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Abstract:

This specification defines a binding for SOAP envelopes to use datagrams.

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1 Introduction

Many application protocol patterns match the semantics of the User Datagram Protocol (UDP) [RFC 768]. Some do not require the delivery guarantees of TCP while others make use of multicast transmission. In order to allow Web services to support these patterns, we need a way to map SOAP envelopes to user datagrams. This support is essential for services using WS-Discovery, where the use of multicast and need for low connection overhead makes UDP a natural choice. It is anticipated that other protocols will have similar requirements. This specification defines a binding of SOAP to user datagrams, including message patterns, addressing requirements, and security considerations.

1.1 Requirements

This specification intends to meet the following requirements:

- Support a one-way message-exchange pattern (MEP) where a SOAP envelope is carried in a user datagram.
- Support a request-response message-exchange pattern (MEP) where SOAP envelopes are carried in user datagrams.
- Support multicast transmission of SOAP envelopes carried in user datagrams.

Support both SOAP 1.1 [SOAP 1.1] and SOAP 1.2 [SOAP 1.2 Part 1] Envelopes.

1.2 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 [RFC 2119].

1.2.1 Notational Conventions

This specification uses the following syntax to define normative outlines for messages:

The syntax appears as an XML instance, but values in *italics* indicate data types instead of literal values.

Characters are appended to elements and attributes to indicate cardinality:

- “?” (0 or 1)
- “*” (0 or more)
- “+” (1 or more)
- The character “|” is used to indicate a choice between alternatives.
- The characters “[” and “]” are used to indicate that contained items are to be treated as a group with respect to cardinality or choice.
- Ellipses (i.e., “...”) indicate points of extensibility. Additional children and/or attributes MAY be added at the indicated extension points but MUST NOT contradict the semantics of the parent and/or owner, respectively. If a receiver does not recognize an extension, the receiver SHOULD ignore the extension.
- XML namespace prefixes (see Table 1) are used to indicate the namespace of the element being defined.

Elsewhere in this specification, the characters “[” and “]” are used to call out references and property names. This specification uses the **[action]** and Fault properties [WS-Addressing] to define faults.

1.2.2 Terms and Definitions

Defined below are the basic definitions for the terms used in this specification.

Receiver

The endpoint terminating a SOAP/UDP datagram

Sender

The endpoint originating a SOAP/UDP datagram

SOAP/UDP datagram

A user datagram containing a SOAP envelope in the data octets

User datagram

A User Datagram Protocol (UDP) packet

1.3 XML Namespaces

The following lists XML namespaces that are used in this specification. The choice of any namespace prefix is arbitrary and not semantically significant.

Table 1. Prefix and XML namespaces used in this specification

| Prefix | XML Namespace | Specification(s) |
|--------|---------------------------------------------------------------------------------------------------|--------------------------|
| s | (Either SOAP 1.1 or 1.2) | (Either SOAP 1.1 or 1.2) |
| s11 | http://schemas.xmlsoap.org/soap/envelope/ | [SOAP 1.1] |
| s12 | http://www.w3.org/2003/05/soap-envelope | [SOAP 1.2 Part 1] |
| a | http://www.w3.org/2005/08/addressing | [WS-Addressing] |

1.4 Relationship to Web Service Specifications

This specification provides a binding appropriate for:

- SOAP 1.1 [SOAP 1.1]
- SOAP 1.2 [SOAP 1.2 Part 1]

Messages conforming to either SOAP specification can use this binding. This specification relies on WS-Addressing [WS-Addressing].

1.5 Normative References

[RFC 768]

J. Postel, "User Datagram Protocol," RFC 768, <http://www.ietf.org/rfc/rfc768.txt>, August 1980.

[RFC 2119]

S. Bradner, "Key words for use in RFCs to Indicate Requirement Levels," RFC 2119, <http://www.ietf.org/rfc/rfc2119.txt>, March 1997.

[RFC 2365]

D. Meyer, "Administratively Scoped IP Multicast," RFC 2365, <http://www.ietf.org/rfc/rfc2365.txt>, July 1998.

[RFC 3986]

T. Berners-Lee, et al, "Uniform Resource Identifiers (URI): Generic Syntax", IETF RFC 3986, <http://www.ietf.org/rfc/rfc3986.txt>, January 2005.

71 **[RFC 791]**
72 "Internet Protocol (IPv4)", IETF [RFC 791](http://www.ietf.org/rfc/rfc791.txt), <http://www.ietf.org/rfc/rfc791.txt>, September 1981.

73 **[RFC 2460]**
74 S. Deering, et al, "Internet Protocol, Version 6 (IPv6) Specification", IETF [RFC 2460](http://www.ietf.org/rfc/rfc2460.txt),
75 <http://www.ietf.org/rfc/rfc2460.txt>, December 1998.

76 **[SOAP 1.1]**
77 W3C Note, "[Simple Object Access Protocol \(SOAP\) 1.1](http://www.w3.org/TR/2000/NOTE-SOAP-20000508)", [http://www.w3.org/TR/2000/NOTE-](http://www.w3.org/TR/2000/NOTE-SOAP-20000508)
78 [SOAP-20000508](http://www.w3.org/TR/2000/NOTE-SOAP-20000508), 08 May 2000.

79 **[SOAP 1.2 Part 1]**
80 W3C Recommendation, "[SOAP Version 1.2 Part 1: Messaging Framework \(Second Edition\)](http://www.w3.org/TR/2007/REC-soap12-part1-20070427)",
81 <http://www.w3.org/TR/2007/REC-soap12-part1-20070427>, April 2007.

82 **[WS-Addressing]**
83 W3C Recommendation, "[Web Services Addressing 1.0 - Core](http://www.w3.org/TR/2006/REC-ws-addr-core-20060509)", [http://www.w3.org/TR/2006/REC-](http://www.w3.org/TR/2006/REC-ws-addr-core-20060509)
84 [ws-addr-core-20060509](http://www.w3.org/TR/2006/REC-ws-addr-core-20060509), 9 May 2006.

85 **[WS-Security]**
86 OASIS Standard, "[Web Services Security Core specification 1.1](http://www.oasis-open.org/committees/download.php/16790/wss-v1.1-spec-os-SOAPMessageSecurity.pdf)", [http://www.oasis-](http://www.oasis-open.org/committees/download.php/16790/wss-v1.1-spec-os-SOAPMessageSecurity.pdf)
87 [open.org/committees/download.php/16790/wss-v1.1-spec-os-SOAPMessageSecurity.pdf](http://www.oasis-open.org/committees/download.php/16790/wss-v1.1-spec-os-SOAPMessageSecurity.pdf),
88 February 2006.

89 **[XML 1.0]**
90 W3C Recommendation, "[Extensible Markup Language \(XML\) 1.0 \(Fourth Edition\)](http://www.w3.org/TR/2006/REC-xml-20060816)",
91 <http://www.w3.org/TR/2006/REC-xml-20060816>, 16 August 2006.

2 UDP Packet

Except as noted explicitly below, this specification does not constrain RFC 768 [RFC 768].

2.1 Source Address and Port

For security reasons, the source address MUST be supplied at the IP packet level and MUST be the IPv4 [RFC 791] address (including but not limited to unicast, multicast, and broadcast addresses) or IPv6 [RFC 2460] address (including but not limited to unicast and multicast addresses) of the sender; the receiver SHOULD reject IP packets containing a SOAP/UDP datagram that have inappropriate values for the source address.

2.2 Data Octets

The data octets MUST contain a SOAP envelope [SOAP 1.1] [SOAP 1.2 Part 1]. The SOAP envelope MUST fit within a single datagram, that is, it MUST be small enough that the overall datagram is less than 65,536 (2^{16}) octets.

The SOAP envelope MUST use the mechanisms defined in WS-Addressing [WS-Addressing].

3 Message Patterns

This specification supports the following message patterns:

- Unicast one-way
- Multicast one-way
- Unicast request, unicast response
- Multicast request, unicast response

as detailed in the rest of this section.

This specification uses the constructs **[action]**, **[destination]**, **[message id]**, **[reply endpoint]**, **[address]** in WS-Addressing [\[WS-Addressing\]](#). SOAP messages transmitted over UDP MUST have a **[message id]** property.

3.1 One-way

The one-way message is sent in a user datagram.

3.1.1 One-way Example

```
(01) <s:Envelope xmlns:s="http://www.w3.org/2003/05/soap-envelope"
(02)           xmlns:a="http://www.w3.org/2005/08/addressing">
(03)   <s:Header>
(04)     <a:To>http://fabrikam.com/Server</a:To>
(05)     <a:Action>http://fabrikam.com/Probe</a:Action>
(06)     <a:MessageID>
(07)       urn:uuid:1da72f1a-5546-493c-934c-a9e3577e206a
(08)     </a:MessageID>
(09)   </s:Header>
(10)   <s:Body>
(11)     ...
(12)   </s:Body>
(13) </s:Envelope>
```

This example shows a one-way SOAP message. Lines 01-03 are standard SOAP elements. Lines 04-08 specify various WS-Addressing headers. Note that despite the fact that the **[destination]** for the message is specified using a URI that uses the http scheme, the message is still transmitted over UDP. Lines 09-13 show standard SOAP elements.

3.2 Request-response

The request message is sent in one user datagram and the corresponding response message is sent in another user datagram.

3.2.1 Anonymous **[reply endpoint]**

WS-Addressing defines a URI, "http://www.w3.org/2005/08/addressing/anonymous", that can appear in the **[address]** property of an endpoint reference. If the **[reply endpoint]** property of a SOAP message transmitted over UDP has an **[address]** property with this value, the UDP source address (and source port) is considered to be the address to which reply messages should be sent.

The implied value of the **[reply endpoint]** property for SOAP messages transmitted over UDP is an endpoint reference with an **[address]** property whose value is "http://www.w3.org/2005/08/addressing/anonymous".

3.2.2 Request Example 1

```
(01) <s:Envelope xmlns:s="http://www.w3.org/2003/05/soap-envelope"  
(02)      xmlns:a="http://www.w3.org/2005/08/addressing">  
(03)   <s:Header>  
(04)     <a:To>http://fabrikam.com/Server</a:To>  
(05)     <a:Action>http://fabrikam.com/Probe</a:Action>  
(06)     <a:MessageID>  
(07)       urn:uuid:9ceada16-2403-4404-a8cc-60799acd9d1c  
(08)     </a:MessageID>  
(09)     <a:ReplyTo>  
(10)       <a:Address>  
(11)         http://www.w3.org/2005/08/addressing/anonymous  
(12)       </a:Address>  
(13)     </a:ReplyTo>  
(14)   </s:Header>  
(15)   <s:Body>  
(16)     ...  
(17)   </s:Body>  
(18) </s:Envelope>
```

This example shows a request SOAP message. Lines 01-03 are standard SOAP elements. Lines 04-13 specify various WS-Addressing headers. Note that despite the fact that the **[destination]** for the message is specified using a URI that uses the http scheme, the message is still transmitted over UDP. Line 09 shows a **[reply endpoint]** header specifying the anonymous URI (see Section 3.2.1). Lines 14-18 show standard SOAP elements.

3.2.3 Response Example 1

```
(01) <s:Envelope xmlns:s="http://www.w3.org/2003/05/soap-envelope"  
(02)      xmlns:a="http://www.w3.org/2005/08/addressing">  
(03)   <s:Header>  
(04)     <a:To>  
(05)       http://www.w3.org/2005/08/addressing/anonymous  
(06)     </a:To>  
(07)     <a:Action>http://fabrikam.com/ProbeMatch</a:Action>  
(08)     <a:MessageID>  
(09)       urn:uuid:5a6ed11a-7a80-409a-82bf-43c4c5092911  
(10)     </a:MessageID>  
(11)     <a:RelatesTo>  
(12)       urn:uuid:9ceada16-2403-4404-a8cc-60799acd9d1c  
(13)     </a:RelatesTo>  
(14)   </s:Header>  
(15)   <s:Body>  
(16)     ...  
(17)   </s:Body>  
(18) </s:Envelope>
```

This example shows a response SOAP message. Lines 01-03 are standard SOAP elements. Lines 04-13 specify various WS-Addressing headers. Note that the **[destination]** for the message is specified as the anonymous URI. Line 11 shows a **[relationship]** header indicating that this message is a reply to the example message in Section 3.2.2. Lines 14-18 show standard SOAP elements.

3.2.4 Request Example 2

```
(01) <s:Envelope xmlns:s="http://www.w3.org/2003/05/soap-envelope"  
(02)      xmlns:a="http://www.w3.org/2005/08/addressing" >  
(03)   <s:Header>  
(04)     <a:To>soap.udp://fabrikam1.com:54321/Server</a:To>  
(05)     <a:Action>http://fabrikam1.com/Probe</a:Action>  
(06)     <a:MessageID>  
(07)       urn:uuid:9ceada16-2403-4404-a8cc-60799acd9d1c
```

```

201 (08)    </a:MessageID>
202 (09)    <a:ReplyTo>
203 (10)    <a:Address>
204 (11)    soap.udp://fabrikam2.com:54322/Client
205 (12)    </a:Address>
206 (13)    </a:ReplyTo>
207 (14)    </s:Header>
208 (15)    <s:Body>
209 (16)    ...
210 (17)    </s:Body>
211 (18) </s:Envelope>

```

212 This example shows a request SOAP message. Lines 01-03 are standard SOAP elements. Lines 04-13
 213 specify various WS-Addressing headers. Note that the **[destination]** for the message is specified using a
 214 URI that uses the soap.udp scheme. Line 09 shows a **[reply endpoint]** header containing an
 215 addressable URI that uses the soap.udp scheme. Lines 14-18 show standard SOAP elements.

216 3.2.5 Response Example 2

```

217 (01) <s:Envelope xmlns:s="http://www.w3.org/2003/05/soap-envelope"
218 (02)    xmlns:a="http://www.w3.org/2005/08/addressing">
219 (03)    <s:Header>
220 (04)    <a:To>
221 (05)    soap.udp://fabrikam2.com:54322/Client
222 (06)    </a:To>
223 (07)    <a:Action>http://fabrikam.com/ProbeMatch</a:Action>
224 (08)    <a:MessageID>
225 (09)    urn:uuid:5a6ed11a-7a80-409a-82bf-43c4c5092911
226 (10)    </a:MessageID>
227 (11)    <a:RelatesTo>
228 (12)    urn:uuid:9ceada16-2403-4404-a8cc-60799acd9d1c
229 (13)    </a:RelatesTo>
230 (14)    </s:Header>
231 (15)    <s:Body>
232 (16)    ...
233 (17)    </s:Body>
234 (18) </s:Envelope>

```

235 This example shows a response SOAP message. Lines 01-03 are standard SOAP elements. Lines 04-13
 236 specify various WS-Addressing headers. Note that the **[destination]** for the message contains an
 237 addressable URI that uses the soap.udp scheme. Line 11 shows a **[relationship]** header indicating that
 238 this message is a reply to the example message in Section 3.2.4. Lines 14-18 show standard SOAP
 239 elements.

240 3.3 Multicast

241 The message patterns defined above can be used with unicast or multicast transmission of UDP
 242 datagrams with the following restriction: The response in a request-response message pattern **MUST**
 243 **NOT** be multicast.

244 Note that in the case of a multicast request, unicast response MEP, the sender of the request might
 245 receive multiple responses.

246 Multicast SOAP/UDP datagrams **SHOULD** be scoped to ensure they are not forwarded beyond the
 247 boundaries of the administrative system. For IPv4, this can be done with either time-to-live (TTL) field or
 248 administrative scopes [\[RFC 2365\]](#) depending on what is implemented in the network. For IPv6, this can
 249 be done by setting the hop-limit field. If either IPv4 TTL or IPv6 hop-limit is used, it is **RECOMMENDED**
 250 that its value be set to 1.

251 The destination IP address of a multicast message **MUST** be a multicast group.

252 3.4 Retransmission

253 To avoid repeated packet collisions, any retransmission implementation SHOULD observe good practices
254 such as using exponential back-off algorithms and spreading. An implementation MAY use the algorithm
255 defined in Appendix A. For each transmission of such a message, the value of the **[message id]** property
256 MUST be the same.

257 4 Message Encoding

258 The algorithm defined in Appendix F of XML 1.0 [[XML 1.0](#)] SHOULD be used to determine whether a
259 message is encoded as XML. If use of said algorithm does not result in an XML serialization, the
260 encoding is undefined.

5 URI Scheme

This section defines a URI scheme for UDP endpoints. The scheme allows hostname and port to be specified. Resolving such a URI provides the information needed to send messages to a UDP endpoint per the protocol defined in this document.

5.1 Syntax

The syntax of the URI scheme is as follows:

```
soap.udp://<host>:<port>[/<rel_path>][?<query>]
```

The syntax and interpretation of the host, port, rel_path and query portions is as defined in RFC 3986 [[RFC 3986](#)].

5.2 Semantics

The semantics of resolving a soap.udp URI are as follows:

1. Use the port portion as the port number.
2. Resolve the host portion to an IP address.
3. Using the message protocol defined in this document, send a message to the IP address determined in step 2 using the port number determined in step 1.

6 Security Considerations

It is recommended that all messages be secured using the mechanisms described in [\[WS-Security\]](#) to prevent tampering or falsification.

All critical headers, such as those described in [\[WS-Addressing\]](#), and the message body, need to be included in signatures to bind all parts of the message together.

Recipients **SHOULD** verify that the sender has the right to speak for the specified source or response location (if one is provided).

Messages **SHOULD** be accepted and processed only from trusted sources (either directly trusted or indirectly trusted via third parties).

The UDP packet size introduces a challenge for secure messages due to its limited size. For this reason it is recommended that security tokens not be passed but referenced using the Key Identifier mechanisms described in [\[WS-Security\]](#).

SOAP messages containing a **[reply endpoint]** property transmitted over UDP **MAY** be rejected by a recipient due to security concerns such as distributed denial-of-service attacks.

290

7 Conformance

291

A conformant implementation MUST satisfy all the MUST or REQUIRED level requirements defined herein.

292

Appendix A. Example retransmission algorithm (non-normative)

Constants referenced within the algorithm are defined in Table 2 (for unicast messages) and Table 3 (for unreliable multicast messages). The value of those constants (as defined in Table 2 and Table 3) is non-normative. Implementations and other specifications MAY override the value of those constants.

Retry and back-off algorithm.

1. Transmit;
2. if *_UDP_REPEAT <= 0 go to Step 11;
3. else *_UDP_REPEAT--;
4. Generate a random number T in [UDP_MIN_DELAY .. UDP_MAX_DELAY];
5. Wait T milliseconds;
6. Retransmit;
7. if *_UDP_REPEAT <= 0 goto Step 11;
8. else *_UDP_REPEAT--;
9. $T = T * 2$; If $T > \text{UDP_UPPER_DELAY}$ then $T = \text{UDP_UPPER_DELAY}$;
10. go to 5;
11. Done.

Table 2. Protocol retry and back-off constants for unicast messages

| Constant / Message | Value |
|--------------------|-------|
| UNICAST_UDP_REPEAT | 1 |
| UDP_MIN_DELAY | 50 |
| UDP_MAX_DELAY | 250 |
| UDP_UPPER_DELAY | 500 |

Table 3. Protocol retry and back-off constants for unreliable multicast messages

| Constant / Message | Value |
|----------------------|-------|
| MULTICAST_UDP_REPEAT | 2 |
| UDP_MIN_DELAY | 50 |
| UDP_MAX_DELAY | 250 |
| UDP_UPPER_DELAY | 500 |

Appendix B. Example duplicate detection mechanisms (non-normative)

A receiver keeps a list of the last n messages received along with the **[message id]** property [\[WS-Addressing\]](#) associated with each message. When a new (non-duplicate) message arrives, the oldest message is removed from the list.

A receiver tracks all messages received in the last x milliseconds along with the **[message id]** property [\[WS-Addressing\]](#) associated with each message. Messages received more than x milliseconds ago are removed from the list.

For both approaches any message arriving with a **[message id]** property identical to one of those the receiver has in its list is a duplicate. Messages with unique values for the **[message id]** property are not duplicates.

The timestamp specified in the Security header block [\[WS-Security\]](#) MAY be used to limit the duration for which **[message id]** properties need to be remembered.

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Appendix D. Revision History

[optional; should not be included in OASIS Standards]

| Revision | Date | Editor | Changes Made |
|----------|--------------------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| wd-01 | September 16, 2008 | Ram Jeyaraman | Created the initial working draft by converting the input specification to OASIS template. |
| wd-02 | September 29, 2008 | Ram Jeyaraman | Updated document identifier, added co-chair and editor names, use of urn:uuid (issue 50) in examples. |
| wd-03 | January 15, 2009 | Ram Jeyaraman | Created working draft 03 by applying the proposed resolutions of the following issues to CD-01 version: 116 - Update references and related changes 136 - SOAP-over-UDP - UNICAST_UDP_REPEAT and MULTICAST_UDP_REPEAT constant values Updated copyright year to 2009. Appendix C (Acknowledgements). Included a list of TC participants. |
| wd-04 | February 09, 2009 | Ram Jeyaraman | Editorial corrections: Converted citations to hyperlinks, fixed links to tables, fixed Appendix heading. |
| wd-05 | April 09, 2009 | Ram Jeyaraman | Updates to Appendix C (Acknowledgements). Changes resulting from issue pr007. |