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WS-BPEL Client and Implementation
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Abstract:

The Service Component Architecture (SCA) WS-BPEL Client and Implementation model specifies how WS-BPEL 2.0 can be used with SCA. The goal of the specification is to address the following scenarios.

**Start from WS-BPEL process.** It should be possible to use any valid WS-BPEL process definition as the implementation of a component within SCA. In particular, it should be possible to generate an SCA Component Type from any WS-BPEL process definition and use that type within an SCA assembly. Most BPEL4WS 1.1 process definitions may also be used with SCA by using the backward compatibility approach described in section 4.

**Start from SCA Component Type.** It should be possible to use WS-BPEL to implement any SCA Component Type that uses only WSDL interfaces to define services and references, possibly with some SCA specific extensions used in process definition.

**Start from WS-BPEL with SCA extensions.** It should be possible to create a WS-BPEL process definition that uses SCA extensions and generate an SCA Component Type and use that type within an SCA assembly. Some SCA capabilities (such as properties and multi-party references) can only be used by WS-BPEL process definitions that use SCA extensions.

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1 Introduction

This specification describes how a WS-BPEL process definition can be used as the implementation of an SCA component.

For an SCA component to use a WS-BPEL process as an implementation, it uses an `<implementation.bpel/>` element:

```xml
<component ...>
  ...
  <implementation.bpel process="xsd:QName"/>
  ...
</component>
```

The only aspect of this that is specific to WS-BPEL is the `<implementation.bpel>` element. [SBPEL1001] The `process` attribute of the `<implementation.bpel>` element MUST be the QName of an executable WS-BPEL process.

1.1 Terminology


1.2 Normative References


1.4 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.
  \[ \text{e.g.} \quad \text{<element name="componentType" type="sca:ComponentType"/>} \]

- For the names of types within XSD files, the names follow the CamelCase convention with all names starting with an upper case letter.
  \[ \text{e.g.} \quad \text{<complexType name="ComponentService"/>} \]
2 Introspected Component Type of a WS-BPEL Process

While a WS-BPEL process definition provides an implementation that can be used by a component, the process definition also determines the introspected ComponentType of any SCA component that uses that implementation. The introspected component type represents the aspects of the implementation that SCA needs to be aware of in order to support assembly and deployment of components that use that implementation. The generic form of a component type is defined in the SCA Assembly Specification [SCA-Assembly].

```
<componentType ...
    <service name="xsd:NCName" ... > ... </service>
    <reference name="xsd:NCName" ... > ... </reference>
    <property name="xsd:NCName" ... > ... </property>
    <implementation ... />
</componentType>
```

The SCA Assembly Specification defines an asyncInvocation policy intent for long-running operations. BPEL processes that implement long-running request-response operations are encouraged to use interfaces marked with this intent.

2.1 Services and References

In SCA, both services and references correspond to WS-BPEL’s concept of partner link. In SCA, the difference between a service and a reference is determined by which party sends the first message in a conversation. No matter of how many messages a bi-directional conversation involves or how long it takes, there is always a first message. The sender of the first message is considered to be the client and the receiver is the service provider. Messages that go from the service provider to the client are called callback messages.

WS-BPEL’s partner links are not differentiated based on who sends the first message. So, in order to map a WS-BPEL process to an SCA Component Type, it is necessary to determine which role sends the first message. A simple static analysis of the control flow, which does not involve determining the values of any expressions, is used to determine which role can send the first message.

It is also possible to override the default mapping of partner links to services or references as described by explicitly marking the partner link with an SCA attribute that describes the service or reference (i.e. `sca-bpel:service` or `sca-bpel:reference`). These attributes are described in section 3.3.
2.1.1 Generating Services and References

The following sections describe the rules that determine the contents of the introspected component type for a WS-BPEL process.

- [SBPEL2001] If a partner link specifies a `sca-bpel:service` attribute, then a service MUST be generated for the introspected component type. [SBPEL2002] The name of the service MUST be the value of the `sca-bpel:service` attribute.

- [SBPEL2003] If a partner link specifies a `sca-bpel:reference` attribute, then a reference MUST be generated for the introspected component type. [SBPEL2004] The name of the reference MUST be the value of the `sca-bpel:reference` attribute.

- [SBPEL2005] If neither `sca-bpel:service` nor `sca-bpel:reference` is present on the partner link, then if a static analysis of the process determines that it is possible that the first message for a partner link will be received in a `<receive>` activity, the `<onMessage>` element of a `<pick>` activity or the `<onEvent>` element of an event handler then the introspected component type MUST include an SCA service that corresponds to the partner link in the component type.

- [SBPEL2006] If the name of the partner link is unique within the process, then it MUST be used as the name of the service. Otherwise, the name is determined according to the rules of section 2.3.

- [SBPEL2007] If the rules [SBPEL2001]-[SBPEL2006] do not determine that the partner link maps to an SCA service, then the introspected component type MUST include an SCA reference that corresponds to the partner link in the component type. [SBPEL2008] If the name of the partner link is unique within the process, then it MUST be used as the name of the reference. Otherwise, the name is determined according to the rules of section 2.3.

- [SBPEL2009] The multiplicity of the reference MUST be determined according to the algorithm defined by rules [SBPEL2010]-[SBPEL2013].

1. Multi-Reference. [SBPEL2010] If the partner link is declared with a `sca-bpel:multiRefFrom="aVariableName"` extension, the multiplicity of the SCA reference used in the corresponding variable. Details of these extensions are described in section 3.2.4.

References: If a static analysis of the process does not determine that the partner link should map to an SCA service, then the partner link is mapped to an SCA reference in the component type.

The multiplicity of the reference is determined by the following algorithm:

- **Required Reference.** If not (1) and the partner link has `initializePartnerRole="yes"`, then the multiplicity is 1..1 (i.e. it’s a required reference).

- **Stub Reference.** If not (1) or (2) and if the analysis of the process determines that the first use of the partner link by any activity is in an assign activity that sets the partner role, then the multiplicity is “0..1” and the attribute `wiredByImpl` is set to “true”. A reference with [SBPEL2008]
2. **Required Reference.** [SBPEL2011] If [SBPEL2010] does not apply and the partner link has \texttt{initializePartnerRole=\texttt{yes}}\texttt{, then the multiplicity MUST be “1..1” (i.e. it is a required reference).}

3. **Stub Reference.** [SBPEL2012] If neither [SBPEL2010] nor [SBPEL2011] apply and the analysis of the process determines that the first use of the partner link by any activity is in an \texttt{\texttt{assign}} activity that sets the partner role, then the multiplicity MUST be “0..1” and the attribute \texttt{wiredByImpl} MUST be set to “true”. A reference with \texttt{wiredByImpl=\texttt{true}} is referred to as a stub reference. Although the target can’t be set for such a reference, SCA can still apply bindings and policies to it and potentially need to set the endpoint address for callbacks, if the interface is bi-directional.


### 2.1.2 Handling @initializePartnerRole on Services

SCA has no concept of multiplicity on services, but partner links that map to services can still be marked with an \texttt{initializePartnerRole} attribute. [SBPEL2014] If \texttt{initializePartnerRole=\texttt{yes}} is specified for a partner link and the partner link maps to a service in the component type, then any component that uses this business process as an implementation MUST configure the corresponding service to use a binding that knows the identity of the partner as soon as the partner link becomes active (e.g. the binding cannot depend on using a \texttt{\texttt{reply-to}} field as the mechanism to initialize the partner role).

### 2.2 Partner Link Types and SCA Interfaces

When a partner link is determined to correspond to an SCA service, the type of the service is determined by the partner link type of the partner link. [SBPEL2015] The WSDL port type in the \texttt{\texttt{\texttt{interface.wsdl}}} declaration for the service in the introspected component type MUST be the same as the port type of the \texttt{myRole} of the partner link. [SBPEL2016] If the partner link type has two roles, then the \texttt{\texttt{\texttt{interface.wsdl}}} declaration MUST also have a \texttt{\texttt{\texttt{\texttt{\texttt{CallbackInterface}}}}} attribute whose value points to the same WSDL port type as the \texttt{\texttt{\texttt{partnerRole}}} of the partner link.

Consider an example that uses one of the partner link types used as an example in the WS-BPEL specification. The partner link type definition is:

```xml
<plnk:partnerLinkType name="invoicingLT">
  <plnk:role name="invoiceService"
    portType="pos:computePricePT" />
  <plnk:role name="invoiceRequester"
    portType="pos:invoiceCallbackPT" />
</plnk:partnerLinkType>
```

The "invoiceProcess", which provides invoice services, would define a partner link that uses that type with a declaration that would look like:

```xml
<partnerLink name="invoicing"
  partnerLinkType="lns:invoicingLT"
  myRole="invoiceService"
  partnerRole="invoiceRequester" />
```

Somewhere in the process, a start activity would use that partner link, which might look like:

```xml
<receive partnerLink="invoicing"
  portType="pos:computePricePT"
  operation="initiatePriceCalculation"
  variable="PO"
  createInstance="yes" />
```
Because the partner link is used in a start activity, SCA maps that partner link to a service for on the component type. In this case, the service element of the component type would be:

```xml
<service name="invoicing">
  <!--interface.wsdl
  interface="http://manufacturing.org/wsd1/purchase#
  wsdl.interface(computePricePT)"
  callbackinterface="http://manufacturing.org/wsd1/purchase#
  wsdl.interface(invoiceCallbackPT)" />
</service>
```

Conversely, when a partner link is determined to correspond to an SCA reference in the introspected component type, then interface for the reference is also determined by the partner link type, but with the roles reversed. The WSDL port type in the `<interface.wsdl>` declaration for the reference MUST be the same as the port type of the partnerRole of the partner link. If the partner link type has two roles, then the `<interface.wsdl>` declaration MUST also have a `@callbackInterface` attribute whose value points to the same WSDL port type as the `myRole` of the partner link.

### 2.3 Handling of Local Partner Links

It is possible to declare partner links local to a `<process>` in WS-BPEL, besides declaring partner links at the `<scope>` level. The names of partner link declared in different `<scope>` could potentially share the identical name. When multiple partner links share the same name, the scheme defined by [SBPEL2018] must be used to disambiguate different occurrences of partner link declaration.

- Let "originalName" be the original NCName used in multiple partner link declarations.

- [SBPEL2020] The introspected component type MUST include services or references corresponding to these partner links with names: "originalName_1" to "originalName_N". Whether the partner link corresponds to a service or reference does not affect the name used. [SBPEL2021] The number suffixes for the partner links MUST be based on the lexical order of the corresponding partner link occurrences in the process definition.

- [SBPEL2022] If any "originalName_i" (where 1 <= i <= N) is already the name of a partner link declaration in the process definition, additional underscore characters MAY be added at the beginning of all aliases consistently to avoid collision.

For users that prefer this WS-BPEL element, it is also possible to define interfaces with an alternative partnerLinkType form of an interface type. This form does not provide any more information than is present in the `<interface.wsdl>` element. The example above would look like the following:

```xml
<interface.partnerLinkType
  type="lns:invoicingLT" serviceRole="invoiceService"/>
```

The generic form of this interface type definition is as follows:

```xml
<interface.partnerLinkType
  type="xs:QName" serviceRole="xs:NCName"?/>
```

The `type` attribute is mandatory and references a partner link type. In case the partner link type has two roles, the optional attribute `serviceRole` MUST be used to specify which of the two roles is used as the interface. The other role is used as the callback. If the partnerLinkType has only one role, it cannot be a callback. Moreover, the `serviceRole` attribute MAY be omitted.

This form has a couple advantages over the interface.wsdl form. It is...
3 SCA Extensions to WS-BPEL

It is possible to use WS-BPEL processes in conjunction with SCA, while the processes have no knowledge of SCA. A few SCA concepts are only available to WS-BPEL processors that support SCA specific extensions. The capabilities that require knowledge of SCA are provided by an SCA extension, whose namespace is "http://docs.oasis-open.org/ns/opencsa/sca-bpel/200801".

Whether this extension is mandatory or optional is specified by the mustUnderstand attribute as described in section 14 of the WS-BPEL 2.0 specification [SCA-Assembly].

An example, where the SCA extension is mandatory, is as follows:

```xml
<process ...>
  <extensions>
    <extension
      namespace="http://docs.oasis-open.org/ns/opencsa/sca-bpel/200801"
      mustUnderstand="yes" />
  </extensions>
  ...
</process>
```

3.1 Properties

A WS-BPEL variable declaration can include an SCA extension that says that the variable represents an SCA property for the component represented by the WS-BPEL process.

The declaration looks like the following:

```xml
<variable name="currency" type="xsd:string"
  sca-bpel:property="yes" />
```
When `sca-bpel:property="yes"` is used on a variable declaration, the name of the variable is used as the name of a property of the component type represented by the WS-BPEL process. The name of a variable used as a property of the component MUST be unique within the process.

If the variable has an initialization from-spec, then that becomes the default value for the variable in cases where the SCA component does not provide a value for that property.

If the from-spec is a literal value, where it has the following form:

```xml
<from><literal>literal value</literal></from>
```

then the literal value will be represented as the default value in the component type for the process. Any other kind of initialization from-spec will not be represented in the component type. However, even though the other kinds of initialization from-spec are not represented in the component type, they would still be computed and used as the default value for the property when the component does not provide a value for that property.

**[SBPEL3002]** If a value is provided for a property, any initialization from-spec MUST still be evaluated, but the value of the variable will be changed to the provided property value immediately after the initialization is evaluated, and specifically, before any following variable initialization from-spec is evaluated. Thus, any side effects that result from the execution of the initialization from-spec will occur irrespective of whether the property is set.

**[SBPEL3003]** If a BPEL variable that is used as a property has an initialization from-spec then `mustSupply="false"` MUST be specified on the component type property declaration, even if the default value is not literal and therefore not represented in the component type.

### 3.2 Multi-Valued References

Component types can declare references with a multiplicity that allows a single reference to be wired to multiple targets. An example use of this capability is a purchasing component wired to a list of accepted vendors. SCA assumes that each programming language binding will provide its own approach for making the list of targets available within that programming language.

**[SBPEL3004]** In a WS-BPEL process definition, a variable MAY include an `sca-bpel:multiReference` extension element that declares that the variable represents a multi-valued reference. **[SBPEL3005]** When a variable declaration contains the `sca-bpel:multiReference`
extension, the type of the variable MUST be an element of `sca-bpel:serviceReferenceList`. However, since that type only specifies that the variable holds a list of endpoint references, the `sca-bpel:multiReference` element also has attributes to specify the partner link type and partner role of the target of the reference. [SBPEL3006] The introspected component type MUST include a reference with a multiplicity of either "0..n" or "1..n" that corresponds to a variable with the `sca-bpel:multiReference` element. [SBPEL3007] The type of the reference MUST be determined by the partner link type and the partner role attributes of the `sca-bpel:multiReference` extension element. [SBPEL3008] The `sca-bpel:multiRefFrom` attribute MUST not be specified for a partner link with a `myRole` attribute referencing a role which is the only role of a partner link type. [SBPEL3009] The `sca-bpel:multiRefFrom` attribute MUST NOT be specified for a partner link that has the `sca-bpel:service` attribute.

An example of a variable that represents a list of references to vendors would look like:

```xml
<variable name="vendors" element="sca-bpel:serviceReferenceList">
  <sca-bpel:multiReference partnerLinkType="pos:vendorPT" partnerRole="vendor"/>
</variable>
```

Syntax of this extension:

```xml
<sca-bpel:multiReference partnerLinkType="xsd:QName" partnerRole="xsd:NCName">
  <multiplicity="0..n or 1..n"/>
</sca-bpel:multiReference>
```

The default value of multiplicity is "1..n".

The `sca-bpel:serviceReferenceList` element declaration is the following:

```xml
<xsd:element name="serviceReferenceList">
  <xsd:complexType>
    <xsd:sequence>
      <xsd:element ref="sref:service-ref" minOccurs="0" maxOccurs="unbounded"/>
    </xsd:sequence>
  </xsd:complexType>
</xsd:element>
```

A typical use of a variable that holds a multi-valued reference would be to have a `<forEach>` activity with an iteration for each element in the list. The `body` of the `<forEach>` activity would declare a local partner link and assign one of the list elements to the local partner link. Such a local partner link is typically categorized as the "References" case 1 listed in section 2.1.

To assist a more effective SCA modeling, another SCA extension is introduced to associate a multi-valued reference, manifested as a `sca-bpel:serviceReferenceList` variable with a partner link. This extension is in an attribute form attached to the partner link declaration. Syntax of this extension is:

```xml
<sca-bpel:partnerLink ... sca-bpel:multiRefFrom="bpel:BPELVariableName"/>
```

[SBPEL3010] The value of the `sca-bpel:multiRefFrom` attribute MUST refer to the name of a variable manifesting an SCA multi-valued reference. [SBPEL3011] The `partnerLinkType` and `partnerRole` attributes of the partner link and multi-valued reference variable MUST be matched. [SBPEL3012] There MUST be at least one code-path where the values from the multi-valued reference variable are copied to the `partnerRole` of the partner link.

If any above constraints are violated, it will be considered an error during static analysis.
When this `sca-bpel:multiRefFrom` extension is applied to pair up a multi-valued reference variable and a partner link which is categorized as the "References" case 1 (as described in section 2.1), the partner link and variable are manifested as a single multi-valued reference entity in SCA assembly model using the name of the variable. If the interface involved is bi-directional, this implies the wiring of the bi-directional interface as a single reference in SCA.

For example:

```xml
<process>
  ...
  <variable name="vendors" element="sca-bpel:serviceReferenceList">
    <sca-bpel:multiReference partnerLinkType="pos:vendorPT"
      partnerRole="vendor" />
  </variable>
  ...
  <forEach counterName="idx" ...>
    <startCounterValue>1</startCounterValue>
    <finalCounterValue>
      count($vendors/sref:service-ref)
    </finalCounterValue>
    ...
    <scope>
      ...
      <partnerLink name="vendorLink"
        partnerLinkType="pos:vendorPT"
        partnerRole="vendor"
        myRole="quoteRequester"
        sca-bpel:multiRefFrom="vendors" />
      ...
      <assign>
        <copy>
          <from>$vendors/sref:service-ref[$idx]</from>
          <to partnerLink="vendorLink" />
        </copy>
      </assign>
      ...
    </scope>
  </forEach>
  ...
</process>
```

A multi-valued reference named "vendors" is declared in the example above. The partner link named "vendorLink", which is categorized as the "References" case 1, is not manifested directly into the SCA Assembly Model. The extra `sca-bpel:multiRefFrom="vendors"` extension associates the "vendorLink" partner link with multi-valued reference variable "vendors". Consequently, the partner link and variable are manifested as a single multi-valued reference named "vendors" in SCA. This makes the SCA Assembly modeling easier to follow.

### 3.3 Partner Link Mapping to Services and References

[SBPEL3013] A WS-BPEL process definition *MAY* override the default mapping of partner links to services or references as described in section 2.1 by explicitly marking the partner link with an SCA attribute that describes the service or reference.

[SBPEL3014] To explicitly map a partner link to a service, the `sca-bpel:service` attribute *MAY* be specified for the partner link. Example:

```xml
<partnerLink ... sca-bpel:service="xsd:NCName" />
```
[SBPEL3015] The name of the service specified in the `sca-bpel:service` attribute MUST NOT conflict with any other service name generated in the component type for this process.

[SBPEL3016] The `sca-bpel:service` attribute MUST NOT be specified for a partner link with a `partnerRole` attribute referencing a role which is the only role of a partner link type.

[SBPEL3017] To explicitly map a partner link to a reference, the `sca-bpel:reference` attribute MAY be specified for the partner link. Example:

```xml
<partnerLink ... sca-bpel:reference="xsd:NCName" />
```

[SBPEL3018] The name of the reference specified in the `sca-bpel:service` attribute MUST NOT conflict with any other reference name generated in the component type for this process.

[SBPEL3019] The `sca-bpel:reference` attribute MUST NOT be specified for a partner link with a `myRole` attribute referencing a role which is the only role of a partner link type.

When either of these attributes is used, the componentType will include a service or reference with the given name and no other service or reference will be generated for the partner link. The type of that service or reference is unaffected (it will be as specified in section 2.2).

[SBPEL3020] A process MUST NOT include both `sca-bpel:service` and `sca-bpel:reference` attributes on a single partner link.

### 3.4 Required Intents for Partner Links

[SBPEL3021] An SCA extension attribute `sca-bpel:requires` MAY be used to declare required policy intents on a partner link. This can be used by WS-BPEL process designers to require specific abstract policies to be associated with the partner link, without limiting the bindings that can be used for the partner link. The form of the attribute is the following:

```xml
<partnerLink ... sca-bpel:requires="sca:listOfQNames" />
```

[SBPEL3022] The contents of the `sca-bpel:requires` attribute MUST be a space separated list of SCA intent QNames, exactly as specified in the SCA Policy Framework Specification for the contents of the `@sca:requires` attribute.

[SBPEL3023] If the `sca-bpel:requires` attribute is specified, the corresponding service or reference in the introspected component type MUST include an `@sca:requires` attribute with the same contents.
4 Using BPEL4WS 1.1 with SCA (Non-Normative)

A BPEL4WS 1.1 process definition can be used as the implementation of an SCA component. The syntax introduced in section Introduction is used to define a component having a BPEL4WS 1.1 process as the implementation. In this case, the process attribute specifies the target QName of a BPEL4WS 1.1 executable process.

A BPEL4WS 1.1 process definition can be used to generate an SCA Component Type.
5 Conformance

There are two categories of artifacts that this specification defines conformance for: SCA Documents and SCA Runtimes.

5.1 SCA WS-BPEL Document

A SCA WS-BPEL Document is a document that complies with the requirements defined by WS-BPEL 2.0 [WS-BPEL] and MAY include the SCA WS-BPEL extensions defined in Section 3. Any document using these extensions must comply with the sca-bpel schema and any other constraints defined by this specification.

5.2 SCA Runtimes

There are two conformance options defined by this specification:

1. Implementations of an SCA WS-BPEL Runtime

5.2.1 SCA WS-BPEL Runtime

An implementation that claims to conform to an SCA WS-BPEL Runtime MUST meet the following conditions:

1. The implementation MUST meet all the conformance requirements defined by the SCA Assembly Model Specification [SCA-Assembly] i.e. it MUST be a conforming SCA Runtime.
2. The implementation MUST be a compliant WS-BPEL Processor as defined in WS-BPEL 2.0. It must accept and process WS-BPEL 2.0 process descriptions in a manner defined by WS-BPEL 2.0.
3. The SCA BPEL extensions defined in this specification MUST be treated as WS-BPEL 2.0 extensions. WS-BPEL process descriptions containing the SCA BPEL extensions MAY be rejected.
4. With the exception of the SCA BPEL extensions, the implementation MUST comply with all the normative statements in this specification (Appendix B), notably all the MUST statements have to be implemented.

5.2.2 SCA Extended WS-BPEL Runtime

An implementation that claims to conform to an SCA Extended WS-BPEL Runtime MUST meet the following conditions:

1. The implementation MUST meet the conditions for an SCA WS-BPEL Runtime above with the exception that SCA BPEL extensions defined in this specification MUST be supported, WS-BPEL process descriptions containing the SCA BPEL extensions MUST NOT be rejected.
2. The implementation MUST support the SCA BPEL extensions defined in Section 3, and MUST implement them as defined.
A. XML Schemas

XML Schema for SCA-BPEL Extensions of SCA Elements

The definitions contributed by the SCA-BPEL specifications to the common SCA namespace are also provided in a separate XML Schema artifact.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<!-- Copyright (c) OASIS Open 2008. All Rights Reserved. -->
<schema
targetNamespace="http://docs.oasis-open.org/ns/opencsa/sca/200903"
xmlns:sca="http://docs.oasis-open.org/ns/opencsa/sca/200903"
xmlns:xsd="http://www.w3.org/2001/XMLSchema"
elementFormDefault="qualified">
<!-- SCA-Assembly XML Schema -->
<include
schemaLocation="sca-core-1.1-cd03.xsd" />

<!-- SCA-BPEL Component Implementation Type -->
<element name="implementation.bpel"
type="sca:BPELImplementation" substitutionGroup="sca:implementation" />
<complexType name="BPELImplementation">
<complexContent>
<extension base="sca:Implementation">
<sequence>
<any namespace="##other" processContents="lax"
minOccurs="0" maxOccurs="unbounded" />
</sequence>
<attribute name="process" type="QName" use="required" />
<anyAttribute namespace="##any" processContents="lax" />
</extension>
</complexContent>
</complexType>
</schema>

XML Schema for SCA-BPEL Extensions of WS-BPEL 2.0

The definitions of SCA-BPEL extensions to WS-BPEL 2.0 are also provided in a separate XML Schema artifact.

```
```xml
<import
    namespace="http://docs.oasis-open.org/ns/opencsa/sca/200903"
    schemaLocation="http://docs.oasis-open.org/ns/opencsa/sca/200903.xsd" />

<import
    namespace="http://docs.oasis-open.org/wsbpel/2.0/process/executable"
    schemaLocation="http://docs.oasis-open.org/wsbpel/2.0/OS/process/executable/ws-bpel_executable.xsd" />

<import
    namespace="http://docs.oasis-open.org/wsbpel/2.0/serviceref"
    schemaLocation="http://docs.oasis-open.org/wsbpel/2.0/OS/serviceref/ws-bpel_serviceref.xsd" />

<!-- WS-BPEL extension attribute for a bpel:variable associated with an SCA property -->
<attribute name="property" type="bpel:tBoolean" />

<!-- WS-BPEL extension attribute for a bpel:partnerLink associated with an SCA multi-valued reference -->
<attribute name="multiRefFrom" type="bpel:BPELVariableName" />

<!-- WS-BPEL extension element for a bpel:variable holding an SCA multi-valued reference -->
<element name="multiReference">
  <complexType>
    <extension base="xsd:string">
      <attribute name="partnerLinkType" type="QName" />
      <attribute name="partnerRole" type="NCName" />
      <attribute name="multiplicity" type="sca-bpel:Multiplicity" use="optional" default="1..n" />
    </extension>
  </complexType>
</element>

<simpleType name="Multiplicity">
  <restriction base="string">
    <enumeration value="0..n" />
    <enumeration value="1..n" />
  </restriction>
</simpleType>
```
<element name="serviceReferenceList">
  <complexType>
    <sequence>
      <element ref="sref:service-ref" minOccurs="0" maxOccurs="unbounded" />
    </sequence>
  </complexType>
</element>

<!-- WS-BPEL extension attribute for a bpel:partnerLink explicitly naming the service that should be generated for this partnerLink in the component type. -->
<attribute name="service" type="xsd:NCName" />

<!-- WS-BPEL extension attribute for a bpel:partnerLink explicitly naming the reference that should be generated for this partnerLink in the component type. -->
<attribute name="reference" type="xsd:NCName" />

<!-- WS-BPEL extension attribute for a bpel:partnerLink specifying required intents for the service or reference that is generated for this partner link. -->
<attribute name="requires" type="sca:listOfQNames" />
</schema>
B. Conformance Items

This section contains a list of conformance items for the SCA-BPEL specification.

<table>
<thead>
<tr>
<th>Conformance ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[SBPEL1001]</td>
<td>The process attribute of the <code>&lt;implementation:bpel&gt;</code> element MUST be the QName of an executable WS-BPEL process.</td>
</tr>
<tr>
<td>[SBPEL2001]</td>
<td>If a partner link specifies a <code>sca-bpel:service</code> attribute, then a service MUST be generated for the introspected component type.</td>
</tr>
<tr>
<td>[SBPEL2002]</td>
<td>The name of the service MUST be the value of the <code>sca-bpel:service</code> attribute.</td>
</tr>
<tr>
<td>[SBPEL2003]</td>
<td>If a partner link specifies a <code>sca-bpel:reference</code> attribute, then a reference MUST be generated for the introspected component type.</td>
</tr>
<tr>
<td>[SBPEL2005]</td>
<td>If neither <code>sca-bpel:service</code> nor <code>sca-bpel:reference</code> is present on the partner link, then a static analysis of the process determines that it is possible that the first message for a partner link will be received in a <code>receive</code> activity, the <code>conMessage</code> element of a <code>pick</code> activity or the <code>onEvent</code> element of an event handler then the introspected component type MUST include an SCA service that corresponds to the partner link in the component type.</td>
</tr>
<tr>
<td>[SBPEL2006]</td>
<td>If the name of the partner link is unique within the process, then it MUST be used as the name of the service.</td>
</tr>
<tr>
<td>[SBPEL2007]</td>
<td>If the rules [SBPEL2001]-[SBPEL2006] do not determine that the partner link should map to an SCA service, then the introspected component type MUST include an SCA reference that corresponds to the partner link in the component type.</td>
</tr>
<tr>
<td>[SBPEL2008]</td>
<td>If the name of the partner link is unique within the process, then it MUST be used as the name of the reference.</td>
</tr>
<tr>
<td>[SBPEL2009]</td>
<td>The multiplicity of the reference MUST be determined according to the algorithm defined by rules [SBPEL2010]-[SBPEL2013].</td>
</tr>
<tr>
<td>[SBPEL2010]</td>
<td>If the partner link is declared with an <code>sca-bpel:multiReferenceFrom=&quot;aVariableName&quot;</code> extension, the multiplicity of the SCA reference MUST be determined by the <code>multiplicity attribute</code> of <code>sca-bpel:multiReference</code> extension used in the corresponding variable.</td>
</tr>
<tr>
<td>[SBPEL2011]</td>
<td>If [SBPEL2010] does not apply and the partner link has <code>initializePartnerRole=&quot;yes&quot;</code>, then the multiplicity MUST be &quot;1..1&quot;.</td>
</tr>
<tr>
<td>[SBPEL2012]</td>
<td>If neither [SBPEL2010] nor [SBPEL2011] apply and the analysis of the process determines that the first use of the partner link by any activity is in a <code>assign</code> activity that sets the partner role, then the multiplicity MUST be &quot;0..1&quot; and the attribute <code>wiredByImpl</code> MUST be set to &quot;true&quot;.</td>
</tr>
<tr>
<td>[SBPEL2013]</td>
<td>If neither [SBPEL2010] nor [SBPEL2011] nor [SBPEL2012] apply, then the multiplicity MUST be &quot;0..1&quot;.</td>
</tr>
<tr>
<td>[SBPEL2014]</td>
<td>If <code>initializePartnerRole=&quot;yes&quot;</code> is specified for a partner link and the partner link maps to a service in the component type, then any component that uses this business process as an implementation MUST configure the corresponding service to use a binding that knows the identity of the partner as soon as the partner link becomes active (e.g., the binding cannot depend on using a &quot;reply-to&quot; field as the mechanism to initialize the partner role).</td>
</tr>
</tbody>
</table>
The WSDL port type in the `<interface.wsdl>` declaration for the service in the introspected component type MUST be the same as the port type of the `myRole` of the partner link.

If the partner link type has two roles, then the `<interface.wsdl>` declaration MUST also have a `#callbackInterface` attribute whose value points to the same WSDL port type as the `partnerRole` of the partner link.

The WSDL port type in the `<interface.wsdl>` declaration for the reference MUST be the same as the port type of the `partnerRole` of the partner link.

If the partner link type has two roles, then the `<interface.wsdl>` declaration MUST also have a `#callbackInterface` attribute whose value points to the same WSDL port type as the `myRole` of the partner link.

When multiple partner links share the same name, the scheme defined by [SBPEL2020]-[SBPEL2022] MUST be used to disambiguate different occurrences of partner link declaration.

The introspected component type MUST include services or references corresponding to these partner links with names: "originalName_1" to "originalName_N".

The number suffixes for the partner links MUST be based on the lexical order of the corresponding partner link occurrences in the process definition.

If any "originalName_I" (where 1 <= I <= N) is already the name of a partner link declaration in the process definition, additional underscore characters MAY be added at the beginning of all aliases consistently to avoid collision.

The name of a variable used as a property of the component MUST be unique within the process.

If a value is provided for a property, any initialization from-spec MUST still be evaluated, but the value of the variable will be changed to the provided property value immediately after the initialization is evaluated, and specifically, before any following variable initialization from-spec is evaluated.

If a BPEL variable that is used as a property has an initialization from-spec then `mustSupply="false"` MUST be specified on the component type property declaration, even if the default value is not literal and therefore not represented in the component type.

In a WS-BPEL process definition, a variable MAY include an `sca-bpel:multiReference` extension element that declares that the variable represents a multi-valued reference.

When a variable declaration contains the `sca-bpel:multiReference` extension, the type of the variable MUST be an element of `sca-bpel:serviceReferenceList`.

The introspected component type MUST include a reference with a multiplicity of either "0..n" or "1..n" that corresponds to a variable with the `sca-bpel:multiReference` element.

The type of the reference MUST be determined by the partner link type and the partner role attributes of the `sca-bpel:multiReference` extension element.

The `sca-bpel:multiRefFrom` attribute MUST NOT be specified for a partner link with a `myRole` attribute referencing a role which is the only role of a partner link type.

The `sca-bpel:multiRefFrom` attribute MUST NOT be specified for a partner link that has the `sca-bpel:service` attribute.

The value of the `sca-bpel:multiRefFrom` attribute MUST refer to the name of a variable manifesting an SCA multi-valued reference.
The `partnerLinkType` and `partnerRole` attributes of the partner link and multi-valued reference variable MUST be matched.

There MUST be at least one code-path where the values from the multi-valued reference variable are copied to the `partnerRole` of the partner link.

A WS-BPEL process definition MAY override the default mapping of partner links to services or references as described in section 2.1 by explicitly marking the partner link with an SCA attribute that describes the service or reference.

To explicitly map a partner link to a service, the `sca-bpel:service` attribute MAY be specified for the partner link.

The name of the service specified in the `sca-bpel:service` attribute MUST NOT conflict with any other service name generated in the component type for this process.

The `sca-bpel:service` attribute MUST NOT be specified for a partner link with a `partnerRole` attribute referencing a role which is the only role of a partner link type.

To explicitly map a partner link to a reference, the `sca-bpel:reference` attribute MAY be specified for the partner link.

The name of the reference specified in the `sca-bpel:reference` attribute MUST NOT conflict with any other reference name generated in the component type for this process.

The `sca-bpel:reference` attribute MUST NOT be specified for a partner link with a `myRole` attribute referencing a role which is the only role of a partner link type.

A process MUST NOT include both `sca-bpel:service` and `sca-bpel:reference` attributes on a single partner link.

An SCA extension attribute `sca-bpel:requires` MAY be used to declare required policy intents on a partner link.

The contents of the `sca-bpel:requires` attribute MUST be a space separated list of SCA intent QNames, exactly as specified in the SCA Policy Framework Specification for the contents of the `@sca:requires` attribute.

If the `sca-bpel:requires` attribute is specified, the corresponding service or reference in the introspected component type MUST include an `@sca:requires` attribute with the same contents.
C. Acknowledgements

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

Members of the SCA-BPEL Technical Committee:

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Graham Barber, IBM
William Barnhill, Booz Allen Hamilton
Charlton Barreto, Adobe Systems
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Michael Beisiegel, IBM
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Dieter Koenig, IBM
Michael Rowley, BEA Systems, Inc.
Ivana Trickovic, SAP AG
Alex Yiu, Oracle
# D. Revision History

[optional; should not be included in OASIS Standards]

<table>
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<td>2</td>
<td>2007-10-10</td>
<td>Dieter König</td>
<td>Issue resolutions BPEL-4, BPEL-7</td>
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<td></td>
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<td>New section “5. Conformance”</td>
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<td>List of XML namespaces</td>
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<td>Syntax and Examples formatting</td>
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<tr>
<td>3</td>
<td>2007-10-10</td>
<td>Dieter König</td>
<td>Reduced component/composite syntax in sections 1 and 2</td>
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<td>4</td>
<td>2007-12-05</td>
<td>Dieter König</td>
<td>Issue resolutions BPEL-5, BPEL-6, BPEL-9, BPEL-13</td>
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<td>5</td>
<td>2008-01-11</td>
<td>Michael Rowley</td>
<td>Issue resolution for BPEL-11</td>
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<td>6</td>
<td>2008-01-17</td>
<td>Dieter König</td>
<td>Approved Committee Draft</td>
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<td>7</td>
<td>2008-03-17</td>
<td>Dieter König</td>
<td>Revised Approved Committee Draft</td>
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<td>Applied resolution to BPEL-19: Added XML Schema definitions as Appendix A</td>
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<td>8</td>
<td>2008-03-27</td>
<td>Michael Rowley</td>
<td>Applied resolution to BPEL-14</td>
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<td>9</td>
<td>2008-04-10</td>
<td>Michael Rowley</td>
<td>Added @sca-bpel:requires attribute, also as part of resolving BPEL-14</td>
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<td></td>
<td></td>
<td>Reapplied changes from rev5</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Added section 2.6 (issue 17) and added sca-bpel:implementationRef to XML Schema</td>
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<td>Backed out changes for section 2.1, which was</td>
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CD01-rev5 2008-06-19 Michael Rowley Reworked 2.1 to use 2119 language, Removed Alex Yiu from editor list.


CD01-rev8 2008-07-10 Dieter König Namespace prefix "xsd" used consistently in all XML Schema snippets.

CD01-rev9 2008-07-10 Michael Rowley Marked Chapter 4 Non-Normative (issue 1) Reapplied changes from rev5, Added section 2.6 (issue 17) and added sca-bpel:implementationRef to XML Schema.
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<tr>
<td>CD01-rev11</td>
<td>2008-09-5</td>
<td>Michael Rowley</td>
<td>Added new section 2.7 (issue 2), Change Section 3 Intro (issue 20)</td>
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<td>CD01-rev12</td>
<td>2008-10-23</td>
<td>Michael Rowley</td>
<td>Rewrote of section 2.1 for clearer 2119 requirements (accepted by the TC 16-oct-08)</td>
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<td>CD01-rev13</td>
<td>2008-10-30</td>
<td>Michael Rowley</td>
<td>2119 language for the rest of the document</td>
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<tr>
<td>CD01-rev14</td>
<td>2008-10-30</td>
<td>Michael Rowley</td>
<td>Updates 2119 language through sections 2.2 based on TC call of Oct-30</td>
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<td>CD01-rev15</td>
<td>2009-02-07</td>
<td>Dieter König</td>
<td>Removed interface.partnerlink as per Issue 22, 2119 updates starting at section 2.3.</td>
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<td>CD02</td>
<td>2009-03-06</td>
<td>Dieter König</td>
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Appendix Heading 2: Outline numbered + Level: 2 + Numbering Style: 1, 2, 3, … + Start at: 1 + Alignment: Left + Aligned at: 0 pt + Tab after: 0 pt + Indent at: 28.8 pt


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Appendix Heading 3: Outline numbered + Level: 3 + Numbering Style: 1, 2, 3, … + Start at: 1 + Alignment: Left + Aligned at: 0 pt + Tab after: 0 pt + Indent at: 36 pt

Field Code Changed
2.1 Services and References .............................................................................................................
2.2 PartnerLinkTypes and SCA Interfaces

2.3 Specifying an SCA interface with a partnerLinkType

2.4 Handling of Local PartnerLinks

2.5 Support for conversational interfaces
3.2 Multi-Valued References

4. Using BPEL4WS 1.1 with SCA
Services: If a static analysis of the process determines that it is possible that the first message for a partner link will be received in a <receive> activity, the <onMessage> element of a <pick> activity or the <onEvent> element of an event handler then the partner link MUST be associated with a corresponding SCA service in the component type. If the partner link declaration has initializePartnerRole="yes", then the service MUST be configured using a binding that knows the identity of the partner as soon as the partner link becomes active (e.g. the binding cannot depend on using a “reply-to” field as the mechanism to initialize partner role.).

References: If a static analysis of the process does not determine that the partner link should map to an SCA service, then the partner link is mapped to an SCA reference in the component type.

The multiplicity of the reference is determined by the following algorithm:

  **Multi-Reference.** If the partner link is declared with sca-bpel:multiRefFrom="aVariableName" extension, the multiplicity of the SCA reference will be determined by the multiplicity attribute of sca-bpel:multiReference extension used in the corresponding variable. The multiplicity declaration of the variable which is either 0..n or 1..n. Details of these extensions are described in section 3.2.

  **Required Reference.** If not (1) and the partner link has initializePartnerRole="yes", then the multiplicity is 1..1 (i.e. it’s a required reference).

  **Stub Reference.** If not (1) or (2) and if the analysis of the process determines that the first use of the partner link by any activity is in an assign activity that sets the partner role, then the multiplicity is “0..1” and the attribute wiredByImpl is set to “true”. A reference with wiredByImpl="true" is referred to as a stub reference. Although the target can’t be set for such a reference, SCA can still apply bindings and policies to it and may need to set the endpoint address for callbacks, if the interface is bi-directional.

  **Optional Reference.** If not (1) or (2) or (3) then the multiplicity="0..1".

For both services and references, the name of the service or reference is the name partner link, when that name is unique (see the “Handling Local Partner Links” section below, for how to handle ambiguous cases).

**PartnerLinkTypes and SCA Interfaces**

When a partner link is determined to correspond to an SCA service, the type of the service is determined by the partner link type of the partner link. The role that the partner
link specified as myRole provides the WSDL port type of the service. If the partner link type has two roles, then the partnerRole provides the WSDL port type of the callback interface.

Consider an example that uses one of the partner link types used as an example in the WS-BPEL specification. The partner link type definition is:

Conversely, when a partner link is determined to correspond to an SCA reference, the role that the partner link specified as partnerRole provides the WSDL port type of the reference. If the partner link type has two roles, then the myRole provides the WSDL port type of the callback interface.

Specifying an SCA interface with a partnerLinkType

In the approach described above, the SCA definition of service and reference uses the <interface.wsdl> which restates the association between the interface and the callback interface that is already present in the WS-BPEL partnerLinkType. A partnerLinkType defines the relationship between two services by specifying roles the services play in the conversation. A partnerLinkType specifies at least one role.

For users that prefer this WS-BPEL element, it is also possible to define interfaces with an alternative partnerLinkType form of an interface type. This form does not provide any more information than is present in the <interface.wsdl> element. The example above would look like the following:

```
<interface.partnerLinkType type="lns:invoicingLT"
    serviceRole="invoiceService" />
```

The generic form of this interface type definition is as follows:

```
<interface.partnerLinkType type="xs:QName"
    serviceRole="xs:NCName" ? />
```

The type attribute is mandatory and references a partner link type. In case the partner link type has two roles, the optional attribute serviceRole MUST be used to specify which of the two roles is used as the interface. The other role is used as the callback. If the partnerLinkType has only one role, it cannot be a callback. Moreover, the serviceRole attribute MAY be omitted.

This form has a couple advantages over the interface.wsdl form. It is more concise. It also doesn’t restate the link between the interface and the callbackInterface, so with this form, the partnerLinkType could change the portType used to define one of the roles and all of the SCA componentTypes that use that partnerLinkType would remain accurate without having to also change the interface definitions for those componentTypes. This form also may be more familiar to some users.
Handling of Local PartnerLinks

It is possible to declare partnerLinks local to a `<scope>` in WS-BPEL, besides declaring partnerLinks at the `<process>` level. The names of partnerLink declared in different `<scope>` may potentially share the identical name. In case of this name sharing situation, the following scheme is used to disambiguate different occurrences of partnerLink declaration:

Suppose "originalName" is the original NCName used in multiple partnerLink declarations

When these partnerLinks are exposed to SCA assembly, these partnerLinks will given aliases from "_originalName_1" to "_originalName_N" regardless of how partnerLink participate in SCA assembly (i.e. services vs. references) and the number suffixes are based on the lexical order of the corresponding partnerLink occurrences in the process definition.

If any "_originalName_i" (where 1 <= i <= N) is already taken by existing partnerLink declaration in the process definition, additional underscore characters may be added at the beginning of all aliases consistently to avoid collision.

Support for conversational interfaces

WS-BPEL can be used to implement an SCA Component with conversational services. See the SCA Assembly Specification [SCA-Assembly] for a description of conversational interfaces. When an interface that has been marked as conversational is used for a role of a partner link, no other mechanism (such as the WS-BPEL correlation mechanism) is needed to correlate messages on that partner link, although it is still allowed. This means the SCA conversational interface is used as an implicit correlation mechanism to associate all messages exchanged (in either direction) on that partner link to a single conversation. When the EPR of the partnerRole is initialized a new conversation MUST be used for an operation of the conversational service. Any process which, through static analysis, can be proved to use an operation on a conversational interface after an `endsConversation` operation has completed SHOULD be rejected. In cases where the static analysis cannot determine that such a situation could occur, then at runtime a sca:ConversationViolation fault would be generated when using a conversational partner link after the conversation has ended. See the SCA Assembly Specification [SCA-Assembly], section 1.5.3 for a description of this fault.

It is important to point out that the WS-BPEL correlation mechanism is not restricted to a single partner link. It can be used to associate messages exchanged on different partner links to a particular WS-BPEL process instance.
<extension base="sca:Interface">
  <sequence>
  </sequence>
  <attribute name="serviceRole" type="NCName" use="optional" />
  <anyAttribute namespace="#any" processContents="lax" />
</extension>