anyType	commonj::sdo::DataObject	anyType
anyURI	std::string	string
base64Binary	char*	string
boolean	bool	boolean
byte	int8_t	byte
date	std::string	string
dateTime	std::string	string
decimal	std::string	string
double	double	double
duration	std::string	string
ENTITIES	std::list<std::string>	IDREFS
ENTITY	std::string	string
float	float	float
gDay	std::string	string
gMonth	std::string	stirng
gMonthDay	std::string	string

gYear	std::string	string
gYearMonth	std::string	string
hexBinary	char*	string
ID	std::string	string
IDREF	std::string	string
IDREFS	std::list<std::string>	IDREFS
int	int32_t	int
integer	std::string	string
language	std::string	string
long	int64_t	long
Name	std::string	string
NCName	std::string	string
negativeInteger	std::string	string
NMTOKEN	std::string	string
NMTOKENS	std::list<std::string>	IDREFS
nonNegativeInteger	std::string	string
nonPositiveInteger	std::string	string
normalizedString	std::string	string
NOTATION	std::string	string
positiveInteger	std::string	string
QName	std::string	string
short	int16_t	short
string	std::string	string
time	std::string	string
token	std::string	string
unsignedByte	uint8_t	unsignedByte
unsignedInt	uint32_t	unsignedInt
unsignedLong	uint64_t	unsignedLong
unsignedShort	uint16_t	unsignedShort

1745 *Table 1: XSD simple type to C++ type mapping*

1746

C++ Type →	***XSD Schema Type***
char	string

wchar_t	string
signed char	byte
unsigned char	unsignedByte
short	short
unsigned short	unsignedShort
int	int
unsigned int	unsignedInt
long	long
unsigned long	unsignedLong
long long	long
unsigned long long	unsignedLong
wchar_t *	string
long double	decimal
time_t	dateTime
struct tm	dateTime

Table 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 1 and Table 2 by default. [CPP100008]

10.3.2 Complex Content Binding

Any XSD complex types are mapped to an instance of an SDO DataObject.

11 Conformance

An SCA implementation MUST reject a composite file that does not conform to http://docs.oasis-open.org/opencsa/sca/200903/sca-interface-cpp-1.1.xsd or http://docs.oasis-open.org/opencsa/sca/200903/sca-implementation-cpp-1.1.xsd. [CPP110001]

An SCA implementation MUST reject a componentType or constraining type file that does not conform to http://docs.oasis-open.org/opencsa/sca/200903/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/200903/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/cpp/200901/sca-wsdlext-cpp-1.1.xsd. [CPP110004]

11.1 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.

11.2 SCA Implementations

An implementation conforms to this specification if it meets the following 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 Conformance Items related to an SCA implementation.
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, componentType and constrainingType 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.
8. It MAY support WSDL extentsions as defined in WSDL C++ Mapping Extensions.

11.3 SCA Documents

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

9. It MUST conform to the SCA Assembly Model Specification **[ASSEMBLY]** and, if appropriate, the SCA Policy Framework **[POLICY]**.
10. If it is a composite document, it MUST conform to the http://docs.oasis-open.org/opencsa/sca/200903/sca-interface-cpp-1.1.xsd and http://docs.oasis-open.org/opencsa/sca/200903/sca-implementation-cpp-1.1.xsd schema and MUST comply with the additional constraints on the document contents as defined in Conformance Items.

If it is a componentType or constrainingType document, it MUST conforms to the http://docs.oasis-open.org/opencsa/sca/200903/sca-interface-cpp-1.1.xsd schema and MUST comply with the additional constraints on the document contents as defined in Conformance Items.

If it is a contribution document, it MUST conforms to the http://docs.oasis-open.org/opencsa/sca/200903/sca-contribution-cpp-1.1.xsd schema and MUST comply with the additional constraints on the document contents as defined in Conformance Items.

11.4 C++ Files

A C++ files conforms to this specification if it meets the following conditions:

1. It MUST comply with all statements in Conformance Items related to C++ contents and annotations .

11.5 WSDL Files

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

1. It is a valid WSDL 1.1 **[WSDL11]** document.
2. It MUST comply with all statements in Conformance Items related to WSDL contents and extensions.

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:

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

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:

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

- Member function

  The annotation immediately precedes the member function.

  Example:

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

- Data Member

  The annotation immediately precedes the data member.

  Example:

```
// @Property(name="loanType", type="xsd:int")
long loanType;
```

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. An SCA implementation MUST treat a class with an @WebService annotation specified as if an @Interface annotation was specified. [CPPA0003]

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

Format:

```
// @Interface
```

Applies to: `Class`

Example:

Interface header:

```
// @Interface
class LoanService {
...
};
```

Service definition:

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

A.2.2 @Remotable

Annotation on service interface class to indicate that a service is remotable.

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

Format:

```
// @Remotable
```

The default is **false** (not remotable).

Applies to: Class

Example:

Interface header:

```
// @Remotable
class LoanService {
...
};
```

Service definition:

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

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:

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

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:

```
// @Callback(header="MyServiceCallback.h", class="MyServiceCallback")
```

```
class MyService {
public:
   virtual void someFunction( unsigned int arg ) = 0;
};
```

Service definition:

```
<service name="MyService">
   <interface.cpp header="MyService.h"
          callbackHeader="MyServiceCallback.h"
          callbackClass="MyServiceCallback"  />
</service>
```

A.2.4 @OneWay

Annotation on a service 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:

```
// @OneWay
```

The default is **false** (not OneWay).

Applies to: Member function

Example:

Interface header:

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

Service definition:

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

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:

```
// @ComponentType
```

Applies to: Class

Example:

Implementation header:

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

Component definition:

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

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:

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

where

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

Applies to: Class

Example:

Implementation header:

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

Component definition:

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

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.

Format:

```
// @EagerInit
```

The default is **false** (the service is initialized lazily).

Applies to: Class

Example:

Implementation header:

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

Component definition:

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

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
```

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>
```

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.

Format:

```
// @Property(name="propertyName", type="typeQName"
//                default="defaultValue", required="true")
```

where

- ***name : NCName (0..1) -*** specifies the name of the property. If name is not specified the property name is taken from the name of the following data member.
- ***type : QName (0..1) -*** specifies the type of the property. If not specified the type of the property is based on the C++ mapping of the type of the following data member to an xsd type as defined in SDO Data Binding. If the data member is an array, then the property is many-valued.
- ***required : boolean (0..1) -*** specifies whether a value has to be set in the component definition for this property. Default is *false*
- ***default : <type> (0..1) -*** specifies a default value and is only needed if *required* is *false*,

Applies to: DataMember

Example:

Implementation:

```
// @Property(name="loanType", type="xsd:int")
long loanType;
```

Component Type definition:

```
<componentType … >
   <service … />
   <property name="loanType" type="xsd:int" />
</componentType>
```

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.

Format:

```
// @Reference(name="referenceName", interfaceHeader="LoanService.h",
//                   interfaceClass="LoanService", required="true")
```

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::list 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:

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

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

Component Type definition:

```
<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>
```

A.4 Base Annotation Grammar

```
<annotation> ::= // @<baseAnnotation>

<baseAnnotation> ::= <name> [(<params>)]

<params> ::= <paramNameValue>[, <paramNameValue>]* |
             <paramValue>[, <paramValue>]*
```

```
<paramNameValue> ::= <name>=”<value>”

<paramValue> ::= “<value>”

<name> ::= NCName

<value> ::= string
```

- 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 concerned first provide general facilities for attaching SCA Intents and Policy Sets to C++ code. Secondly, there are further specific annotations that deal with particular policy intents for certain policy domains such as Security.

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 as follows:

```
"{" + Namespace URI + "}" + intentname
```

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/200903}"
// @Define CONFIDENTIALITY SCA_PREFIX ## "confidentiality"
// @Define CONFIDENTIALITY_MESSAGE CONFIDENTIALITY ## ".message"
```

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 a *service*, *reference*, *operation* or *property* element.

Format:

```
// @Requires("qualifiedIntent" | {"qualifiedIntent" [, "qualifiedIntent"]})
```

where

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

Applies to: Class, Member Function

Examples:

Attaching the intents "confidentiality.message" and "integrity.message".

```
// @Requires({CONFIDENTIALITY_MESSAGE, INTEGRITY_MESSAGE})
```

A reference requiring support for confidentiality:

```
class Foo {
   …
// @Requires(CONFIDENTIALITY)
// @Reference(interfaceHeader="SetBar.h")
   void setBar(Bar* bar);
   …
}
```

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);
   …
}
```

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 some 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 a *service*, *reference*, *operation* or *property* 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
```

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

Example:

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

This annotation attaches the pair of qualified intents: *authentication.message* and *authentication.transport* (the sca: namespace is assumed in both of these cases – "http://docs.oasis-open.org/opencsa/ns/sca/200903").

The Policy Framework **[POLICY]** defines a number of intents and qualifiers. The following sections define the annotations for those intents.

B.2.1 Security Interaction

Intent	Annotation
authentication	@Authentication
confidentiality	@Confidentiality
integrity	@Integrity

These three intents can be qualified with

- transport
- message

B.2.2 Security Implementation

Intent	Annotation
runAs	@RunAs(role"role")
Allow	@Allow(roles="<comma separated list of roles>")
permitAll	@PermitAll
denyAll	@DenyAll

In addition to allow roles to defined, an SCA runtime MAY use the following annotation

@DeclareRoles(<comma separated list of roles>")

B.2.3 Reliable Messaging

Intent	Annotation
atLeastOnce	@AtLeastOnce
atMostOnce	@AtMostOnce
Ordered	@Ordered
exactlyOnce	@ExactlyOnce

B.2.4 Transactions

Intent	Annotation	Qualifiers

managedTransaction	@ManagedTransaction	Local global
transactedOneWay	@TransactedOneWay	
immediateOneWay	@ImmediateOneWay	
propagates Transaction	@PropagatesTransaction	
suspendsTransaction	@SuspendsTransaction	

B.2.5 Miscellaneous

Intent	**Annotation**	Qualifiers
SOAP	@SOAP	1_1 1_2
JMS	@JMS	

B.3 Application of Intent Annotations

Where multiple intent annotations (general or specific) are applied to the same C++ element, they are additive in effect. An example of multiple policy annotations being used together follows:

```
// @Authentication
// @Requires({CONFIDENTIALITY_MESSAGE, INTEGRITY_MESSAGE})
```

In this case, the effective intents are *authentication*, *confidentiality.message* and *integrity.message*.

If an annotation is specified at both the class/interface level and the member function or data member level, then the member function or data member level annotation completely overrides the class level annotation of the same type.

The intent annotation can be applied either to classes or to class member functions when adding annotated policy on SCA services.

B.4 Inheritance and Intent Annotations

The following example shows the inheritance relations of intents on classes, operations, and super classes.

```
// @Remotable
// @Integrity("transport")
// @Authentication
class HelloService {
public:
// @Integrity
// @Authentication("message")
   wchar_t* hello(wchar_t* message) {...}

// @Integrity
// @Authentication("transport")
   wchar_t* helloThere() {...}
}
```

```
// @Remotable
// @Confidentiality("message")
class HelloChildService : public HelloService {
public:
// @Confidentiality("transport")
   wchar_t* hello(wchar_t* message) {...}
// @Authentication
   wchar_t* helloWorld(){...}
}
```

Example 1a. Usage example of annotated policy and inheritance.

- The effective intent annotation on the helloWorld member function is @Integrity(“transport”), @Authentication, and @Confidentiality(“message”).
- The effective intent annotation on the hello member function of the HelloChildService is @Integrity(“transport”), @Authentication, and @Confidentiality(“transport”),
- The effective intent annotation on the helloThere member function of the HelloChildService is @Integrity and @Authentication(“transport”), the same as in HelloService class.
- The effective intent annotation on the hello member function of the HelloService is @Integrity and @Authentication(“message”)

The listing below contains the equivalent declarative security interaction policy of the HelloService and HelloChildService implementation corresponding to the C++ classes shown in Example 1a.

```
<?xml version="1.0" encoding="ASCII"?>

<composite xmlns="http://docs.oasis-open.org/ns/opencsa/sca/200903"
                name="HelloServiceComposite" >
   ...

   <component name="HelloServiceComponent">
          <service name="HelloService" requires="integrity/transport
                authentication">
                …
          </service>
          <implementation.cpp library="HelloService.dll"
                class=”HellowServiceImpl”>
                <function name=”hello” requires="integrity
                      authentication/message"/>
                <function name=”helloThere” requires="integrity
                      authentication/transport"/>
          </implementation.cpp>
   </component>
   <component name="HelloChildServiceComponent">
          <service name="HelloChildService" requires="integrity/transport
                authentication confidentiality/message">
          …
          </service>
          <implementation.cpp library="HelloChildService.dll"
                class="HelloChildServiceImpl">
                <function name="hello" requires="confidentiality/transport"/>
                <function name="helloThere" requires="integrity/transport
                      authentication"/>
                <function name="helloWorld" requires="authentication"/>
          </implementation.cpp>
   </component>

   ...

</composite>
```

Example 1b. Declaratives intents equivalent to annotated intents in Example 1a.

B.5 Relationship of Declarative and Annotated Intents

Annotated intents on a C++ class cannot be overridden by declarative intents either in a composite document which uses the class as an implementation or by statements in a componentType document associated with the class. This rule follows the general rule for intents that they represent fundamental requirements of an implementation.

An unqualified version of an intent expressed through an annotation in the C function or function declaration can be qualified by a declarative intent in a using composite document.

B.6 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 a *service*, *reference*, *operation* or *property* element.

Format:

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

As for intents, PolicySet names are QNames – in the form of "{Namespace-URI}localPart".

Applies to: Class, Member Function,

Example:

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

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.7 Policy Annotation Grammar Additions

```
<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
```

- anyURI is as defined by XML schema **[XSD]**

B.8 Annotation Constants

```
<annotationConstant> ::= // @Define <identifier> <token string>

<identifier> ::= token

<token string> ::= “string” | “string”[ ## <token string>]
```

- Constants are immediately expanded

C 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 @Interface annotation and without an explicit @WebService annotation as if a @WebService annotation with no parameters was specified.An SCA implementation MUST treat any instance of a @Interface annotation and without an explicit @WebService annotation as if a @WebService annotation with no parameters was specified.An SCA implementation MUST treat any instance of a @Interface 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:

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

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.
- ***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”. The name of the associated binding is also determined by the serviceName. In the case of a SOAP binding, the binding name is the name of the service suffixed with “SoapBinding”.
- ***portName : NCName (0..1) –*** specifies the name to be used for the associated WSDL port for the service. If a @WebService does not have a **portName** element, an SCA implementation MUST use the value associated with the **name** element, suffixed with *“Port”*. [CPPC0003]

Applies to: Class

Example:

Input C++ source file:

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

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/">

   <portType name="StockQuote">
      <cpp:bindings>
         <cpp:class name="StockQuoteService"/>
```

```
      </cpp:bindings>
   </portType>

   <binding name="StockQuoteServiceSoapBinding">
      <soap:binding style="document"
            transport="http://schemas.xmlsoap.org/soap/http"/>
   </binding>

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

C.1.2 @WebFunction

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

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

Format:

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

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:

```
// @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:

```
<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="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">
      </part>
   </message>

   < message name="GetLastTradePriceResponse">
      <part name="parameters" element="tns:GetLastTradePriceResponse">
      </part>
   </ 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">
         </input>
         <output name="GetLastTradePriceResponse"
               message="tns:GetLastTradePriceResponse">
         </output>
      </operation>
   </portType>

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

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

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
```

Applies to: Member function.

Example:

Input C++ source file:

```
// @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:

```
<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">
      </part>
   </message>

   <portType name="StockQuote">
      <cpp:bindings>
         <cpp:class name="StockQuoteService"/>
      </cpp:bindings>
      <operation name="SetTradePrice">
         <cpp:bindings>
            <cpp:memberFunction name="setTradePrice"/>
         </cpp:bindings>
         <input name="SetTradePrice" message="tns:SetTradePrice">
         </input>
      </operation>
   </portType>
```

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

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

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")
```

where:

- ***paramName : NCName (1..1) –*** specifies the name of the parameter that this annotation applies to. Only named parameters MAY be referenced by a @WebParam annotation. [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 he 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:

```
// @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:

```
<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">
      </part>
   </message>

   < message name="GetLastTradePriceResponse">
      <part name="parameters" element="tns:GetLastTradePriceResponse">
      </part>
   </ 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">
         </input>
         <output name="GetLastTradePriceResponse"
               message="tns:GetLastTradePriceResponse">
         </output>
      </operation>
```

```
   </portType>

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

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

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:

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

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:

```
// @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:

```
<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="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">
      </part>
   </message>

   < message name="GetLastTradePriceResponse">
      <part name="parameters" element="tns:GetLastTradePriceResponse">
      </part>
   </ 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">
         </input>
         <output name="GetLastTradePriceResponse"
               message="tns:GetLastTradePriceResponse">
         </output>
      </operation>
   </portType>

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

```
         </wsdl:input>
         <wsdl:output name="GetLastTradePriceResponse">
            <soap:body use="literal"/>
         </wsdl:output>
      </wsdl:operation>
   </binding>

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

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:

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

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:

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

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/">

   <portType name="StockQuote">
      <cpp:bindings>
         <cpp:class name="StockQuoteService"/>
      </cpp:bindings>
   </portType>

   <binding name="StockQuoteServiceSoapBinding">
      <soap:binding style="document"
            transport="http://schemas.xmlsoap.org/soap/http"/>
   </binding>

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

```
   </service>
</definitions>
```

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/"
//       serviceName="StockQuoteService")
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/">

   <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:element name="UnknownSymbolFault" type="xs:string"/>
   </xs:schema>

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

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

   <message name=”UnknownSymbol”>
      <part name=”parameters” element=”tns:UnknownSymbolFault”>
      </part>
   </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">
         </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"/>
      <wsdl:operation name="GetLastTradePrice">
         <soap:operation soapAction="urn:GetLastTradePrice" style="document"/>
         <wsdl:input name="GetLastTradePrice">
            <soap:body use="literal"/>
         </wsdl:input>
         <wsdl:output name="GetLastTradePriceResponse">
            <soap:body use="literal"/>
         </wsdl:output>
         <wsdl:fault>
            <soap:fault name="UnknownSymbol" use="literal"/>
         </wsdl:fault>
      </wsdl:operation>
   </binding>

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

```
   </service>
</definitions>
```

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:

```
// @WebThrows(faults="faultMsg1"[, "faultMsgn"]*)
```

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

The following 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:

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

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:

```
<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/">

   <portType name="StockQuote">
      <cpp:bindings>
         <cpp:class name="StockQuoteService"/>
      </cpp:bindings>
   </portType>
</definitions>
```

Generated C++ file:

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

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>
```

where:

- ***enableWrapperStyle/text() : boolean (1..1)*** – specifies whether wrapper style is enabled or disabled for this element and any of it's 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

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

Example:

Input 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/">

   <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">
      </part>
   </message>

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

   <portType name="StockQuote">
      <cpp:bindings>
         <cpp:class name="StockQuoteService"/>
         <cpp:enableWrapperStyle>false</cpp:enableWrapperStyle>
      <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:

```
// @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);
};
```

D.4 <cpp:namespace>

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

Format:

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

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:

```
<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/">
   <cpp:bindings>
      <cpp:namespace name="stock"/>
   </cpp:bindings>

   <portType name="StockQuote">
      <cpp:bindings>
         <cpp:class name="StockQuoteService"/>
      </cpp:bindings>
   </portType>
</definitions>
```

Generated C++ file:

```
namespace stock
{
   // @WebService(name="StockQuote", targetNamespace="http://www.example.org/"
```

```
   //       serviceName="StockQuoteService")
   // @WebService(name=”StockQuote”,
   class StockQuoteService {
   };
}
```

D.5 <cpp:memberFunction>

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

Format:

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

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. [CPPD0005]

Example:

Input 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/">

   <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">
      </part>
   </message>

   < message name="GetLastTradePriceResponse">
      <part name="parameters" element="tns:GetLastTradePriceResponse">
      </part>
   </ 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">
         </input>
         <output name="GetLastTradePriceResponse"
               message="tns:GetLastTradePriceResponse">
         </output>
      </operation>
   </portType>
</definitions>
```

Generated C++ file:

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

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

D.6 <cpp:parameter>

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

Format:

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

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.
- ***type : NCName (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 valid C++ type. [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:

```
<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">
      </part>
   </message>

   < message name="GetLastTradePriceResponse">
      <part name="parameters" element="tns:GetLastTradePriceResponse">
      </part>
   </ 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">
         </input>
         <output name="GetLastTradePriceResponse"
               message="tns:GetLastTradePriceResponse">
         </output>
      </operation>
   </portType>

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

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.

[CPPD0007] The following is a list of JAX-WS WSDL extensions that MAY be recognized, and their corresponding SCA WSDL extension.

JAX-WS Extension	SCA Extension
jaxws:bindings	cpp:bindings
jaxws:class	cpp:class
jaxws:method	cpp:memberFunction
jaxws:parameter	cpp:parameter
jaxws:enableWrapperStyle	cpp:enableWrapperStyle

D.8 WSDL Extensions Schema

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 appendix.

```
<?xml version="1.0" encoding="UTF-8"?>
<schema xmlns="http://www.w3.org/2001/XMLSchema"
        targetNamespace="http://docs.oasis-open.org/ns/opencsa/sca-c-
cpp/cpp/200901"
        xmlns:cpp="http://docs.oasis-open.org/ns/opencsa/sca-c-cpp/cpp/200901"
        xmlns: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>
```

E XML Schemas

Three XML schemas are defined to support the use of C++ for implementation and definition of interfaces.

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 appendix.

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/200903"
      xmlns:sca="http://docs.oasis-open.org/ns/opencsa/sca/200903"
      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"/>
            <anyAttribute namespace="##other" processContents="lax"/>
         </extension>
      </complexContent>
   </complexType>

   <complexType name="CPPFunction">
      <attribute name="name" type="NCName" use="required"/>
      <attribute name="requires" type="sca:listOfQNames" use="optional"/>
      <attribute name="oneWay" type="boolean" use="optional"/>
      <anyAttribute namespace="##other" processContents="lax"/>
   </complexType>

</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/200903"
      xmlns:sca="http://docs.oasis-open.org/ns/opencsa/sca/200903"
      elementFormDefault="qualified">
```

```
   <include schemaLocation="sca-core.xsd"/>

   <element name="implementation.cpp" type="sca:CPPImplementation"
         substitutionGroup="sca:implementation" />
   <complexType name="CPPImplementation">
      <complexContent>
         <extension base="sca:Implementation">
            <sequence>
               <element name="function" type="sca:CPPImplementationFunction"
                     minOccurs="0" maxOccurs="unbounded" />
               <any namespace="##other" processContents="lax"
                     minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
            <attribute name="library" type="NCName" use="required"/>
            <attribute name="header" type="NCName" use="required"/>
            <attribute name="path" type="string" use="optional"/>
            <attribute name="class" type="Name" use="optional"/>
            <attribute name="componentType" type="string" use="optional"/>
            <attribute name="scope" type="sca:CPPImplementationScope"
                  use="optional"/>
            <attribute name="eagerInit" type="boolean" use="optional"/>
            <attribute name="allowsPassByReference" type="boolean"
                  use="optional"/>
            <anyAttribute namespace="##other" processContents="lax"/>
         </extension>
      </complexContent>
   </complexType>

   <simpleType name="CPPImplementationScope">
      <restriction base="string">
         <enumeration value="stateless"/>
         <enumeration value="composite"/>
      </restriction>
   </simpleType>

   <complexType name="CPPImplementationFunction">
      <attribute name="name" type="NCName" use="required"/>
      <attribute name="requires" type="sca:listOfQNames" use="optional"/>
      <attribute name="allowsPassByReference" type="boolean"
         use="optional"/>
      <anyAttribute namespace="##other" processContents="lax"/>
   </complexType>

</schema>
```

E.3 sca-contribution-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/200903"
      xmlns:sca="http://docs.oasis-open.org/ns/opencsa/sca/200903"
      elementFormDefault="qualified">

   <include schemaLocation="sca-contributions.xsd"/>

   <element name="export.cpp" type="sca:CPPExport"
         substitutionGroup="sca:Export"/>

   <complexType name="CPPExport">
      <complexContent>
         <attribute name="name" type="QName" use="required"/>
         <attribute name="path" type="string" use="optional"/>
      </complexContent>
```

```
   </complexType>

   <element name="import.cpp" type="sca:CPPImport"
         substitutionGroup="sca:Import"/>

   <complexType name="CPPImport">
      <complexContent>
         <attribute name="name" type="QName" use="required"/>
         <attribute name="location" type="string" use="required"/>
      </complexContent>
   </complexType>

</schema>
```

F Conformance Items

This section contains a list of conformance items for the SCA C++ Client and Implementation Model specification.

Conformance ID	Description
[CPP20001]	A C++ implementation MUST implement all of the operation(s) of the service interface(s) of its componentType.
[CPP20003]	An SCA runtime MUST support these scopes; **stateless** and **composite**. Additional scopes MAY be provided by SCA runtimes.
[CPP20005]	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.
[CPP20006]	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.
[CPP20007]	The *@name* attribute of a *<function/>* child element of a *<interface.cpp/>* MUST be unique amongst the *<function/>* elements of that *<interface.cpp/>*.
[CPP20008]	The *@name* attribute of a *<callbackFunction/>* child element of a *<interface.cpp/>* MUST be unique amongst the *<callbackFunction/>* elements of that *<interface.cpp/>*.
[CPP20009]	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.
[CPP20010]	The *@name* attribute of a *<function/>* child element of a *<implementation.cpp/>* MUST be unique amongst the *<function/>* elements of that *<implementation.cpp/>*.
[CPP20011]	A C++ implementation class MUST be default constructable by the SCA runtime to instantiate the component.
[CPP20012]	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 method.
[CPP20013]	An SCA runtime MAY run multiple threads in a single composite scoped implementation instance object and it MUST NOT perform any synchronization.
[CPP20014]	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”.
[CPP20015]	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”.
[CPP30001]	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.
[CPP30002]	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.
[CPP30003]	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.
[CPP30004]	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.
[CPP40001]	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.
[CPP40002]	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.
[CPP40003]	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.
[CPP70001]	The*@name* attribute of a <*export.cpp/*> element MUST be unique amongst the <*export.cpp/*> elements in a domain.
[CPP70002]	The*@name* attribute of a <*import.cpp/*> child element of a <*contribution/*> MUST be unique amongst the <*import.cpp/*> elements in of that contribution.
[CPP80001]	The return type and types of the parameters of a member function of a local service interface MUST be one of: • Any of the C++ primitive types (for example, `int`, `short`, `char`). In this case the data will be passed by value as is normal for C++. • Pointers to any of the C++ primitive types (for example, `int *`, `short *`, `char *`). • The `const` keyword can be used for any pointer to a C++ primitive type (for example `const char *`). If this is used on a parameter then the destination can not change the value. • C++ `class`. The class will be passed by value as is normal for C++. • Pointer to a C++ `class`. A pointer will be passed to the destination which can then modify the original contents. • `DataObjectPtr`. An SDO pointer. This will be passed by reference. • References to C++ classes (passed by reference).
[CPP80002]	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++ primitive types (for example, `int`, `short`, `char`). This will be copied. • `DataObjectPtr`. An SDO pointer. The SDO will be copied and passed to the

	destination.
[CPP90001]	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 MUST be pure virtual (virtual with no implementation)
[CPP90002]	A C++ header file used to define an interface MUST NOT use the following constructs: • Macros • Inline member functions • Friend classes
[CPP100001]	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.
[CPP100002]	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.
[CPP100003]	• 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-value. – **in/out -** the message part to a member function parameter, passed by reference.
[CPP100004]	• 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-value. – **in/out -** the wrapper child to a member function parameter, passed by reference.
[CPP100005]	An SCA implementation SHOULD provide a mechanism for overriding the default targetNamespace.
[CPP100006]	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.
[CPP100007]	An SCA implementation MUST ensure each class that is referenced from an @WebThrows annotation MUST itself have a @WebFault annotation that associates the fault with a particular global element that will be associated with the fault message.
[CPP100008]	An SCA implementation MUST map simple types as defined in Table 1 and Table 2 by default.

[CPP110001]	An SCA implementation MUST reject a composite file that does not conform to http://docs.oasis-open.org/opencsa/sca/200903/sca-interface-cpp-1.1.xsd or http://docs.oasis-open.org/opencsa/sca/200903/sca-implementation-cpp-1.1.xsd.
[CPP110002]	An SCA implementation MUST reject a componentType or constraining type file that does not conform to http://docs.oasis-open.org/opencsa/sca/200903/sca-interface-cpp-1.1.xsd.
[CPP110003]	An SCA implementation MUST reject a contribution file that does not conform to http://docs.oasis-open.org/opencsa/sca/200903/sca-contribution-cpp-1.1.xsd.
[CPP110004]	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-wsdlext-cpp-1.1.xsd.
[CPPA0001]	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.
[CPPA0002]	If multiple annotations apply to a program element, all of the annotations SHOULD be in the same comment block.
[CPPA0003]	An SCA implementation MUST treat a class with an @WebService annotation specified as if an @Interface annotation was specified.
[CPPC0001]	If WSDL mapping annotations are supported by an implementation, the annotations defined here MUST be supported and MUST be mapped to WSDL as described.
[CPPC0002]	An SCA implementation MUST treat any instance of a @Interface annotation and without an explicit @WebService annotation as if a @WebService annotation with no parameters was specified.
[CPPC0003]	If a @WebService does not have a **portName** element, an SCA implementation MUST use the value associated with the **name** element, suffixed with *"Port"*.
[CPPC0004]	Only named parameters MAY be referenced by a @WebParam annotation.
[CPPC0005]	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.
[CPPC0006]	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.
[CPPC0007]	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.
[CPPC0008]	A C++ class that is listed in a @WebThrows annotation MUST itself have a @WebFault annotation.
[CPPD0001]	If WSDL extensions are supported by an implementation, all the extensions defined here MUST be supported and MUST be mapped to C++ as described.
[CPPD0002]	A <cpp:bindings/> element MUST NOT have more than one <cpp:class/> child element.
[CPPD0003]	<cpp:bindings/> element MUST NOT have more than one <cpp:enableWrapperStyle/> child element.
[CPPD0004]	A <cpp:bindings/> element MUST NOT have more than one <cpp:namespace/> child element.

[CPPD0005]	A <cpp:bindings/> element MUST NOT have more than one <cpp:memberFunction/> child element.
[CPPD0006]	The @type attribute of a <cpp:parameter/> element MUST be a valid C++ type.
[CPPD0007]	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.

3539 # F.1 JAX-WS Conformance

3540 The JAX-WS 2.1 specification **[JAXWS21]** defines conformance statements for various requirements
3541 defined by that specification. The following table outlines those conformance statements, and describes
3542 whether the conformance statement applies to the WSDL binding described in this specification.

Section	Conformance Statement	Notes	Conformance ID
2	WSDL 1.1 support	[A]	[CPPF0001]
2	Customization required	[CPPD0001] The reference to the JAX-WS binding language are treated as a reference to the C++ WSDL extensions defined in section WSDL C++ Mapping Extensions.	
2	Annotations on generated classes		[CPPF0002]
2.1	Definitions mapping	[CPP100001]	
2.1	WSDL and XML Schema import directives		[CPPF0003]
2.1.1	Optional WSDL extensions		[CPPF0004]
2.2	SEI naming		[CPPF0005]
2.2	javax.jws.WebService required	[B] References to javax.jws.WebService in the conformance statement are treated as the C++ annotation @WebService.	[CPPF0006]
2.3	Method naming		[CPPF0007]
2.3	javax.jws.WebMethod required	[A], [B] References to javax.jws.WebMethod in the conformance statement are treated as the C++ annotation @WebFunction.	[CPPF0008]
2.3	Transmission primitive support		[CPPF0009]
2.3	Using javax.jws.OneWay	[A], [B] References to javax.jws.OneWay in the conformance statement are treated as the C++ annotation @OneWay.	[CPPF0010]
2.3.1	Using javax.jws.SOAPBinding	[A], [B] References to javax.jws.SOAPBinding in	[CPPF0011]

		the conformance statement are treated as the C++ annotation @SOAPBinding.	
2.3.1	Using javax.jws.WebParam	[A], [B] References to javax.jws.WebParam in the conformance statement are treated as the C++ annotation @WebParam.	[CPPF0012]
2.3.1	Using javax.jws.WebResult	[A], [B] References to javax.jws.WebResult in the conformance statement are treated as the C++ annotation @WebResult.	[CPPF0013]
2.3.1.1	Non-wrapped parameter naming		[CPPF0014]
2.3.1.2	Default mapping mode		[CPPF0015]
2.3.1.2	Disabling wrapper style	[B] References to jaxws:enableWrapperStyle in the conformance statement are treated as the WSDL extension cpp:enableWrapperStyle.	[CPPF0016]
2.3.1.2	Wrapped parameter naming		[CPPF0017]
2.3.1.2	Parameter name clash	[A]	[CPPF0018]
2.5	javax.xml.ws.WebFault required	[B] References to javax.jws.WebFault in the conformance statement are treated as the C++ annotation @WebFault.	[CPPF0019]
2.5	Exception naming		[CPPF0020]
2.5	Fault equivalence	[A]	[CPPF0021]
2.6	Required WSDL extensions	MIME Binding not necessary	[CPPF0022]
2.6.1	Unbound message parts	[A]	[CPPF0023]
2.6.2.1	Duplicate headers in binding		[CPPF0024]
2.6.2.1	Duplicate headers in message		[CPPF0025]
3	WSDL 1.1 support	[A]	[CPPF0026]
3	Standard annotations	[A] [CPPC0001]	
3.1	Java identifier mapping	[A]	[CPPF0027]
3.1.1	Method name disambiguation	[A] References to javax.jws.WebMethod in the conformance statement are treated as the C++ annotation @WebFunction.	[CPPF0028]

3.2	WSDL and XML Schema import directives		[CPPF0029]
3.4	portType naming		[CPPF0030]
3.4.1	Inheritance flattening	[A]	[CPPF0044]
3.4.1	Inherited interface mapping		[CPPF0045]
3.5	Operation naming		[CPPF0031]
3.5.1	One-way mapping	[B] References to javax.jws.OneWay in the conformance statement are treated as the C++ annotation @OneWay.	[CPPF0032]
3.5.1	One-way mapping errors		[CPPF0033]
3.6.1	Parameter classification	[CPP100006]	
3.6.1	Parameter naming		[CPPF0035]
3.6.1	Result naming		[CPPF0036]
3.6.1	Header mapping of parameters and results	References to javax.jws.WebParam in the conformance statement are treated as the C++ annotation @WebParam. References to javax.jws.WebResult in the conformance statement are treated as the C++ annotation @WebResult.	[CPPF0037]
3.7	Exception naming	[A] References to javax.jws.WebFault in the conformance statement are treated as the C++ annotation @WebFault.	[CPPF0038]
3.8	Binding selection	References to the BindingType annotation are treated as references to SOAP related intents defined by **[POLICY]**.	[CPPF0039]
3.10	SOAP binding support	[A]	[CPPF0040]
3.10.1	SOAP binding style required		[CPPF0041]
3.11	Port selection		[CPPF0042]
3.11	Port binding	References to the BindingType annotation are treated as references to SOAP related intents defined by **[POLICY]**.	[CPPF0043]

3543 [A] All references to Java in the conformance statement are treated as C++.

3544 [B] Annotation generation is only necessary if annotations are supported by an SCA implementation.

3545 ## F.1.1 Ignored Conformance Statements

Section	Conformance Statement	Notes
2.2	javax.xml.bind.XmlSeeAlso required	

2.3.1	use of JAXB annotations	
2.3.1.2	Using javax.xml.ws.RequestWrapper	
2.3.1.2	Using javax.xml.ws.ResponseWrapper	
2.3.3	Use of Holder	
2.3.4	Asynchronous mapping required	
2.3.4	Asynchronous mapping option	
2.3.4.2	Asynchronous method naming	
2.3.4.2	Asynchronous parameter naming	
2.3.4.2	Failed method invocation	
2.3.4.4	Response bean naming	
2.3.4.5	Asynchronous fault reporting	
2.3.4.5	Asychronous fault cause	
2.4	JAXB class mapping	
2.4	JAXB customization use	
2.4	JAXB customization clash	
2.4.1	javax.xml.ws.wsaddressing.W3CEndpointReference	
2.5	Fault Equivalence	
2.6.3.1	Use of MIME type information	
2.6.3.1	MIME type mismatch	
2.6.3.1	MIME part identification	
2.7	Service superclass required	
2.7	Service class naming	
2.7	javax.xml.ws.WebServiceClient required	
2.7	Default constructor required	
2.7	2 argument constructor required	
2.7	Failed getPort Method	
2.7	javax.xml.ws.WebEndpoint required	
3.2	Package name mapping	
3.3	Class mapping	
3.6	use of JAXB annotations	
3.6.2.1	Default wrapper bean names	
3.6.2.1	Default wrapper bean package	
3.6.2.3	Null Values in rpc/literal	

3.7	java.lang.RuntimeExceptions and java.rmi.RemoteExceptions	
3.7	Fault bean name clash	
3.11	Service creation	

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.

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I Revision History

[optional; should not be included in OASIS Standards]

Revision	Date	Editor	Changes Made
			•