Framework for EPR-Based SML Reference Schemes

W3C Working Group Note XX XXX 2008

This version:

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Previous versions:

Editor:
Kirk Wilson, CA, Inc.

Abstract

The Service Modeling Language [SML 1.1] specification extends XML and XML Schema with a mechanism for incorporating into XML documents references to other documents or document fragments. This technical note addresses the construction of SML reference schemes for document or document fragment references that employ WS-Addressing [WS-A] endpoint references (EPRs).

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This is the W3C Working Group Note "SML EPR Reference Scheme". This document was produced by the SML Working Group, as part of the XML Activity.

Please send comments related to this document to public-sml@w3.org (public archive list).

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This document is intended to serve as guidance for designing SML reference schemes that employ WS-Addressing [WS-A] endpoint references (EPRs).

Currently, this document is consistent with the [SML] 1.1 and [SML-IF] 1.1 specifications, but it may be obsoleted by future versions of these specifications.

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1. Introduction

The Service Modeling Language [SML] specification extends XML and XML Schema with a mechanism for incorporating into XML documents references to other documents or document fragments. A reference to another document or document fragment is encoded by means of markup compliant with one or more reference schemes. The SML specification defines one reference scheme, the SML URI Reference Scheme, which enables XML documents to use URIs to identify documents or document fragments. The SML URI Reference Scheme has the significant advantage of guaranteeing referential conformance of models that are exchanged between vendors (see [SML-IF section 5.1]).

However, not all documents or document fragments can be retrieved simply by means of a URI that may function as a URL. For example, the targeted document may be accessible only through a Web service endpoint. There are several protocols, each specifying its own message exchange pattern (MEP), that make documents and document fragments available through interaction with a Web service. These include (but are not limited to):

- WS-Transfer [WS-T] and WS-Management [WS-Man]
- WS-ResourceProperties [WS-RP] / Web Services Distributed Management [WSDM]
- CMDB Federation [CMDBf]

Other such services may be defined in the future. It is a common characteristic of these services that their endpoints must be addressed using endpoint references, EPRs, as defined in the WS-Addressing [WS-A] specification. Consequently, this note considers how SML reference schemes can use Web services endpoint references to refer to services that provide documents or document fragments through message exchanges.

The SML specification provides a mechanism to define other reference schemes beyond the SML URI Reference Scheme in order to accommodate special

purpose reference schemes as well as reference schemes that fall outside of the capabilities of URIs. The purpose of this Note is to propose a framework for defining SML reference schemes that accommodate references to documents accessed via EPRs.

EPRs cannot simply be placed in browsers and dereferenced to locate the target resource. Processors must know how to process a given EPR and this knowledge often involves knowing (1) the operations offered by the service and (2) the protocol required for invoking the targeted operation of the service. In this sense, the use of EPRs goes beyond the standard architecture of the Web. Therefore, use of the SML URI Reference Scheme is encouraged and remains the recommended approach for SML models. Nevertheless, it is recognized that in some cases model documents may be accessible only through a service that requires being addressed by means of an EPR. For further discussion of EPRs and interoperability, see [section 4.2].

2. Framework: Core Characteristics of EPR-Based Reference Schemes

This section proposes a set of characteristics, or framework, for EPR-based SML reference schemes. These characteristics are based on the Reference Scheme definition requirements of [SML 1.1, section 4.3].

2.1 Framework for SML EPR Reference Schemes

The following guidance is recommended for defining EPR-based SML reference schemes:

1. An SML reference element should be identified as an instance of an EPR-based reference scheme if and only if exactly one element information item whose [local name] is `EndpointReference` and whose [namespace name] is defined by a WS-Addressing specification (for example, `http://www.w3.org/2005/08/addressing`) is present as a child of the SML reference element.

2. An instance of an EPR-based SML reference scheme should be resolved by the SML validator by constructing the appropriate message to the service based on the provided EPR and any additional information it has or is provided about how to interact with the Web service endpoint. This additional information includes the signature of the operation that is to be invoked to access the targeted document or document fragment. This operation needs to be bound into a message to the service (e.g., a SOAP [SOAP] message) according the rules identified below (items a. through c.).

Note that to resolve an instance of an EPR-based SML reference scheme compliant with this framework, the SML validator must be a Web services client. If the validator does not have adequate information to construct the appropriate Web services request to the service providing access to the targeted document, then the EPR-based SML reference is unresolved.

The resolution process should conform to the following rules:

a. The Web service client should follow the appropriate binding rules for the EPR as specified in the WS-Addressing [WS-A] specification.

b. The appropriate binding rules for the operation (WSDL bindings [WSDL]) should be applied in constructing the request to the service.

c. The SML reference target [http://www.w3.org/TR/sml#target] should be the content or a child within the content of the service response message. If there is no response message returned by the service (as defined by the service protocol), then the SML reference is unresolved.

3. Since the URI/IRI in the wsa:Address element of the EPR identifies only an endpoint of a service and typically requires out-of-band knowledge to retrieve a document or document fragment from that endpoint, an EPR-based SML reference scheme does not use target-complete identifiers.

The preceding definition of the Framework Core (FC) is provided as non-normative. However, if this FC is adopted as the basis of defining EPR-based SML reference schemes (see [section 3.1]), then testing compliance with the framework would require the following changes to the language of the framework.

- All positive FC assertions, e.g. “should”, “is”, MUST be interpreted as requirements (MUSTs) in conformity with [RFC 2119].
- All negative FC assertions, e.g. “should not”, “is not”, MUST be interpreted as requirements (MUST NOTs) in conformity with [RFC 2119].
- All FC assertions of explicit variability, e.g. “may”, MUST be interpreted as explicit points of variability (implementation-defined) in conformity with [RFC 2119].

As noted in point 2 above, the additional knowledge that is required by a Web service client to resolve an instance of the SML EPR reference scheme framework may include knowledge of the operations supported by the service endpoint. Because the operations are typically not provided in the EPR itself, and the SML EPR reference scheme framework does not constrain these bindings, two otherwise equal EPRs associated with different service bindings could target different documents. Specific knowledge regarding the MEPs needed to interact with the service pointed to by the EPR may need to be made available to the SML model validator. See section 3.1 for a means by which such

knowledge may be made available through an EPR-based SML reference scheme.

2.2 Example of an SML EPR Reference Scheme

Consider the following (very) simple XML document:

```
<UniversityCourses xmlns="http://www.university.example.org/ns">
   <PHY101>
      . . .
   </PHY101>
   <PHY102>
      . . .
   </PHY102>
   . . .
</UniversityCourses>
```

This simple document will illustrate both the following example and the EPR-based SML reference scheme to be developed in [Section 3]. In the following example we will assume that each course entry is indexed by an xs:ID or xs:keyref, `CourseName`, whose value is the name of the element.

The following example illustrates how the `EnrolledCourse` SML reference that references a course, PHY101, can be represented using an EPR-based SML Reference Scheme that is compliant with the preceding framework:

```
<EnrolledCourse xmlns:sml="http://www.w3.org/sml/2007/02"
  sml:ref="true">
    <wsa:EndpointReference
            xmlns:wsa="http://www.w3.org/2005/08/addressing">
          <wsa:Address>http://www.university.example.org
                      ?CourseName=PHY101</wsa:Address>
    </wsa:EndpointReference>
</EnrolledCourse>
```

The service providing the university's list of courses is addressed by the URL `http://www.university.example.org`. In this case, the service endpoint expects to receive the identifier of the desired document fragment as a query component, `CourseName`, in the address. Access to the same content may require a different EPR-based SML reference scheme if the university's service interface involved a different means to target the desired fragment. For example, [section 3.2] provides another example of an SML reference using a totally different EPR-based SML reference scheme.

3. Using the Framework with Web Services Protocols

Because of the virtually unlimited latitude in specifying Web service interfaces for retrieving documents, EPR-based SML reference schemes may be defined with mechanisms to address the requirements of specific service protocols. For example, it may be desirable to include in the reference scheme definition a specific wsa:Action that the Web service client is to use in constructing the message to the service, or to provide a fragment identifier as a separate operation parameter in the form of a QName or XPath expression. In some cases, because of the service protocol, it may not be feasible to include this additional information within the `wsa:EndpointReference` element itself. The definition of a specific EPR reference scheme should use the Framework Core as its basis and may add several conditions for identifying an instance of the specific scheme.

3.1 An SML WS-ResourceFramework Reference Scheme

For example, let us assume that the course listing in the previous example ([Section 2.2]) is maintained by a WS-Resource conformant to the WS-ResourceFramework [WS-RF] specification, and each course is a resource property of this resource (an XML Schema is provided in [Section 3.2]). A definition of a specific SML WSRF Reference Scheme might proceed as follows:

SML WSRF Reference Scheme Definition:

- This reference scheme fully complies with the Framework Core (FC) defined in [Framework: Core Characteristics].
- An SML reference element is identified as an instance of the SML WSRF Reference Scheme if and only if it is identified as using the EPR Framework and it contains the following:
  - it has exactly one child element information item for which all of the following are true:
    - its [local name] is EndpointReference
    - its [namespace name] is http://www.w3.org/2005/08/addressing.
  - it has exactly one child element information item for which all of the following are true:
    - its [local name] is Action
    - its [namespace name] is http://www.w3.org/2005/08/addressing.
    - the content of this element must be a URI from the domain `docs.oasis-open.org/wsrf/` that represents a valid WS-ResourceProperties request operation.
  - it has at most one valid WSRF message request element for which all the following are true:
    - its [local name] corresponds to a WS-ResourceProperties operation element

239 - its [namespace name] is `http://docs.oasis-open.org/wsrf/rp-2`.
240
241 - the content of this element is a single QName or XPath expression.*
242
243 - Resolution of this reference scheme should conform with the following rules:
244
245 - The `EndpointReference` element is mapped to SOAP Header element(s) as specified in the WS-Addressing SOAP Binding specification [WS-A SOAP].
246
247
248 - The `Action` child element is mapped to a SOAP Header element with the same QName and content value
249
250 - The WSRF message request element, if present, is mapped to the SOAP Body element with the same QName and content value.
251
252 - The SML reference target is the content of the service response message. If there is no response message returned by the service, then the SML reference is unresolved.
253
254
255 - As a consequence of conforming to FC, and not placing additional constraints on the resolution process sufficient to make it fully deterministic in the absence of outside knowledge, this reference scheme does not use target-complete identifiers.
256
257
258

259 Note that this definition is not proposed as a normative definition of a WS-
260 ResourceFramework reference scheme; however, this lack of normative standing
261 should not be taken as precluding a similar definition being normatively defined.
262 [Section 4.1] will identify further components of this definition that are required to
263 insure that the reference scheme is interoperable.

264 3.2 WSRF Reference Scheme Example

265 This section illustrates the WSRF Reference Scheme defined in the preceding
266 section. For simplicity, we will use the same simple XML document introduced in
267 [section 2.2]. To conform to the WS-ResourceFramework, we assume that the
268 schema of this document is constructed in the following manner:

269

```
270 <?xml version="1.0" encoding="utf-8"?>
271 <xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
272 xmlns:tns=" http://www.university.example.org/ns "
273 targetNamespace=" http://www.university.example.org/ns ">
274
275   <xs:complexType name="CourseType">
```

* The WS-ResourceProperties GetResourcePropertyDocument operation does not require a message request element. The other WS-RP operations, GetResourceProperty, and QueryResourceProperties, require an appropriate element as the content of the SOAP Body. Note that the WS-ResourceProperties GetMultipleResourceProperties operation, which may retrieve multiple resource properties (elements), would, under conditions of normal usage, yield an invalid SML reference because it references multiple elements.

```
    <xs:sequence>
      . . .
    </xs:sequence>
  </xs:complexType>

  <xs:element name="PHY101" type="tns:CourseType"/>
  <xs:element name="PHY102" type="tns:CourseType"/>
   . . .
  <xs:element name="UniversityCourses">
    <xs:complexType>
      <xs:sequence>
        <xs:element ref="tns:PHY101"/>
        <xs:element ref="tns:PHY102"/>
        . . .
      </xs:sequence>
    </xs:complexType>
  </xs:element>

</xs:schema>
```

(NOTE: This example is not meant to imply that this is the best way to design the XML document or the schema for this kind of list; it is meant only as a means to enable both SML reference scheme examples to reference instance documents the same simple structure.)

To retrieve the `PHY101` element via the WSRF Reference Scheme, the WS-ResourceProperties `GetResourceProperty` operation may be used. This operation has a wsa:Action:

```
<wsa:Action>http://docs.oasis-open.org/wsrf/rpw-
2/GetResourceProperty/GetResourcePropertyRequest</wsa:Action>
```

The WS-ResourceProperties message request element specifies the QName of the targeted document fragment, which must be a Global Element Declaration (GED), as the content value of the element representing the operation:

```
  <wsrp:GetResourceProperty
        xmlns:wsrp="http://docs.oasis-open.org/wsrf/rp-2"
        xmlns:tns="http://www.university.example.org/ns">
     tns:PHY101
  </wsrp:GetResourceProeprty>
```

Thus, a functionally equivalent SML reference to the reference in [Section 2.2] (for an identifically structured XML instance document) could be specified with the WSRF Reference Scheme as follows:

```
<EnrolledCourse xmlns:sml="http://www.w3.org/sml/2007/02"
xmlns:wsrp="http://docs.oasis-open.org/wsrf/rp-2"
xmlns:wsa="http://www.w3.org/2005/08/addressing"
sml:ref="true">
  <wsa:EndpointReference>
    <wsa:Address>http://www.university.example.org</wsa:Address>
  </wsa:EndpointReference>
  <wsa:Action>http://docs.oasis-open.org/wsrf/rpw-
2/GetResourceProperty/GetResourcePropertyRequest</wsa:Action>
```

```
  <wsrp:GetResourceProperty
        xmlns:tns="http://www.university.example.org/ns">
     tns:PHY101
  </wsrp:GetResourceProeprty>
</EnrolledCourse>
```

WSRF Reference Scheme instances provide to the SML model validator three essential parts for constructing the message that is to be sent to the university course service: the EPR of the service, the `wsa:Action` that is bound into the SOAP Header, and the content of the SOAP Body. Note that knowledge of how to use the service bindings in constructing a SOAP message, for example, what component(s) should go into the SOAP Header and which into the SOAP Body, must be made available to the model consumer. This information is typically provided by the WSDL Binding for the service.

4. Interchange and Interoperability Considerations

4.1 Using EPR-Based SML Reference Schemes in SML-IF Documents

Interchanging SML models consisting of documents containing SML references that use EPR-based SML reference schemes requires special consideration. Interchange is performed by packaging the documents comprising an SML model into a single document as described in the [SML-IF] specification. In order to perform interchange set validation, the SML-IF validator must first look to validate any SML reference in terms of what is packaged in the SML-IF document itself. If validation fails from this perspective, SML-IF validators may choose to pursue the reference outside of the SML-IF document; however, given the complexity of de-referencing an EPR, SML-IF validators may be reluctant to do so.

In order to support this internal test of SML reference validity, the SML-IF specification introduces the notion of a document ***alias*** [SML-IF section 5.3.3]. For aliases to be usable in the context of SML-IF, an alias name (a URI) must be derivable from the reference scheme instance so that the validator can determine what document in the interchange set the reference scheme is intending to point to. Thus if an EPR-based SML reference scheme will be used in the context of SML-IF, the reference scheme definition should include a method for mapping each EPR to a predictable URI.

The following considerations pertain to the processing of SML references exposing EPR-based SML reference schemes in SML-IF documents by means of aliasing:

4.1.1 Document Aliases

Unless the EPR-based SML reference scheme is sufficiently constrained to make use of target-complete identifiers, which is unlikely for EPRs, its wsa:`Address` cannot be used as an SML-IF document alias. Nevertheless, the referenced document may be embedded in the SML-IF document. If maintaining the fidelity

of these links during interchange is necessary, several alternatives are available, including but not limited to:

1. For each EPR-based SML reference scheme of an SML reference, the SML-IF producer adds a second reference scheme instance understood by the receiving SML-IF consumer. This second reference could use a URI that does not follow the SML-IF rules for resolving target-complete identifiers, see [SML-IF, section 5.3.4]. That is, the URI would fall into "category 3" discussed in that section. Note that the identifier value must be generated dynamically from the information given in the EPR reference scheme instance. Care must be taken to avoid collisions, since SML-IF allows document aliases to be preserved across multiple interchanges.

2. An EPR-based SML reference scheme definition can specify an algorithm for generating target-complete identifiers for the purpose of SML-IF URI reference processing as described in [SML-IF section 5.3.4].

Using the first case as an example, the SML-IF document producer generates a reference scheme instance based on information in the given instance of the EPR reference scheme that is sufficient to uniquely identify the target document or document fragment within the interchange model. Thus, this scheme specifies a document alias. For example, the SML reference from the example in [section 3.2] may have a generated reference scheme with an algorithmically generated identifier as shown in the following (bolded in the following code):

```
<EnrolledCourse xmlns:sml="http://www.w3.org/sml/2007/02"
xmlns:wsrp="http://docs.oasis-open.org/wsrf/rp-2"
xmlns:wsa="http://www.w3.org/2005/08/addressing"
sml:ref="true">
  <wsa:EndpointReference>
    <wsa:Address>http://www.university.example.org</wsa:Address>
  </wsa:EndpointReference>
  <wsa:Action>http://docs.oasis-open.org/wsrf/rpw-
2/GetResourceProperty/GetResourcePropertyRequest</wsa:Action>
  <wsrp:GetResourceProperty
        xmlns:tns="http://www.university.example.org/ns">
     tns:PHY101
  </wsrp:GetResourceProeprty>
  <newScheme:generatedWSRFIdentifier
          xmlns:newScheme="http://www...myNewScheme_namespace...">
          xmlns:tns="http://www.university.example.org/ns">
      http://www.university.example.org?GetResourceProperty=tns:PHY101
  </newScheme:generatedWSRFIdentifier
</EnrolledCourse>
```

(It is left as an exercise for the reader to trace through the algorithmic steps by which the URI in the newScheme instance can be generated from the preceding EPR Reference Scheme instance. Obviously, the schema declaration of `<EnrolledCourse>` must allow additional elements.)

This new reference scheme targets the document independently of how the document is made available through the Web service targeted by the preceding EPR Reference Scheme. The alias for this reference would be:

```
<alias>
    http://www.university.example.org?GetResourceProperty=tns:PHY101
</alias>
```

Moreover, the process by which the identifier is resolved to the targeted document within the SML-IF document must be defined in the reference scheme definition similar to way the resolution process for target-complete URI references is defined in [SML-IF section 5.3.4]. (This resolution algorithm is also left as an exercise for the reader.)

NOTE: While the SML-IF consumer may recognize the reference scheme added by the SML-IF producer, we assume that the reference scheme will NOT be recognized by the SML model processor; thus the SML model processor will not attempt to resolve it. Should the SML model processor recognize the reference scheme (e.g., if the SML URI Reference Scheme is used to contain the document alias URI) and should the SML model processor attempt to resolve it by normal processing for that reference scheme, the reference may fail. Implementations may take steps to prevent this failure.

If the targeted service exposes only the targeted document, or, more precisely, the `address`-element of the EPR uniquely identifies the target document within the service, it may be possible to utilize the second strategy above and generate a target-complete identifier to both identify and serve as a document alias to the document or document fragment in the SML-IF document. For example, if the university.example service above fulfills the condition of exposing only that one document, a target-complete identifier in the preceding example might be:

```
http://www.university.example.org#smlxpath1(/u:UniverstiyCourses/u:
PHY101)
```

where "`UniversityCourses`" is the root element of the document and "`u`" represents the `http://www.university.example.org/ns` namespace. It is not expected that EPR-based SML reference schemes will typically be able to support a target-complete identifier.

4.1.2 Document Locators

EPRs as values of the SML-IF `<document>/<locator>` element are subject to the same semantic and processing requirements as are EPR-based reference schemes. EPR document/locators should be avoided if wide interoperability is desired.

4.2 Interoperability

Because EPR-based SML reference schemes cannot in general be represented by SML URI Reference schemes, an SML-IF document containing EPR-based reference schemes cannot typically be referentially conforming as defined by [SML-IF section 5.1]. However, the two mechanisms defined in [section 4.1.1] for generating aliases within the SML-IF document partially address interoperability issues at the level of the SML-IF document.[**]

Definitions of EPR-based SML reference schemes should be sufficiently rigorous to support model interoperability amongst those vendors who agree to use a specific EPR-based reference scheme.

5. Summary

The following points summarize the issues that should be considered when defining an EPR-based SML reference scheme.

1. Consideration should be given to using the Framework Core described in [section 2] and to adopting it as normative.

2. Consideration should be given to the operations and their parameters offered by the service interface through which the document or document fragment is accessed. The critical issue in defining an EPR-based SML reference scheme is how much of this special knowledge should be captured in the EPR-based SML reference scheme itself and how much might be otherwise made available to the model consumer.

3. If the EPR-based SML reference scheme will be used in the context of an SML-IF document, then a method for supporting SML-IF document aliases should be defined as part of the reference scheme definition. This note explored several strategies by which this issue could be addressed. These strategies involve:

    1. Defining an algorithm for generating a reference scheme using a URI identifier with an explicitly stated resolution process, so that targeted documents can be identified within the SML-IF document by SML-IF aliasing mechanism, or
    2. Defining an algorithm for generating a target-complete URI reference scheme so that the alias can be resolved by the mandated process for resolving SML URI Reference Schemes.

[**] Other considerations related to interoperability exist even if the reference schemes may be defined with sufficient rigor to insure interoperability amongst those who adopt the reference scheme. These other issues include whether model documents are embedded or included by reference only in the SML-IF document and whether the SML-IF document is schema-complete. These issues lie beyond the scope of this Note. For further discussion, see [SML-IF, section 4.5].

6. References

RFC 2119

This RFC is available at http://www.ietf.org/rfc/rfc2119.txt.

RFC 3986

Uniform Resource Identifiers (URI): Generic Syntax, T. Berners-Lee, R. Fielding and L. Masinter, Editors. IETF, January 2005. *Obsoletes: RFC 2396, RFC 2732*. This RFC is available at http://www.ietf.org/rfc/rfc3986.txt.

SML

Service Modeling Language, Version 1.1, Bhalchandra Pandit, Valentina Popescu, Virginia Smith, Editors. World Wide Web Consortium, @@ @@@@ @@@@. This version of the Service Modeling Language specification is available at http://www.w3.org/TR/@@@@/WD-sml-@@@@@@@@/. The latest version of Service Modeling Language, Version 1.1 is available at http://www.w3.org/TR/sml.

SML-IF

To be Completed

WS-A

To be Completed

WS-A SOAP

To be Completed http://www.w3.org/TR/ws-addr-soap

3.2 Informative References

CMDBf

To be Completed (reference to CMDBf white paper)

SOAP

SOAP Version 1.2 Part 1: Messaging Framework (Second Edition), Martin Gudgin, Marc Hadley, Noah Mendelsohn, Jean-Jacques Moreau, Henrik Frystyk Nielsen, Anish Karmarkar, Yves Lafon, Editors. World Wide Web Consortium, 27 April 2007. This version is http://www.w3.org/TR/2007/REC-soap12-part1-20070427/. The latest version is available at http://www.w3.org/TR/soap12-part1/.

Web Arch

To be completed

WSDM

To be completed

WS-Man

To be completed

WS-RF

To be Completed

WS-RP

To be Completed

WS-T

To be Completed

WSDL

548 To be Completed
549

550 7. Acknowledgments

551 This note is based on based on input from the members of the SML Working
552 Group, particularly John Arwe (IBM).
553