

SOAP-over-UDP Version 1.1

Committee Draft 01

27 January 2009

Specification URIs:

This Version:

<http://docs.oasis-open.org/ws-dd/soapoverudp/1.1/cd-01/wsdd-soapoverudp-1.1-spec-cd-01.html>

<http://docs.oasis-open.org/ws-dd/soapoverudp/1.1/cd-01/wsdd-soapoverudp-1.1-spec-cd-01.docx> (Authoritative Format)

<http://docs.oasis-open.org/ws-dd/soapoverudp/1.1/cd-01/wsdd-soapoverudp-1.1-spec-cd-01.pdf>

Previous Version:

N/A

Latest Version:

<http://docs.oasis-open.org/ws-dd/soapoverudp/1.1/wsdd-soapoverudp-1.1-spec.html>

<http://docs.oasis-open.org/ws-dd/soapoverudp/1.1/wsdd-soapoverudp-1.1-spec.docx>

<http://docs.oasis-open.org/ws-dd/soapoverudp/1.1/wsdd-soapoverudp-1.1-spec.pdf>

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None.

Abstract:

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

Status:

This document was last revised or approved by the WS-DD TC on the above date. The level of approval is also listed above. Check the “Latest Version” or “Latest Approved Version” location noted above for possible later revisions of this document.

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# 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.

## 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.

## Notational Conventions

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].

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 ) 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.

## Terminology

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

## 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 : 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](#SOAP11)] |
| s12 | <http://www.w3.org/2003/05/soap-envelope> | [[SOAP 1.2](#SOAP12Part1)] |
| a | <http://schemas.xmlsoap.org/ws/2004/08/addressing> | [[WS-Addressing](#WSAddressing)] |
| wsse | <http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-secext-1.0.xsd> | [[WS-Security](#WSSecurity)] |

## 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].

## 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 2396]

T. Berners-Lee, et al, "Uniform Resource Identifiers (URI): Generic Syntax," [RFC 2396](http://www.ietf.org/rfc/rfc2396.txt), August 1998.

[SOAP 1.1]

D. Box, et al, "[Simple Object Access Protocol (SOAP) 1.1](http://www.w3.org/TR/2000/NOTE-SOAP-20000508/)," May 2000.

[SOAP 1.2 Part 1]

M. Gudgin, et al, "[SOAP Version 1.2 Part 1: Messaging Framework](http://www.w3.org/TR/2003/REC-soap12-part1-20030624/)," June 2003.

[WS-Addressing]

D. Box, et al, "[Web Services Addressing (WS-Addressing)](http://www.w3.org/Submission/2004/SUBM-ws-addressing-20040810/)," August 2004.

[WS-Security]

A. Nadalin, et al, "[Web Services Security: SOAP Message Security V1.0](http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-soap-message-security-1.0.pdf)," March 2004.

 [XML 1.0]

T. Bray, et al, "[Extensible Markup Language (XML) 1.0 (Second Edition)](http://www.w3.org/TR/2000/REC-xml-20001006)," October 2000.

# UDP Packet

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

## Source Address and Port

For security reasons, the source address MUST be supplied at the UDP packet level and MUST be the IPv4 or IPv6 address of the sender; the receiver SHOULD reject SOAP/UDP datagrams that have inappropriate values for the source address.

A source port MAY be specified. If a source port is not specified then the source port is assumed to be the default port for the SOAP-over-UDP protocol.

## 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].

# 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.

## One-way

This specification uses the constructs in WS-Addressing for one-way messages. The one-way message is sent in a user datagram.

### One-way Example

(001) <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"

 xmlns:wsa="http://schemas.xmlsoap.org/ws/2004/08/addressing" >

(002) <S:Header>

(003) <wsa:To>http://fabrikam.com/Server</wsa:To>

(004) <wsa:Action>http://fabrikam.com/Probe</wsa:Action>

(005) <wsa:MessageId>

 urn:uuid:1da72f1a-5546-493c-934c-a9e3577e206a

 </wsa:MessageId>

(006) </S:Header>

(007) <S:Body>

(008) ...

(009) </S:Body>

(010) </S:Envelope>

This example shows a one-way SOAP message. Lines 001-002 are standard SOAP elements. Lines 003-005 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 006-010 show standard SOAP elements.

## Request-response

This specification uses the constructs in WS-Addressing for request and response messages. The request message is sent in one user datagram, response messages are sent in separate user datagrams.

### Anonymous [reply endpoint]

WS-Addressing defines a URI, "http://schemas.xmlsoap.org/ws/2004/08/addressing/role/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://schemas.xmlsoap.org/ws/2004/08/addressing/role/anonymous".

### Request Example

(001) <S:Envelope xmlns:S=http://www.w3.org/2003/05/soap-envelope
 xmlns:wsa="http://schemas.xmlsoap.org/ws/2004/08/addressing" >

(002) <S:Header>

(003) <wsa:To>http://fabrikam.com/Server</wsa:To>

(004) <wsa:Action>http://fabrikam.com/Probe</wsa:Action>

(005) <wsa:MessageId>

 urn:uuid:9ceada16-2403-4404-a8cc-60799acd9d1c

 </wsa:MessageId>

(006) <wsa:ReplyTo>

 <wsa:Address>

 http://schemas.xmlsoap.org/ws/2004/08/addressing/role/anonymous

 </wsa:Address>

 </wsa:ReplyTo>

(007) </S:Header>

(008) <S:Body>

(009) ...

(010) </S:Body>

(011) </S:Envelope>

This example shows a request SOAP message. Lines 001-002 are standard SOAP elements. Lines 003-005 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 6 shows a [reply endpoint] header specifying the anonymous URI (see section 4.2.1). Lines 007-011 show standard SOAP elements.

### Response Example

(001) <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"

 xmlns:wsa="http://schemas.xmlsoap.org/ws/2004/08/addressing" >

(002) <S:Header>

(003) <wsa:To>

 http://schemas.xmlsoap.org/ws/2004/08/addressing/role/anonymous

 </wsa:To>

(004) <wsa:Action>http://fabrikam.com/ProbeMatch</wsa:Action>

(005) <wsa:MessageId>

 urn:uuid:5a6ed11a-7a80-409a-82bf-43c4c5092911

 </wsa:MessageId>

(006) <wsa:RelatesTo>

 urn:uuid:9ceada16-2403-4404-a8cc-60799acd9d1c

 </wsa:RelatesTo>

(007) </S:Header>

(008) <S:Body>

(009) ...

(010) </S:Body>

(011) </S:Envelope>

This example shows a response SOAP message. Lines 001-002 are standard SOAP elements. Lines 003-005 specify various WS-Addressing headers. Note that the [destination] for the message is specified as the anonymous URI. Line 006 shows a [relationship] header indicating that this message is a reply to the example message in Section 4.2.2. Lines 007-011 show standard SOAP elements.

## Multicast

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

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

Multicast SOAP/UDP datagrams SHOULD be scoped to ensure they are not forwarded beyond the boundaries of the administrative system. This MAY be done with either TTL or administrative scopes [RFC 2365], depending on what is implemented in the network. If TTL is used it is RECOMMENDED that the TTL value be set to 1.

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

## Retransmission

To avoid repeated packet collisions, implementation retransmission SHOULD observe good practices such as using exponential back-off algorithms and spreading. An implementation MAY use the algorithm defined in Appendix A. If a message is to be retransmitted it MUST have a [message id] property. For each transmission of such a message, the value of the [message id] property MUST be the same.

# Message Encoding

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

# 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.

## 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 2396 [RFC 2396].

## Semantics

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

1. Use the port portion as the port number, if specified, otherwise use the default port 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.

# 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].

# Conformance

An implementation is not conformant with this specification if it fails to satisfy one or more of the MUST or REQUIRED level requirements defined herein.

1. Appendix (non-normative) — Example retransmission algorithm

Constants referenced within the algorithm are defined in Table 1 (for unicast messages) and Table 2 (for unreliable multicast messages).

Retry and back-off algorithm.

1. Transmit; \*\_UDP\_REPEAT--;
2. If \*\_UDP\_REPEAT <= 0 goto Step 9;
3. Generate a random number T in [UDP\_MIN\_DELAY .. UDP\_MAX\_DELAY];
4. Wait T milliseconds;
5. Transmit; \*\_UDP\_REPEAT--;
6. If \*\_UDP\_REPEAT <= 0 goto Step 9;
7. T = T \* 2;If T > UDP\_UPPER\_DELAY then T = UDP\_UPPER\_DELAY;
8. goto 4
9. Done.

Table 1: Protocol Retry and back-off constants for unicast messages

|  |  |
| --- | --- |
| Constant / Message | Value |
| UNICAST\_UDP\_REPEAT | 2 |
| UDP\_MIN\_DELAY | 50 |
| UDP\_MAX\_DELAY | 250 |
| UDP\_UPPER\_DELAY | 500 |

Table 2: Protocol Retry and back-off constants for unreliable multicast messages

|  |  |
| --- | --- |
| Constant / Message | Value |
| MULTICAST\_UDP\_REPEAT | 4 |
| UDP\_MIN\_DELAY | 50 |
| UDP\_MAX\_DELAY | 250 |
| UDP\_UPPER\_DELAY | 500 |

1. Appendix (non-normative) — Example duplicate detection mechanisms
2. A receiver keeps a list of the last n messages received along with their [message id] properties [WS-Addressing]. When a new (non-duplicate) message arrives, the oldest message is removed from the list.
3. A receiver tracks all messages received in the last x milliseconds along with their [message id] property [WS-Addressing]. 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.

1. Acknowledgements

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

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Geoff Bullen, Microsoft Corporation

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Doug Davis, IBM

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Max Feingold, Microsoft Corporation

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Devon Kemp, Canon Inc.

Akira Kishida, Canon Inc.

Mark Little, Red Hat

Dr. Ingo Lueck, Technische Universitaet Dortmund

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Carl Mattocks

Antoine Mensch

Jaime Meritt, Progress Software

Vipul Modi, Microsoft Corporation

Anthony Nadalin, IBM

Tadahiro Nakamura, Canon Inc.

Masahiro Nishio, Canon Inc.

Toby Nixon, Microsoft Corporation

Shin Ohtake, Fuji Xerox Co., Ltd.

Venkat Reddy, CA

Alain Regnier, Ricoh Company, Ltd.

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Hiroshi Tamura, Ricoh Company, Ltd.

Minoru Torii, Canon Inc.

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Kenny Wolf, Microsoft Corporation

Acknowledgements of the initial contributions:

This specification has been developed as a result of joint work with many individuals and teams, including:

Erik Christensen, Microsoft Corporation

David Langworthy, Microsoft Corporation

Yaniv Pessach, Microsoft Corporation

Stefan Pharies, Microsoft Corporation

Sam Rhodus, Lexmark International Inc.

Jerry Thrasher, Lexmark International Inc.

Mike Vernal, Microsoft Corporation

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Dave Whitehead, Lexmark International Inc.

1. Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision** | **Date** | **Editor** | **Changes Made** |
| wd-01 | 09/16/2008 | Ram Jeyaraman | Created the initial working draft by converting the input specification to OASIS template. |
| wd-02 | 09/29/2008 | Ram Jeyaraman | Updated document identifier, added co-chair and editor names, use of urn:uuid (issue 50) in examples. |