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1 **Web Services Reliable Messaging**  
2 **(WS-Reliable Messaging)**

3 **Working Draft 05, September 26<sup>th</sup> 2005**

**Document identifier:**

4           WS-ReliableMessaging-1.1-draft-03.doc

5 **Location:**

6           TBD

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11 **Abstract:**

12 This specification (WS-ReliableMessaging) describes a protocol that allows messages  
13 to be delivered reliably between distributed applications in the presence of software  
14 component, system, or network failures. The protocol is described in this  
15 specification in a transport-independent manner allowing it to be implemented using  
16 different network technologies. To support interoperable Web services, a SOAP  
17 binding is defined within this specification.

18 The protocol defined in this specification depends upon other Web services  
19 specifications for the identification of service endpoint addresses and policies. How  
20 these are identified and retrieved are detailed within those specifications and are out  
21 of scope for this document.

22 **Composable Architecture:**

23 By using the SOAP [[SOAP](#)] and WSDL [[WSDL](#)] extensibility model, SOAP-based and  
24 WSDL-based specifications are designed to be composed with each other to define a  
25 rich Web services environment. As such, WS-ReliableMessaging by itself does not  
26 define all the features required for a complete messaging solution. WS-  
27 ReliableMessaging is a building block that is used in conjunction with other  
28 specifications and application-specific protocols to accommodate a wide variety of  
29 protocols related to the operation of distributed Web services.

30 **Status:**

31 TBD

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## 75 **1 Introduction**

76 It is often a requirement for two Web services that wish to communicate to do so  
77 reliably in the presence of software component, system, or network failures. The  
78 primary goal of this specification is to create a modular mechanism for reliable  
79 message delivery. It defines a messaging protocol to identify, track, and manage the  
80 reliable delivery of messages ~~between exactly two parties, a source and a~~  
81 ~~destination~~. It also defines a SOAP binding that is required for interoperability.  
82 Additional bindings may be defined.

83 This mechanism is extensible allowing additional functionality, such as security, to be  
84 tightly integrated. This specification integrates with and complements the WS-  
85 Security, WS-Policy, and other Web services specifications. Combined, these allow  
86 for a broad range of reliable, secure messaging options.

### 87 **1.1 Goals and Requirements**

#### 88 **1.1.1 Requirements**

#### 89 **1.2 Notational Conventions**

90 The keywords "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",  
91 "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this  
92 document are to be interpreted as described in RFC 2119 [[KEYWORDS](#)].

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

- 95 • The syntax appears as an XML instance, but values in italics indicate data types instead  
96 of values.
- 97 • Characters are appended to elements and attributes to indicate cardinality:
  - 98 ○ "?" (0 or 1)
  - 99 ○ "\*" (0 or more)
  - 100 ○ "+" (1 or more)
- 101 • The character "|" is used to indicate a choice between alternatives.
- 102 • The characters "[" and "]" are used to indicate that contained items are to be treated as a  
103 group with respect to cardinality or choice.

- 104 • An ellipsis (i.e. "...") indicates a point of extensibility that allows other child, or attribute,  
105 content. Additional children elements and/or attributes MAY be added at the indicated  
106 extension points but MUST NOT contradict the semantics of the parent and/or owner,  
107 respectively. If an extension is not recognized it SHOULD be ignored.
- 108 • XML namespace prefixes (See Section [Namespace](#)) are used to indicate the namespace  
109 of the element being defined.

•

### 110 1.3 Namespace

111 The XML namespace [[XML-ns](#)] URI that MUST be used by implementations of this  
112 specification is:

113 <http://docs.oasis-open.org/wsrn/200510/>

114 Table 1 lists XML namespaces that are used in this specification. The choice of any  
115 namespace prefix is arbitrary and not semantically significant.

116 The following namespaces are used in this document:

117 *Table 1*

Prefix	Namespace
S	<a href="http://www.w3.org/2003/05/soap-envelope">http://www.w3.org/2003/05/soap-envelope</a>
S11	<a href="http://schemas.xmlsoap.org/soap/envelope/">http://schemas.xmlsoap.org/soap/envelope/</a>
wsrn	<a href="http://docs.oasis-open.org/wsrn/200510/">http://docs.oasis-open.org/wsrn/200510/</a>
wsa	<a href="http://schemas.xmlsoap.org/ws/2004/08/addressing">http://schemas.xmlsoap.org/ws/2004/08/addressing</a>
wsse	<a href="http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-secext-1.0.xsd">http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-wssecurity-secext-1.0.xsd</a>
xs	<a href="http://www.w3.org/2001/XMLSchema">http://www.w3.org/2001/XMLSchema</a>

118 The normative schema for WS-Reliable Messaging can be found at:

119 <http://docs.oasis-open.org/wsrn/200510/wsrn.xsd>

120 All sections explicitly noted as examples are informational and are not to be  
121 considered normative.

122 If an action URI is used, and one is not already defined per the rules of the WS-  
123 Addressing specification [[WS-Addressing](#)], then the action URI MUST consist of the  
124 reliable messaging namespace URI concatenated with the "/" character and the  
125 element name. For example:

126 <http://docs.oasis-open.org/wsrn/200510/SequenceAcknowledgement>

## 127 **1.4 Compliance**

128 An implementation is not compliant with this specification if it fails to satisfy one or  
129 more of the MUST or REQUIRED level requirements defined herein. A SOAP Node  
130 MUST NOT use the XML namespace identifier for this specification (listed in  
131 Section [Namespace](#)) within SOAP Envelopes unless it is compliant with this  
132 specification.

133 Normative text within this specification takes precedence over normative outlines,  
134 which in turn take precedence over the XML Schema [[XML Schema Part 1](#), [Part 2](#)]  
135 descriptions.

## 136 **2 Reliable Messaging Model**

137 Many errors may interrupt a conversation. Messages may be lost, duplicated or  
138 reordered. Further the host systems may experience failures and lose volatile state.

139

140 The WS-ReliableMessaging specification defines an interoperable protocol that  
141 requires a Reliable Messaging (RM) Source and Reliable Messaging (RM) Destination  
142 to ensure that each message transmitted by the RM Source is successfully received  
143 by an RM Destination, or barring successful receipt, that an RM Source can, except in  
144 the most extreme circumstances, accurately determine the disposition of each  
145 message transmitted as perceived by the RM Destination, so as to resolve any in-  
146 doubt status. Note that this specification make no restriction on the scope of an RM  
147 Source or RM Destination entities.

148 In addition, The protocol allows the RM Source and RM Destination to provide their  
149 respective Application Source and Application Destination a guarantee that a  
150 message that is sent by an Application Source will be delivered to the Application  
151 Destination.

152 This guarantee is specified as a delivery assurance. It is the responsibility of the RM  
153 Source and RM Destination to fulfill the delivery assurances on behalf of their  
154 respective Application counterparts, or raise an error. The protocol defined here  
155 allows endpoints to meet this guarantee for the delivery assurances defined below.  
156 However, the means by which these delivery assurances are manifested by either the  
157 RM Source or RM Destination roles is an implementation concern, and is out of scope  
158 of this specification.

159 Note that the underlying protocol defined in this specification remains the same  
160 regardless of the delivery assurance.

161 Persistence considerations related to an endpoint's ability to satisfy the delivery  
162 assurances defined below are the responsibility of the implementation and do not  
163 affect the wire protocol. As such, they are out of scope of this specification.

164 There are four basic delivery assurances that endpoints can provide:

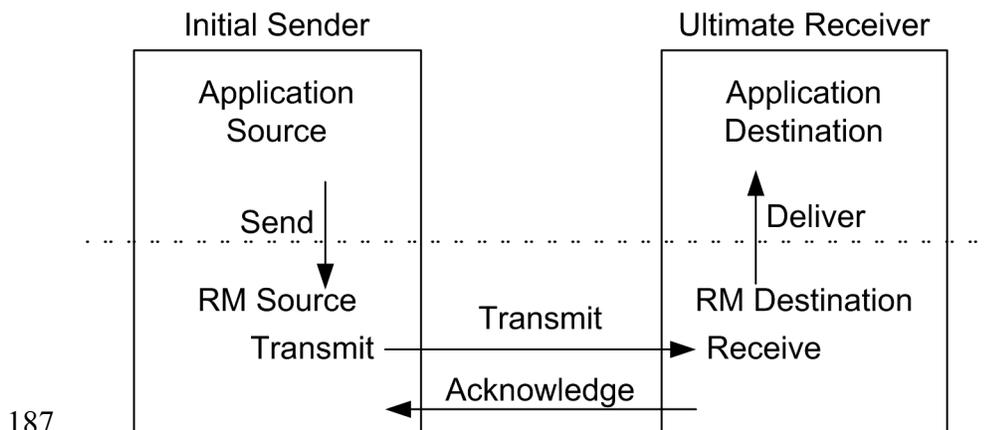
165 **AtMostOnce** Messages will be delivered at most once without duplication or an error  
166 will be raised on at least one endpoint. It is possible that some messages in a  
167 sequence may not be delivered.

168 **AtLeastOnce** Every message sent will be delivered or an error will be raised on at  
169 least one endpoint. Some messages may be delivered more than once.

170 **ExactlyOnce** Every message sent will be delivered without duplication or an error  
171 will be raised on at least one endpoint. This delivery assurance is the logical "and" of  
172 the two prior delivery assurances.

173 **InOrder** Messages will be delivered in the order that they were sent. This delivery  
174 assurance may be combined with any of the above delivery assurances. It requires  
175 that the messages within a Sequence will be delivered in an order so that the  
176 message numbers are monotonically increasing. Note that this assurance says  
177 nothing about duplications or omissions. Note also that it is only applicable to  
178 messages in the same Sequence. Cross Sequence ordering of messages is not in the  
179 scope of this specification.

180 Figure 1 below illustrates the entities and events in a simple reliable message  
181 exchange. First, the Application Source Sends a message for reliable delivery. The  
182 Reliable Messaging (RM) Source accepts the message and Transmits it one or more  
183 times. After receiving the message, the RM Destination Acknowledges it. Finally,  
184 the RM Destination delivers the message to the Application Destination. The exact  
185 roles the entities play and the complete meaning of the events will be defined  
186 throughout this specification.



188 Figure 1: Reliable Messaging Model

## 189 2.1 Glossary

190 The following definitions are used throughout this specification:

191 **Endpoint:** A referencable entity, processor, or resource where Web service messages  
192 are originated or targeted.

193 **Application Source:** The endpoint that Sends a message.

194 **Application Destination:** The endpoint to which a message is Delivered.  
195 **Delivery Assurance:** The guarantee that the messaging infrastructure provides on  
196 the delivery of a message.  
197 **Receive:** The act of reading a message from a network connection and qualifying it  
198 as relevant to RM Destination functions.  
199 **RM Source:** For any one reliable message tThe endpoint that transmits the  
200 message.  
201 **RM Destination:** For any one reliable message tThe endpoint that receives the  
202 message.  
203 **Send:** The act of submitting a message to the RM Source for reliable delivery. The  
204 reliability guarantee begins at this point.  
205 **Deliver:** The act of transferring a message from the RM Destination to the  
206 Application Destination. The reliability guarantee is fulfilled at this point.  
207 **Transmit:** The act of writing a message to a network connection.  
208 **Receive:** The act of reading a message from a network connection.  
209 **Acknowledgement:** The communication from the RM Destination to the RM Source  
210 indicating the successful receipt of a message.

## 211 **2.2 Protocol Preconditions**

212 The correct operation of the protocol requires that a number of preconditions MUST  
213 be established prior to the processing of the initial sequenced message:  
214 • The RM Source MUST have an endpoint reference that uniquely identifies the RM Destination  
215 endpoint; correlations across messages addressed to the unique endpoint MUST be  
216 meaningful.  
217 • The RM Source MUST have knowledge of the destination's policies, if any, and the RM  
218 Source MUST be capable of formulating messages that adhere to this policy.  
219 If a secure exchange of messages is required, then the RM Source and RM  
220 Destination MUST have a security context.

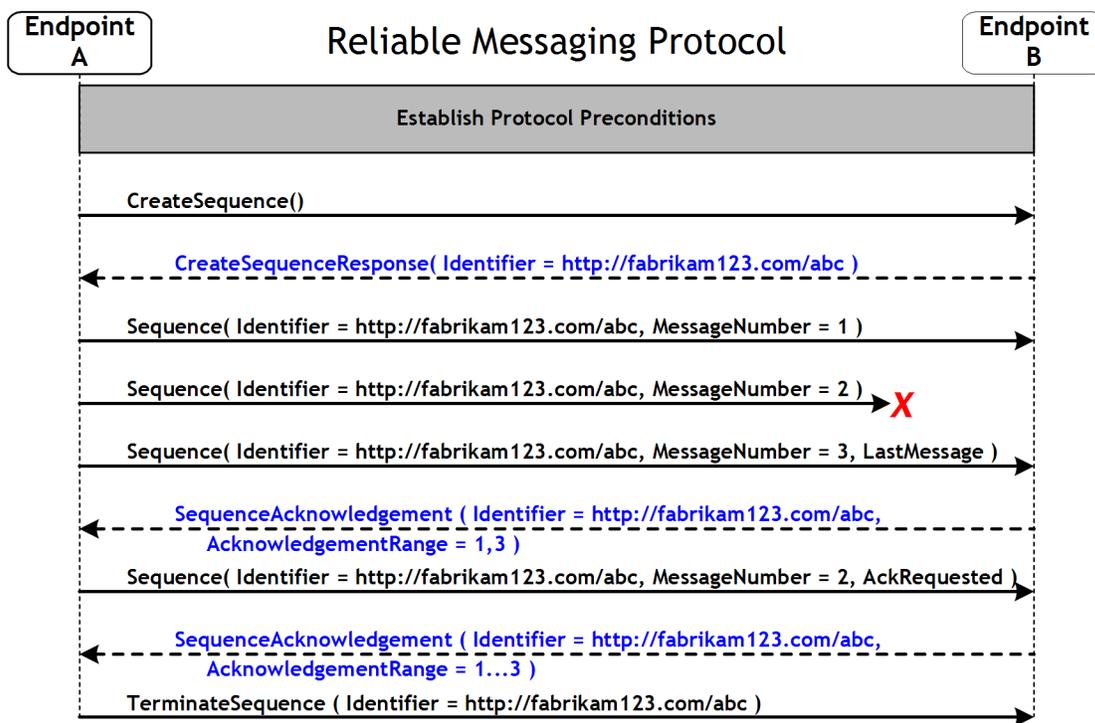
## 221 **2.3 Protocol Invariants**

222 During the lifetime of the protocol, two invariants are REQUIRED for correctness:  
223 • The RM Source MUST assign each reliable message a sequence number (defined below)  
224 beginning at 1 and increasing by exactly 1 for each subsequent reliable message.

225 Every acknowledgement issued by the RM Destination MUST include within an  
 226 acknowledgement range or ranges the sequence number of every message  
 227 successfully received by the RM Destination and MUST exclude sequence numbers of  
 228 any messages not yet received.

## 229 2.4 Example Message Exchange

230 Figure 2 illustrates a possible message exchange between two reliable messaging  
 231 endpoints A and B.



232 Figure 2: The WS-ReliableMessaging Protocol

- 233 1. The protocol preconditions are established. These include policy exchange,  
 234 endpoint resolution, establishing trust.
- 235 2. The RM Source requests creation of a new Sequence.
- 236 3. The RM Destination creates a Sequence by returning a globally unique identifier.
- 237 4. The RM Source begins sending messages beginning with MessageNumber 1. In  
 238 the figure the RM Source sends 3 messages.

- 239 5. Since the 3rd message is the last in this exchange, the RM Source includes a  
240 <wsrm:LastMessage> token.
- 241 6. The 2nd message is lost in transit.
- 242 7. The RM Destination acknowledges receipt of message numbers 1 and 3 in  
243 response to the RM Source's <wsrm:LastMessage> token.
- 244 8. The RM Source retransmits the 2nd message. This is a new message on the  
245 underlying transport, but since it has the same sequence identifier and message  
246 number so the RM Destination can recognize it as equivalent to the earlier  
247 message, in case both are received.
- 248 9. The RM Source includes an <wsrm:AckRequested> element so the RM Destination  
249 will expedite an acknowledgement.
- 250 10. The RM Destination receives the second transmission of the message with  
251 MessageNumber 2 and acknowledges receipt of message numbers 1, 2, and 3  
252 which carried the <wsrm:LastMessage> token.
- 253 11. The RM Source receives this acknowledgement and sends a TerminateSequence  
254 message to the RM Destination indicating that the sequence is completed and  
255 reclaims any resources associated with the Sequence.
- 256 12. The RM Destination receives the TerminateSequence message indicating that the  
257 RM Source will not be sending any more messages, and reclaims any resources  
258 associated with the Sequence.
- 259 Now that the basic model has been outlined, the details of the elements used in this  
260 protocol are now provided in Section 3.

## 261 **3 RM Protocol Elements**

262 The protocol elements define extensibility points at various places. Additional  
263 children elements and/or attributes MAY be added at the indicated extension points  
264 but MUST NOT contradict the semantics of the parent and/or owner, respectively. If a  
265 receiver does not recognize an extension, the receiver SHOULD ignore the extension.

### 266 **3.1 Sequences**

267 The RM protocol uses a `<wsrm:Sequence>` header block to track and manage the  
268 reliable delivery of messages. Messages for which the delivery assurance applies  
269 MUST contain a `<wsrm:Sequence>` header block. Each Sequence MUST have a  
270 unique `<wsrm:Identifier>` element and each message within a Sequence MUST  
271 have a `<wsrm:MessageNumber>` element that increments by 1 from an initial value of  
272 1. These values are contained within a `<wsrm:Sequence>` header block accompanying  
273 each message being delivered in the context of a Sequence. In addition to mandatory  
274 `<wsrm:Identifier>` and `<wsrm:MessageNumber>` elements, the header MAY include a  
275 `<wsrm:LastMessage>` element.

276 There MUST be no more than one `<wsrm:Sequence>` header block in any message.

277 The purpose of the `<wsrm:LastMessage>` element is to signal to the RM Destination  
278 that the message represents the last message in the Sequence.

279 A following exemplar defines its syntax:

```
280 <wsrm:Sequence ...>  
281   <wsrm:Identifier ...> xs:anyURI </wsrm:Identifier>  
282   <wsrm:MessageNumber> xs:unsignedLong </wsrm:MessageNumber>  
283   <wsrm:LastMessage/>?  
284   ...  
285 </wsrm:Sequence>
```

286 The following describes the content model of the Sequence header block.

287 `/wsrm:Sequence`

288 This is the element containing Sequence information for WS-ReliableMessaging. The  
289 `<wsrm:Sequence>` element MUST be understood by the RM Destination. The `<wsrm:Sequence>`  
290 element MUST have a `mustUnderstand` attribute with a value 1/true from the namespace  
291 corresponding to the version of SOAP to which the `<wsrm:Sequence>` SOAP header block is  
292 bound.

293 `/wsrm:Sequence/wsrm:Identifier`

294 This REQUIRED element MUST contain an absolute URI conformant with RFC2396 that uniquely  
295 identifies the Sequence.

296 /wsrm:Sequence/wsrm:Identifier/@{any}

297 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
298 to the element.

299 /wsrm:Sequence/wsrm:MessageNumber

300 This REQUIRED element MUST contain an xs:unsignedLong representing the ordinal position of  
301 the message within a Sequence. Sequence MessageNumbers start at 1 and monotonically  
302 increase throughout the Sequence. If the message number exceeds the internal limitations of an  
303 RM Source or RM Destination or reaches the maximum value of an xs:unsignedLong  
304 (18,446,744,073,709,551,615), the RM Source or Destination MUST issue a  
305 MessageNumberRollover fault.

306 /wsrm:Sequence/wsrm:LastMessage

307 This element MAY be included by the RM Source ~~endpoint~~. The <wsrm:LastMessage> element  
308 has no content.

309 /wsrm:Sequence/{any}

310 This is an extensibility mechanism to allow different types of information, based on a schema, to  
311 be passed.

312 /wsrm:Sequence/@{any}

313 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
314 to the element.

315 A RM Source ~~endpoint~~ MUST include a <wsrm:LastMessage> element in the  
316 <wsrm:Sequence> element for the last message in a Sequence. An RM Destination  
317 ~~endpoint~~ MUST respond with a <wsrm:SequenceAcknowledgement> upon receipt of a  
318 <wsrm:LastMessage> element. A Sequence MUST NOT use a <wsrm:MessageNumber>  
319 value greater than that which accompanies a <wsrm:LastMessage> element. An RM  
320 Destination MUST generate a LastMessageNumberExceeded (See Section 4.6) fault  
321 upon receipt of such a message. In the event that an RM Source needs to close a  
322 Sequence and there is no application message, the RM Source MAY send a message  
323 with an empty body containing <wsrm:Sequence> header with the  
324 <wsrm:LastMessage> element. In this usage, the action URI MUST be:

325 `http://docs.oasis-open.org/wsrm/200510/LastMessage`

326 in preference to the pattern defined in Section 1.2.

327 The following example illustrates a Sequence header block.

328 `<wsrm:Sequence>`

```

329     <wsrm:Identifier>http://example.com/abc</wsrm:Identifier>
330     <wsrm:MessageNumber>10</wsrm:MessageNumber>
331     <wsrm:LastMessage/>
332 </wsrm:Sequence>

```

## 333 3.2 Sequence Acknowledgement

334 The RM Destination informs the RM Source of successful message receipt using a  
335 <wsrm:SequenceAcknowledgement> header block. The  
336 <wsrm:SequenceAcknowledgement> header block MAY be transmitted independently  
337 or included on return messages. The RM Destination MAY send a  
338 <wsrm:SequenceAcknowledgement> header block at any point during which the  
339 sequence is valid. The timing of acknowledgements can be advertised using policy  
340 and acknowledgements can be explicitly requested using the <wsrm:AckRequested>  
341 directive (see Section 3.3). If a non-mustUnderstand fault occurs when processing  
342 an RM Header that was piggy-backed on another message, a fault MUST be  
343 generated, but the processing of the original message MUST NOT be affected.

344 The following exemplar defines its syntax:

```

345 <wsrm:SequenceAcknowledgement ...>
346   <wsrm:Identifier ...> xs:anyURI </wsrm:Identifier>
347   [ [ <wsrm:AcknowledgementRange ...
348     Upper="xs:unsignedLong"
349     Lower="xs:unsignedLong"/> +
350     <wsrm:Final/> ? ]
351   | <wsrm:Nack> xs:unsignedLong </wsrm:Nack> +
352   | <wsrm:None/> ]
353   ...
354 </wsrm:SequenceAcknowledgement>

```

355 The following describes the content model of the <wsrm:SequenceAcknowledgement>  
356 header block.

357 /wsrm:SequenceAcknowledgement

358 This element contains the Sequence acknowledgement information.

359 /wsrm:SequenceAcknowledgement/wsrm:Identifier

360 This REQUIRED element MUST contain an absolute URI conformant with RFC2396 that uniquely  
361 identifies the Sequence.

362 /wsrm:SequenceAcknowledgement/wsrm:Identifier/@{any}

363 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
364 to the element.

365 /wsrm:SequenceAcknowledgement/wsrm:AcknowledgementRange  
366 This OPTIONAL element, if present, can occur 1 or more times. It contains a range of message  
367 Sequence MessageNumbers successfully received by the receiving endpoint manager. The  
368 ranges SHOULD NOT overlap. This element MUST NOT be present if either the <wsrm:Nack>  
369 or <wsrm:None> elements are also present as a child of  
370 <wsrm:SequenceAcknowledgement>.

371 /wsrm:SequenceAcknowledgement/wsrm:AcknowledgementRange/@Upper  
372 This REQUIRED attribute contains an xs:unsignedLong representing the  
373 <wsrm:MessageNumber> of the highest contiguous message in a Sequence range received by  
374 the RM Destination.

375 /wsrm:SequenceAcknowledgement/wsrm:AcknowledgementRange/@Lower  
376 This REQUIRED attribute contains an xs:unsignedLong representing the  
377 <wsrm:MessageNumber> of the lowest contiguous message in a Sequence range received by  
378 the RM Destination.

379 /wsrm:SequenceAcknowledgement/wsrm:AcknowledgementRange/@{any}  
380 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
381 to the element.

382 /wsrm:SequenceAcknowledgement/wsrm:Final  
383 This OPTIONAL element, if present, indicates that the RM Destination is not receiving new  
384 messages for the specified Sequence. The RM Source can be assured that the ranges of  
385 messages acknowledged by this SequenceAcknowledgement header block will not change in the  
386 future. This element MUST be present when the Sequence is no longer receiving new message  
387 for the specified sequence. Note: this element MUST NOT be used when sending a Nack, it can  
388 only be used when sending AcknowledgementRanges.

389 /wsrm:SequenceAcknowledgement/wsrm:Nack  
390 This OPTIONAL element, if present, MUST contain an xs:unsignedLong representing the  
391 <wsrm:MessageNumber> of an unreceived message in a Sequence. This element permits the  
392 gap analysis of the <wsrm:AcknowledgementRange> elements to be performed at the RM  
393 Destination rather than at the RM Source which may yield performance benefits in certain  
394 environments. The <wsrm:Nack> element MUST NOT be present if either the  
395 <wsrm:AcknowledgementRange> or <wsrm:None> elements are also present as a child of  
396 <wsrm:SequenceAcknowledgement>. Upon the receipt of a Nack, an RM Source SHOULD  
397 retransmit the message identified by the Nack. The RM Destination MUST NOT issue a  
398 <wsrm:SequenceAcknowledgement> containing a <wsrm:Nack> for a message that it has  
399 previously acknowledged within a <wsrm:AcknowledgementRange>. The RM Source SHOULD  
400 ignore a <wsrm:SequenceAcknowledgement> containing a <wsrm:Nack> for a message  
401 that has previously been acknowledged within a <wsrm:AcknowledgementRange>.

402 /wsm:SequenceAcknowledgement/wsm:None

403 This OPTIONAL element, if present, MUST be used when the RM Destination has not received  
404 any messages for the specified sequence. The <wsm:None> element MUST NOT be present if  
405 either the <wsm:AcknowledgementRange> or <wsm:Nack> elements are also present as a  
406 child of the <wsm:SequenceAcknowledgement>.

407 /wsm:SequenceAcknowledgement/{any}

408 This is an extensibility mechanism to allow different (extensible) types of information, based on a  
409 schema, to be passed.

410 /wsm:SequenceAcknowledgement/@{any}

411 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
412 to the element.

413 The following examples illustrate <wsm:SequenceAcknowledgement> elements:

- 414 • Message numbers 1..10 inclusive in a Sequence have been received by the RM Destination.

```
415 <wsm:SequenceAcknowledgement>  
416   <wsm:Identifier>http://example.com/abc</wsm:Identifier>  
417   <wsm:AcknowledgementRange Upper="10" Lower="1"/>  
418 </wsm:SequenceAcknowledgement>
```

- 419 • Message numbers 1..2, 4..6, and 8..10 inclusive in a Sequence have been received by the  
420 RM Destination, messages 3 and 7 have not been received.

```
421 <wsm:SequenceAcknowledgement>  
422   <wsm:Identifier>http://example.com/abc</wsm:Identifier>  
423   <wsm:AcknowledgementRange Upper="2" Lower="1"/>  
424   <wsm:AcknowledgementRange Upper="6" Lower="4"/>  
425   <wsm:AcknowledgementRange Upper="10" Lower="8"/>  
426 </wsm:SequenceAcknowledgement>
```

- 427 • Message number 3 in a Sequence has not been received by the RM Destination.

```
428 <wsm:SequenceAcknowledgement>  
429   <wsm:Identifier>http://example.com/abc</wsm:Identifier>  
430   <wsm:Nack>3</wsm:Nack>  
431 </wsm:SequenceAcknowledgement>
```

### 432 3.3 Request Acknowledgement

433 The purpose of the <wsm:AckRequested> header block is to signal to the RM  
434 Destination that the RM Source is requesting that a  
435 <wsm:SequenceAcknowledgement> be returned.

436 At any time, the RM Source may request an acknowledgement message from the RM  
437 Destination **endpoint** using an `<wsrm:AckRequested>` header block.

438 The RM Source **endpoint** requests this acknowledgement by including an  
439 `<wsrm:AckRequested>` header block in the message. An RM Destination that receives  
440 a message that contains an `<wsrm:AckRequested>` header block MUST respond with  
441 a message containing a `<wsrm:SequenceAcknowledgement>` header block. If a non-  
442 mustUnderstand fault occurs when processing an RM Header that was piggy-backed  
443 on another message, a fault MUST be generated, but the processing of the original  
444 message MUST NOT be affected.

445 The following exemplar defines its syntax:

```
446 <wsrm:AckRequested ...>  
447   <wsrm:Identifier ...> xs:anyURI </wsrm:Identifier>  
448   <wsrm:MessageNumber> xs:unsignedLong </wsrm:MessageNumber> ?  
449   ...  
450 </wsrm:AckRequested>
```

451 `/wsrm:AckRequested`

452 This element requests an acknowledgement for the identified sequence.

453 `/wsrm:AckRequested/wsrm:Identifier`

454 This REQUIRED element MUST contain an absolute URI, conformant with RFC2396, that  
455 uniquely identifies the Sequence to which the request applies.

456 `/wsrm:AckRequested/wsrm:Identifier/@{any}`

457 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
458 to the element.

459 `/wsrm:AckRequested/wsrm:MessageNumber`

460 This OPTIONAL element, if present, MUST contain an *xs:unsignedLong* representing the highest  
461 `<wsrm:MessageNumber>` sent by the RM Source within the Sequence. If present, it MAY be  
462 treated as a hint to the RM Destination as an optimization to the process of preparing to transmit a  
463 `<wsrm:SequenceAcknowledgement>`.

464 `/wsrm:AckRequested/{any}`

465 This is an extensibility mechanism to allow different (extensible) types of information, based on a  
466 schema, to be passed.

467 `/wsrm:AckRequested/@{any}`

468 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
469 to the element.

## 470 3.4 Sequence Creation

471 The RM Source MUST request creation of an outbound Sequence by sending a  
472 `<wsrm:CreateSequence>` element in the body of a message to the RM Destination  
473 which in turn responds either with a `<wsrm:CreateSequenceResponse>` or a  
474 `CreateSequenceRefused` fault in the body of the response message.  
475 `<wsrm:CreateSequence>` MAY carry an offer to create an inbound sequence which is  
476 either accepted or rejected in the `<wsrm:CreateSequenceResponse>`.

477 ~~The RM Destination of the outbound sequence is the WS-Addressing~~  
478 ~~EndpointReference [WS-Addressing] to which `<wsrm:CreateSequence>` is sent. The~~  
479 ~~RM Destination of the inbound sequence is the WS-Addressing `<wsa:ReplyTo>` of the~~  
480 ~~`<wsrm:CreateSequence>`.~~

481 The following exemplar defines the `<wsrm:CreateSequence>` syntax:

```
482 <wsrm:CreateSequence ...>  
483   <wsrm:AcksTo ...> wsa:EndpointReferenceType </wsrm:AcksTo>  
484   <wsrm:Expires ...> xs:duration </wsrm:Expires> ?  
485   <wsrm:Offer ...>  
486     <wsrm:Identifier ...> xs:anyURI </wsrm:Identifier>  
487     <wsrm:Expires ...> xs:duration </wsrm:Expires> ?  
488     ...  
489   </wsrm:Offer> ?  
490   ...  
491 </wsrm:CreateSequence>
```

492 `/wsrm:CreateSequence`

493 This element requests creation of a new Sequence between the RM Source that sends it, and the  
494 RM Destination to which it is sent. This element MUST NOT be sent as a header block. The RM  
495 Destination MUST respond either with a `<wsrm:CreateSequenceResponse>` response  
496 message or a `CreateSequenceRefused` fault.

497 `/wsrm:CreateSequence/wsrm:AcksTo`

498 This REQUIRED element, of type `wsa:EndpointReferenceType` as specified by WS-Addressing  
499 [WS-Addressing] specifies the endpoint reference to which  
500 `<wsrm:SequenceAcknowledgement>` messages and faults related to the created Sequence  
501 are to be sent.

502 `/wsrm:CreateSequence/wsrm:Expires`

503 This element, if present, of type `xs:duration` specifies the RM Source's requested duration for  
504 the Sequence. The RM Destination MAY either accept the requested duration or assign a lesser  
505 value of its choosing. A value of 'PT0S' indicates that the Sequence will never expire. Absence of  
506 the element indicates an implied value of 'PT0S'.

507 /wsm:CreateSequence/wsm:Expires/@{any}  
508 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
509 to the element.

510 /wsm:CreateSequence/wsm:Offer  
511 This element, if present, enables an RM Source to offer a corresponding Sequence for the reliable  
512 exchange of messages transmitted from RM Destination to RM Source.

513 /wsm:CreateSequence/wsm:Offer/wsm:Identifier  
514 This REQUIRED element MUST contain an absolute URI conformant with RFC2396 that uniquely  
515 identifies the offered Sequence.

516 /wsm:CreateSequence/wsm:Offer/wsm:Identifier/@{any}  
517 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
518 to the element.

519 /wsm:CreateSequence/wsm:Offer/wsm:Expires  
520 This element, if present, of type *xs:duration* specifies the duration for the Sequence. A value  
521 of 'PT0S' indicates that the Sequence will never expire. Absence of the element indicates an  
522 implied value of 'PT0S'.

523 /wsm:CreateSequence/wsm:Offer/wsm:Expires/@{any}  
524 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
525 to the element.

526 /wsm:CreateSequence/wsm:Offer/{any}  
527 This is an extensibility mechanism to allow different (extensible) types of information, based on a  
528 schema, to be passed.

529 /wsm:CreateSequence/wsm:Offer/@{any}  
530 This is an extensibility mechanism to allow different (extensible) types of information, based on a  
531 schema, to be passed.

532 OPTIONAL/wsm:CreateSequence/{any}  
533 This is an extensibility mechanism to allow different (extensible) types of information, based on a  
534 schema, to be passed.

535 /wsm:CreateSequence/@{any}  
536 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
537 to the element.

538 A `<wsrm:CreateSequenceResponse>` is sent in the body of a response message by an  
539 RM Destination in response to receipt of a `<wsrm:CreateSequence>` request  
540 message. It carries the `<wsrm:Identifier>` of the created Sequence and indicates  
541 that the RM Source may begin sending messages in the context of the identified  
542 Sequence.

543 The following exemplar defines the `<wsrm:CreateSequenceResponse>` syntax:

```
544 <wsrm:CreateSequenceResponse ...>  
545   <wsrm:Identifier ...> xs:anyURI </wsrm:Identifier>  
546   <wsrm:Expires> xs:duration </wsrm:Expires> ?  
547   <wsrm:Accept ...>  
548     <wsrm:AcksTo ...> wsa:EndpointReferenceType </wsrm:AcksTo>  
549     ...  
550   </wsrm:Accept> ?  
551   ...  
552 </wsrm:CreateSequenceResponse>
```

553 `/wsrm:CreateSequenceResponse`

554 This element is sent in the body of the response message in response to a  
555 `<wsrm:CreateSequence>` request message. It indicates that the RM Destination has created  
556 a new Sequence at the request of the RM Source. This element MUST NOT be sent as a header  
557 block.

558 `/wsrm:CreateSequenceResponse/wsrm:Identifier`

559 This REQUIRED element MUST contain an absolute URI conformant with RFC2396 of the  
560 Sequence that has been created by the RM Destination.

561 `/wsrm:CreateSequenceResponse/wsrm:Identifier/@{any}`

562 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
563 to the element.

564 `/wsrm:CreateSequenceResponse/wsrm:Expires`

565 This element, if present, of type `xs:duration` accepts or refines the RM Source's requested  
566 duration for the Sequence. A value of 'PT0S' indicates that the Sequence will never expire.  
567 Absence of the element indicates an implied value of 'PT0S'. This value MUST be equal or lesser  
568 than the value requested by the RM Source in the corresponding `<wsrm:CreateSequence>`  
569 message.

570 `/wsrm:CreateSequenceResponse/wsrm:Expires/@{any}`

571 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
572 to the element.

573 `/wsrm:CreateSequenceResponse/wsrm:Accept`

574 This element, if present, enables an RM Destination to accept the offer of a corresponding  
575 Sequence for the reliable exchange of messages transmitted from RM Destination to RM Source.  
576 This element MUST be present if the corresponding `<wsrm:CreateSequence>` message  
577 contained an `<wsrm:Offer>` element.

578 `/wsrm:CreateSequenceResponse/wsrm:Accept/wsrm:AcksTo`

579 This REQUIRED element, of type `wsa:EndpointReferenceType` as specified by WS-Addressing  
580 [WS-Addressing], specifies the endpoint reference to which  
581 `<wsrm:SequenceAcknowledgement>` messages related to the accepted Sequence are to be  
582 sent.

583 `/wsrm:CreateSequenceResponse/wsrm:Accept/{any}`

584 This is an extensibility mechanism to allow different (extensible) types of information, based on a  
585 schema, to be passed.

586 `/wsrm:CreateSequenceResponse/wsrm:Accept/@{any}`

587 This is an extensibility mechanism to allow different (extensible) types of information, based on a  
588 schema, to be passed.

589 `/wsrm:CreateSequenceResponse/{any}`

590 This is an extensibility mechanism to allow different (extensible) types of information, based on a  
591 schema, to be passed.

592 `/wsrm:CreateSequenceResponse/@{any}`

593 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
594 to the element.

### 595 **3.5 Sequence Termination**

596 When the RM Source has completed its use of the Sequence, it sends a  
597 `<wsrm:TerminateSequence>` element, in the body of a message to the RM  
598 Destination to indicate that the Sequence is complete, and that it will not be sending  
599 any further messages related to the Sequence. The RM Destination can safely reclaim  
600 any resources associated with the Sequence upon receipt of the  
601 `<wsrm:TerminateSequence>` message. Note, under normal usage the RM source will  
602 complete its use of the sequence when all of the messages in the Sequence have  
603 been acknowledged. However, the RM Source is free to Terminate or Close a  
604 Sequence at any time regardless of the acknowledgement state of the messages.

605 The following exemplar defines the TerminateSequence syntax:

```
606 <wsrm:TerminateSequence ...>  
607   <wsrm:Identifier ...> xs:anyURI </wsrm:Identifier>
```

608

609

```
...  
</wsrm:TerminateSequence>
```

610 /wsrm:TerminateSequence

611 This element is sent by an RM Source to indicate it has completed its use of the Sequence, i.e. it  
612 MUST NOT send any additional message to the RM Destination referencing this sequence. It  
613 indicates that the RM Destination can safely reclaim any resources related to the identified  
614 Sequence. This element MUST NOT be sent as a header block.

615 /wsrm:TerminateSequence/wsrm:Identifier

616 This REQUIRED element MUST contain an absolute URI conformant with RFC2396 of the  
617 Sequence that is being terminated.

618 /wsrm:TerminateSequence/wsrm:Identifier/@{any}

619 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
620 to the element.

621 /wsrm:TerminateSequence/{any}

622 This is an extensibility mechanism to allow different (extensible) types of information, based on a  
623 schema, to be passed.

624 /wsrm:TerminateSequence/@{any}

625 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
626 to the element.

## 627 **3.6 Closing A Sequence**

628 There may be times during the use of an RM Sequence that the RM Source or RM  
629 Destination will wish to discontinue using a Sequence even if some of the messages  
630 have not been successfully delivered to the RM Destination.

631 In the case where the RM Source wishes to discontinue use of a sequence, while it  
632 can send a TerminateSequence to the RM Destination, since this is a one-way  
633 message and due to the possibility of late arriving (or lost) messages and  
634 Acknowledgements, this would leave the RM Source unsure of the final ranges of  
635 messages that were successfully delivered to the RM Destination.

636 To alleviate this, the RM Source can send a <wsrm:CloseSequence> element, in the  
637 body of a message, to the RM Destination to indicate that RM Destination MUST NOT  
638 receive any new messages for the specified sequence, other than those already  
639 received at the time the <wsrm:CloseSequence> element is interpreted by the RMD.  
640 Upon receipt of this message the RM Destination MUST send a

641 SequenceAcknowledgement to the RM Source. Note, this  
642 SequenceAcknowledgement MUST include the <wsrm:Final> element.

643 While the RM Destination MUST NOT receive any new messages for the specified  
644 sequence it MUST still process RM protocol messages. For example, it MUST respond  
645 to AckRequested, TerminateSequence as well as CloseSequence messages. Note,  
646 subsequent CloseSequence messages have no effect on the state of the sequence.

647 In the case where the RM Destination wishes to discontinue use of a sequence it may  
648 'close' the sequence itself. Please see wsrm:Final above and the SequenceClosed  
649 fault below. Note, the SequenceClosed Fault SHOULD be used in place of the  
650 SequenceTerminated Fault, whenever possible, to allow the RM Source to still receive  
651 Acknowledgements.

652 The following exemplar defines the CloseSequence syntax:

```
653 <wsrm:CloseSequence wsrm:Identifier="xs:anyURI"/>
```

654 /wsrm:CloseSequence

655 This element is sent by an RM Source to indicate that the RM Destination MUST NOT receive any  
656 new messages for this sequence. A SequenceClosed fault MUST be generated by the RM  
657 Destination when it receives a message for a sequence that is closed.

658 /wsrm:CloseSequence@Identifier

659 This REQUIRED attribute contains an absolute URI conformant with RFC2396 that uniquely  
660 identifies the sequence.

661 /wsrm:CloseSequence/{any}

662 This is an extensibility mechanism to allow different (extensible) types of information, based on a  
663 schema, to be passed.

664 /wsrm:CloseSequence@{any}

665 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
666 to the element.

667 A <wsrm:CloseSequenceResponse> is sent in the body of a response message by an  
668 RM Destination in response to receipt of a <wsrm:CloseSequence> request message.  
669 It indicates that the RM Destination has closed the sequence.

670 The following exemplar defines the <wsrm:CloseSequenceResponse> syntax:

```
671 /wsrm:CloseSequenceResponse
```

672 /wsrm:CloseSequenceResponse

673 This element is sent in the body of a response message by an RM Destination in response to  
674 receipt of a <wsrm:CloseSequence> request message. It indicates that the RM Destination has  
675 closed the sequence.

676 /wsrm:CloseSequenceResponse/{any}

677 This is an extensibility mechanism to allow different (extensible) types of information, based on a  
678 schema, to be passed.

679 /wsrm:CloseSequenceResponse@{any}

680 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
681 to the element.

## 682 4 Faults

683 The fault definitions defined in this section reference certain abstract properties, such  
684 as [fault endpoint], that are defined in section 3 of the WS-Addressing [WS-  
685 Addressing] specification. Endpoints compliant with this specification MUST include  
686 required Message Addressing Properties on all fault messages.

687 Sequence creation uses a CreateSequence, CreateSequenceResponse request-  
688 response pattern. Faults for this operation are treated as defined in WS-Addressing.  
689 CreateSequenceRefused is a possible fault reply for this operation.

690 UnknownSequence is a fault generated by endpoints when messages carrying RM  
691 header blocks targeted at unrecognized sequences are detected, these faults are also  
692 treated as defined in WS-Addressing. All other faults in this section relate to the  
693 processing of RM header blocks targeted at known sequences and are collectively  
694 referred to as sequence faults. Sequence faults SHOULD be sent to the same  
695 [destination] as <wsrm:SequenceAcknowledgement> messages. These faults are  
696 correlated using the Sequence identifier carried in the detail.

697 WS-ReliableMessaging faults MUST include as the [action] property the default fault  
698 action URI defined in the version of WS-Addressing used in the message. The value  
699 from the current version is below for informational purposes:

700 `http://schemas.xmlsoap.org/ws/2004/08/addressing/fault`

701 The faults defined in this section are generated if the condition stated in the  
702 preamble is met. Fault handling rules are defined in section 4 of WS-Addressing.

703 The definitions of faults use the following properties:

704 [Code] The fault code.

705 [Subcode] The fault subcode.

706 [Reason] The English language reason element.

707 [Detail] The detail element. If absent, no detail element is defined for the fault.

708 The [Code] property MUST be either "Sender" or "Receiver". These properties are  
709 serialized into text XML as follows:

SOAP Version	Sender	Receiver
SOAP 1.1	S11:Client	S11:Server
SOAP 1.2	S:Sender	S:Receiver

710 The properties above bind to a SOAP 1.2 fault as follows:

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```

711 <S:Envelope>
712   <S:Header>
713     <wsa:Action>
714       http://schemas.xmlsoap.org/ws/2004/08/addressing/fault
715     </wsa:Action>
716     <!-- Headers elided for clarity. -->
717   </S:Header>
718   <S:Body>
719     <S:Fault>
720       <S:Code>
721         <S:Value> [Code] </S:Value>
722         <S:Subcode>
723           <S:Value> [Subcode] </S:Value>
724         </S:Subcode>
725       </S:Code>
726       <S:Reason>
727         <S:Text xml:lang="en"> [Reason] </S:Text>
728       </S:Reason>
729       <S:Detail>
730         [Detail]
731         ...
732       </S:Detail>
733     </S:Fault>
734   </S:Body>
735 </S:Envelope>

```

736 The properties above bind to a SOAP 1.1 fault as follows when the fault is triggered  
737 by processing an RM header block:

```

738 <S11:Envelope>
739   <S11:Header>
740     <wsrm:SequenceFault>
741       <wsrm:FaultCode> wsrm:FaultCodes </wsrm:FaultCode>
742       ...
743     </wsrm:SequenceFault>
744     <!-- Headers elided for clarity. -->
745   </S11:Header>
746   <S11:Body>
747     <S11:Fault>
748       <faultcode> [Code] </faultcode>
749       <faultstring> [Reason] </faultstring>
750     </S11:Fault>
751   </S11:Body>

```

752 `</S11:Envelope>`

753 The properties bind to a SOAP 1.1 fault as follows when the fault is generated as a  
754 result of processing a `<wsrm:CreateSequence>` request message:

```
755 <S11:Envelope>
756   <S11:Body>
757     <S11:Fault>
758       <faultcode> [Subcode] </faultcode>
759       <faultstring xml:lang="en"> [Reason] </faultstring>
760     </S11:Fault>
761   </S11:Body>
762 </S11:Envelope>
```

## 763 4.1 SequenceFault Element

764 The purpose of the `<wsrm:SequenceFault>` element is to carry the specific details of  
765 a fault generated during the reliable messaging specific processing of a message  
766 belonging to a Sequence. The `<wsrm:SequenceFault>` container MUST only be used  
767 in conjunction with the SOAP1.1 fault mechanism. It MUST NOT be used in  
768 conjunction with the SOAP1.2 binding.

769 The following exemplar defines its syntax:

```
770 <wsrm:SequenceFault ...>
771   <wsrm:FaultCode> wsrm:FaultCodes </wsrm:FaultCode>
772   ...
773 </wsrm:SequenceFault>
```

774 The following describes the content model of the `SequenceFault` element.

775 `/wsrm:SequenceFault`

776 This is the element containing Sequence information for WS-ReliableMessaging

777 `/wsrm:SequenceFault/wsrm:FaultCode`

778 This element, if present, MUST contain a qualified name from the set of fault codes defined  
779 below.

780 `/wsrm:SequenceFault/{any}`

781 This is an extensibility mechanism to allow different (extensible) types of information, based on a  
782 schema, to be passed.

783 `/wsrm:SequenceFault/@{any}`

784 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added  
785 to the element.

## 786 **4.2 Sequence Terminated**

787 This fault is sent by either the RM Source or the RM Destination to indicate that ~~the~~  
788 ~~endpoint that generated the fault it~~ has either encountered an unrecoverable  
789 condition, or has detected a violation of the protocol and as a consequence, has  
790 chosen to terminate the sequence. The endpoint that generates this fault should  
791 make every reasonable effort to notify the corresponding endpoint of this decision.

792 Properties:

793 [Code] Sender or Receiver

794 [Subcode] wsrn:SequenceTerminated

795 [Reason] The Sequence has been terminated due to an unrecoverable error.

796 [Detail]

797 `<wsrm:Identifier ...> xs:anyURI </wsrm:Identifier>`

## 798 **4.3 Unknown Sequence**

799 This fault is sent by either the RM Source or the RM Destination in response to a  
800 message containing an unknown sequence identifier.

801 Properties:

802 [Code] Sender

803 [Subcode] wsrn:UnknownSequence

804 [Reason] The value of wsrn:Identifier is not a known Sequence identifier.

805 [Detail]

806 `<wsrm:Identifier ...> xs:anyURI </wsrm:Identifier>`

## 807 **4.4 Invalid Acknowledgement**

808 This fault is sent by the RM Source in response to a  
809 `<wsrm:SequenceAcknowledgement>` that violates the cumulative acknowledgement  
810 invariant. An example of such a violation would be a `SequenceAcknowledgement`  
811 covering messages that have not been sent.

812 [Code] Sender

813 [Subcode] wsrn:InvalidAcknowledgement

814 [Reason] The SequenceAcknowledgement violates the cumulative acknowledgement  
815 invariant.

816 [Detail]

817 `<wsrm:SequenceAcknowledgement ...> ... </wsrm:SequenceAcknowledgement>`

## 818 **4.5 Message Number Rollover**

819 This fault is sent to indicate that message numbers for a sequence have been  
820 exhausted.

821 Properties:

822 [Code] Sender

823 [Subcode] wsrn:MessageNumberRollover

824 [Reason] The maximum value for wsrn:MessageNumber has been exceeded.

825 [Detail]

826 `<wsrm:Identifier ...> xs:anyURI </wsrm:Identifier>`

## 827 **4.6 Last Message Number Exceeded**

828 This fault is sent by an RM Destination to indicate that it has received a message that  
829 has a `<wsrm:MessageNumber>` within a Sequence that exceeds the value of the  
830 `<wsrm:MessageNumber>` element that accompanied a `<wsrm:LastMessage>` element  
831 for the Sequence.

832 Properties:

833 [Code] Sender

834 [Subcode] wsrn:LastMessageNumberExceeded

835 [Reason] The value for wsrn:MessageNumber exceeds the value of the  
836 MessageNumber accompanying a LastMessage element in this Sequence.

837 [Detail]

838 `<wsrm:Identifier ...> xs:anyURI </wsrm:Identifier>`

## 839 **4.7 Create Sequence Refused**

840 This fault is sent in response to a create sequence request that cannot be satisfied.

841 Properties:

842 [Code] Sender

843 [Subcode] wsrn:CreateSequenceRefused

844 [Reason] The create sequence request has been refused by the RM Destination.

845 [Detail] empty

## 846 **4.8 Sequence Closed**

847 This fault is sent by an RM Destination to indicate that the specified sequence has  
848 been closed. This fault **MUST** be generated when an RM Destination is asked to  
849 receive a message for a sequence that is closed.

850 Properties:

851 [Code] Sender

852 [Subcode] wsrn:SequenceClosed

853 [Reason] The sequence is closed and can not receive new messages.

854 [Detail] <wsrn:Identifier...> xs:anyURI </wsrn:Identifier>

## 855 **5 Security Considerations**

856 It is strongly recommended that the communication between services be secured  
857 using the mechanisms described in WS-Security. In order to properly secure  
858 messages, the body and all relevant headers need to be included in the signature.  
859 Specifically, the `<wsrm:Sequence>` header needs to be signed with the body in order  
860 to "bind" the two together. The `<wsrm:SequenceAcknowledgement>` header may be  
861 signed independently because a reply independent of the message is not a security  
862 concern.

863 Because Sequences are expected to exchange a number of messages, it is  
864 recommended that a security context be established using the mechanisms described  
865 in WS-Trust and WS-SecureConversation [SecureConversation]. If a Sequence is  
866 bound to a specific endpoint, then the security context needs to be established or  
867 shared with the endpoint servicing the Sequence. While the context can be  
868 established at any time, it is critical that the messages establishing the Sequence be  
869 secured even if they precede security context establishment. However, it is  
870 recommended that the security context be established first. Security contexts are  
871 independent of reliable messaging Sequences. Consequently, security contexts can  
872 come and go independent of the lifetime of the Sequence. In fact, it is  
873 recommended that the lifetime of a security context be less than the lifetime of the  
874 Sequence unless the Sequence is very short-lived.

875 It is common for message Sequences to exchange a number of messages (or a large  
876 amount of data). As a result, the usage profile of a Sequence is such that it is  
877 susceptible to key attacks. For this reason it is strongly recommended that the keys  
878 be changed frequently. This "re-keying" can be effected a number of ways. The  
879 following list outlines four common techniques:

- 880 • Closing and re-establishing a security context
- 881 • Exchanging new secrets between the parties
- 882 • Using a derived key sequence and switch "generations"
- 883 • Attaching a nonce to each message and using it in a derived key function with the shared  
884 secret

885 The security context may be re-established using the mechanisms described in WS-  
886 Trust and WS-SecureConversation. Similarly, secrets can be exchanged using the  
887 mechanisms described in WS-Trust. Note, however, that the current shared secret  
888 should not be used to encrypt the new shared secret. Derived keys, the preferred  
889 solution from this list, can be specified using the mechanisms described in WS-  
890 SecureConversation.

891 There is a core tension between security and reliable messaging that can be  
892 problematic if not considered in implementations. That is, one aspect of security is  
893 to prevent message replay and the core tenet of reliable messaging is to replay  
894 messages until they are acknowledged. Consequently, if the security sub-system  
895 processes a message but a failure occurs before the reliable messaging sub-system  
896 records the message (or the message is considered "processed"), then it is possible  
897 (and likely) that the security sub-system will treat subsequent copies as replays and  
898 discard them. At the same time, the reliable messaging sub-system will likely  
899 continue to expect and even solicit the missing message(s). Care should be taken to  
900 avoid and prevent this rare condition.

901 The following list summarizes common classes of attacks that apply to this protocol  
902 and identifies the mechanism to prevent/mitigate the attacks:

- 903 • **Message alteration** – Alteration is prevented by including signatures of the message  
904 information using WS-Security.
- 905 • **Message disclosure** – Confidentiality is preserved by encrypting sensitive data using WS-  
906 Security.
- 907 • **Key integrity** – Key integrity is maintained by using the strongest algorithms possible (by  
908 comparing secured policies – see WS-Policy and WS-SecurityPolicy).
- 909 • **Authentication** – Authentication is established using the mechanisms described in WS-  
910 Security and WS-Trust. Each message is authenticated using the mechanisms described in  
911 WS-Security.
- 912 • **Accountability** – Accountability is a function of the type of and string of the key and  
913 algorithms being used. In many cases, a strong symmetric key provides sufficient  
914 accountability. However, in some environments, strong PKI signatures are required.
- 915 • **Availability** – All reliable messaging services are subject to a variety of availability attacks.  
916 Replay detection is a common attack and it is recommended that this be addressed by the  
917 mechanisms described in WS-Security. (Note that because of legitimate message replays,  
918 detection should include a differentiator besides message id such as a timestamp). Other  
919 attacks, such as network-level denial of service attacks are harder to avoid and are outside  
920 the scope of this specification. That said, care should be taken to ensure that minimal state is  
921 saved prior to any authenticating sequences.

## 922 **6 References**

### 923 **6.1 Normative**

#### 924 **[KEYWORDS]**

925 S. Bradner, "[Key words for use in RFCs to Indicate Requirement Levels](#)," RFC 2119, Harvard  
926 University, March 1997

#### 927 **[SOAP]**

928 W3C Note, "[SOAP: Simple Object Access Protocol 1.1](#)," 08 May 2000.

#### 929 **[URI]**

930 T. Berners-Lee, R. Fielding, L. Masinter, "[Uniform Resource Identifiers \(URI\): Generic Syntax](#),"  
931 RFC 2396, MIT/LCS, U.C. Irvine, Xerox Corporation, August 1998.

#### 932 **[XML-ns]**

933 W3C Recommendation, "[Namespaces in XML](#)," 14 January 1999.

#### 934 **[XML-Schema1]**

935 W3C Recommendation, "[XML Schema Part 1: Structures](#)," 2 May 2001.

#### 936 **[XML-Schema2]**

937 W3C Recommendation, "[XML Schema Part 2: Datatypes](#)," 2 May 2001.

#### 938 **[WSSecurity]**

939 "[OASIS Web Services Security: SOAP Message Security 1.0 \(WS-Security 2004\)](#)",  
940 Anthony Nadalin, Chris Kaler, Phillip Hallam-Baker, Ronald Monzillo, eds, OASIS  
941 Standard 200401, March 2004.

#### 942 **[Tanenbaum]**

943 "Computer Networks," Andrew S. Tanenbaum, Prentice Hall PTR, 2003.

#### 944 **[WSDL]**

945 W3C Note, "[Web Services Description Language \(WSDL 1.1\)](#)," 15 March 2001.

#### 946 **[WS-Addressing]**

947 D. Box, et al, "[Web Services Addressing \(WS-Addressing\)](#)," August 2004.

### 948 **6.2 Non-Normative**

#### 949 **[WS-Policy]**

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- 950 D. Box, et al, "[Web Services Policy Framework \(WS-Policy\)](#)," September 2004.
- 951 **[WS-PolicyAttachment]**
- 952 D. Box, et al, "[Web Services Policy Attachment \(WS-PolicyAttachment\)](#)," September 2004.
- 953 **[SecurityPolicy]**
- 954 G. Della-Libra, "[Web Services Security Policy Language \(WS-SecurityPolicy\)](#)," December 2002.
- 955 **[SecureConversation]**
- 956 S. Anderson, et al, "[Web Services Secure Conversation Language \(WS-SecureConversation\)](#),"
- 957 May 2004.
- 958

## 959 Appendix A.Schema

960 The normative schema for WS-ReliableMessaging is located at:

961 <http://docs.oasis-open.org/wsrn/200510/wsrn.xsd>

962 The following copy is provided for reference.

```
963 <xs:schema targetNamespace="http://docs.oasis-open.org/wsrn/200510/"
964 xmlns:xs="http://www.w3.org/2001/XMLSchema"
965 xmlns:wsa="http://schemas.xmlsoap.org/ws/2004/08/addressing"
966 xmlns:wsrm="http://docs.oasis-open.org/wsrn/200510/"
967 elementFormDefault="qualified" attributeFormDefault="unqualified">
968   <xs:import
969 namespace="http://schemas.xmlsoap.org/ws/2004/08/addressing"
970 schemaLocation="http://schemas.xmlsoap.org/ws/2004/08/addressing"/>
971   <!-- Protocol Elements -->
972   <xs:complexType name="SequenceType">
973     <xs:sequence>
974       <xs:element ref="wsrm:Identifier"/>
975       <xs:element name="MessageNumber" type="xs:unsignedLong"/>
976       <xs:element name="LastMessage" minOccurs="0">
977         <xs:complexType>
978           <xs:sequence/>
979         </xs:complexType>
980       </xs:element>
981       <xs:any namespace="##other" processContents="lax" minOccurs="0"
982 maxOccurs="unbounded"/>
983     </xs:sequence>
984     <xs:anyAttribute namespace="##other" processContents="lax"/>
985   </xs:complexType>
986   <xs:element name="Sequence" type="wsrm:SequenceType"/>
987   <xs:element name="SequenceAcknowledgement">
988     <xs:complexType>
989       <xs:sequence>
990         <xs:element ref="wsrm:Identifier"/>
991         <xs:choice>
992           <ws:sequence>
993             <xs:element name="AcknowledgementRange"
994 maxOccurs="unbounded">
995               <xs:complexType>
996                 <xs:sequence/>
```

```

997         <xs:attribute name="Upper" type="xs:unsignedLong"
998 use="required"/>
999         <xs:attribute name="Lower" type="xs:unsignedLong"
1000 use="required"/>
1001         <xs:anyAttribute namespace="##other"
1002 processContents="lax"/>
1003     </xs:complexType>
1004 </xs:element>
1005     <ws:element name="Final" minOccurs="0">
1006         <xs:complexType>
1007             <xs:sequence/>
1008         </xs:complexType>
1009     </ws:element>
1010 </ws:sequence>
1011     <xs:element name="Nack" type="xs:unsignedLong"
1012 minOccurs="unbounded"/>
1013     <xs:element name="None" minOccurs="0">
1014         <xs:complexType>
1015             <xs:sequence/>
1016         </xs:complexType>
1017     </xs:element>
1018 </xs:choice>
1019     <xs:any namespace="##other" processContents="lax" minOccurs="0"
1020 minOccurs="unbounded"/>
1021 </xs:sequence>
1022     <xs:anyAttribute namespace="##other" processContents="lax"/>
1023 </xs:complexType>
1024 </xs:element>
1025 <xs:complexType name="AckRequestedType">
1026     <xs:sequence>
1027         <xs:element ref="wsrm:Identifier"/>
1028         <xs:element name="MessageNumber" type="xs:unsignedLong"
1029 minOccurs="0"/>
1030     <xs:any namespace="##other" processContents="lax" minOccurs="0"
1031 minOccurs="unbounded"/>
1032 </xs:sequence>
1033     <xs:anyAttribute namespace="##other" processContents="lax"/>
1034 </xs:complexType>
1035 <xs:element name="AckRequested" type="wsrm:AckRequestedType"/>
1036 <xs:element name="Identifier">
1037     <xs:complexType>
1038         <xs:annotation>

```

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```

    <xs:documentation>
This type is for elements whose [children] is an anyURI and can have
arbitrary attributes.
    </xs:documentation>
</xs:annotation>
<xs:simpleContent>
  <xs:extension base="xs:anyURI">
    <xs:anyAttribute namespace="##other" processContents="lax"/>
  </xs:extension>
</xs:simpleContent>
</xs:complexType>
</xs:element>
<!-- Fault Container and Codes -->
<xs:simpleType name="FaultCodes">
  <xs:restriction base="xs:QName">
    <xs:enumeration value="wsrm:UnknownSequence"/>
    <xs:enumeration value="wsrm:SequenceTerminated"/>
    <xs:enumeration value="wsrm:InvalidAcknowledgement"/>
    <xs:enumeration value="wsrm:MessageNumberRollover"/>
    <xs:enumeration value="wsrm:CreateSequenceRefused"/>
    <xs:enumeration value="wsrm:LastMessageNumberExceeded"/>
  </xs:restriction>
</xs:simpleType>
<xs:complexType name="SequenceFaultType">
  <xs:sequence>
    <xs:element name="FaultCode" type="wsrm:FaultCodes"/>
    <xs:any namespace="##any" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
<xs:element name="SequenceFault" type="wsrm:SequenceFaultType"/>
<xs:element name="CreateSequence" type="wsrm:CreateSequenceType"/>
<xs:element name="CreateSequenceResponse"
type="wsrm:CreateSequenceResponseType"/>
<xs:element name="CloseSequence" type="wsrm:CloseSequenceType"/>
<xs:element name="CloseSequenceResponse"
type="wsrm:CloseSequenceResponseType"/>
<xs:element name="TerminateSequence"
type="wsrm:TerminateSequenceType"/>
<xs:complexType name="CreateSequenceType">
  <xs:sequence>
```

```

1081     <xs:element ref="wsrm:AcksTo"/>
1082     <xs:element ref="wsrm:Expires" minOccurs="0"/>
1083     <xs:element name="Offer" type="wsrm:OfferType" minOccurs="0"/>
1084     <xs:any namespace="##other" processContents="lax" minOccurs="0"
1085 maxOccurs="unbounded">
1086         <xs:annotation>
1087             <xs:documentation>
1088 It is the authors intent that this extensibility be used to transfer a
1089 Security Token Reference as defined in WS-Security.
1090 </xs:documentation>
1091         </xs:annotation>
1092     </xs:any>
1093 </xs:sequence>
1094 <xs:anyAttribute namespace="##other" processContents="lax"/>
1095 </xs:complexType>
1096 <xs:complexType name="CreateSequenceResponseType">
1097     <xs:sequence>
1098         <xs:element ref="wsrm:Identifier"/>
1099         <xs:element ref="wsrm:Expires" minOccurs="0"/>
1100         <xs:element name="Accept" type="wsrm:AcceptType" minOccurs="0"/>
1101         <xs:any namespace="##other" processContents="lax" minOccurs="0"
1102 maxOccurs="unbounded"/>
1103     </xs:sequence>
1104     <xs:anyAttribute namespace="##other" processContents="lax"/>
1105 </xs:complexType>
1106 <xs:complexType name="CloseSequenceType">
1107     <xs:sequence>
1108         <xs:any namespace="##other" processContents="lax" minOccurs="0"
1109 maxOccurs="unbounded"/>
1110     </xs:sequence>
1111     <xs:attribute name="Identifier" type="xs:anyURI" use="required"/>
1112     <xs:anyAttribute namespace="##other" processContents="lax"/>
1113 </xs:complexType>
1114 <xs:complexType name="CloseSequenceResponseType">
1115     <xs:sequence>
1116         <xs:any namespace="##other" processContents="lax" minOccurs="0"
1117 maxOccurs="unbounded"/>
1118     </xs:sequence>
1119     <xs:anyAttribute namespace="##other" processContents="lax"/>
1120 </xs:complexType>
1121 <xs:complexType name="TerminateSequenceType">
1122     <xs:sequence>

```

```

1123     <xs:element ref="wsrm:Identifier"/>
1124     <xs:any namespace="##other" processContents="lax" minOccurs="0"
1125 maxOccurs="unbounded"/>
1126   </xs:sequence>
1127   <xs:anyAttribute namespace="##other" processContents="lax"/>
1128 </xs:complexType>
1129 <xs:element name="AcksTo" type="wsa:EndpointReferenceType"/>
1130 <xs:complexType name="OfferType">
1131   <xs:sequence>
1132     <xs:element ref="wsrm:Identifier"/>
1133     <xs:element ref="wsrm:Expires" minOccurs="0"/>
1134     <xs:any namespace="##other" processContents="lax" minOccurs="0"
1135 maxOccurs="unbounded"/>
1136   </xs:sequence>
1137   <xs:anyAttribute namespace="##other" processContents="lax"/>
1138 </xs:complexType>
1139 <xs:complexType name="AcceptType">
1140   <xs:sequence>
1141     <xs:element ref="wsrm:AcksTo"/>
1142     <xs:any namespace="##other" processContents="lax" minOccurs="0"
1143 maxOccurs="unbounded"/>
1144   </xs:sequence>
1145   <xs:anyAttribute namespace="##other" processContents="lax"/>
1146 </xs:complexType>
1147 <xs:element name="Expires">
1148   <xs:complexType>
1149     <xs:simpleContent>
1150       <xs:extension base="xs:duration">
1151         <xs:anyAttribute namespace="##other" processContents="lax"/>
1152       </xs:extension>
1153     </xs:simpleContent>
1154   </xs:complexType>
1155 </xs:element>
1156 </xs:schema>

```

1157 **Appendix B.Message Examples**

## 1158 B.1.Create Sequence

### 1159 Create Sequence

```
1160 <?xml version="1.0" encoding="UTF-8"?>
1161 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
1162 xmlns:wsmr="http://docs.oasis-open.org/wsmr/200510/"
1163 xmlns:wsa="http://schemas.xmlsoap.org/ws/2004/08/addressing">
1164   <S:Header>
1165     <wsa:MessageID>
1166       http://Business456.com/guid/0baaf88d-483b-4ecf-a6d8-a7c2eb546817
1167     </wsa:MessageID>
1168     <wsa:To>http://example.com/serviceB/123</wsa:To>
1169     <wsa:Action>http://docs.oasis-
1170 open.org/wsmr/200510/CreateSequence</wsa:Action>
1171     <wsa:ReplyTo>
1172       <wsa:Address>http://Business456.com/serviceA/789</wsa:Address>
1173     </wsa:ReplyTo>
1174   </S:Header>
1175   <S:Body>
1176     <wsmr:CreateSequence>
1177       <wsmr:AcksTo>
1178         <wsa:Address>http://Business456.com/serviceA/789</wsa:Address>
1179       </wsmr:AcksTo>
1180     </wsmr:CreateSequence>
1181   </S:Body>
1182 </S:Envelope>
```

### 1183 Create Sequence Response

```
1184 <?xml version="1.0" encoding="UTF-8"?>
1185 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
1186 xmlns:wsmr="http://docs.oasis-open.org/wsmr/200510/"
1187 xmlns:wsa="http://schemas.xmlsoap.org/ws/2004/08/addressing">
1188   <S:Header>
1189     <wsa:To>http://Business456.com/serviceA/789</wsa:To>
1190     <wsa:RelatesTo>
1191       http://Business456.com/guid/0baaf88d-483b-4ecf-a6d8a7c2eb546817
1192     </wsa:RelatesTo>
1193     <wsa:Action>
1194       http://docs.oasis-open.org/wsmr/200510/CreateSequenceResponse
```

```
1195     </wsa:Action>
1196 </S:Header>
1197 <S:Body>
1198     <wsrm:CreateSequenceResponse>
1199         <wsrm:Identifier>http://Business456.com/RM/ABC</wsrm:Identifier>
1200     </wsrm:CreateSequenceResponse>
1201 </S:Body>
1202 </S:Envelope>
```

## 1203 B.2. Initial Transmission

1204 The following example WS-ReliableMessaging headers illustrate the message  
1205 exchange in the above figure. The three messages have the following headers; the  
1206 third message is identified as the last message in the sequence:

### 1207 Message 1

```
1208 <?xml version="1.0" encoding="UTF-8"?>
1209 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
1210 xmlns:wsm="http://docs.oasis-open.org/wsm/200510/"
1211 xmlns:wsa="http://schemas.xmlsoap.org/ws/2004/08/addressing">
1212   <S:Header>
1213     <wsa:MessageID>
1214       http://Business456.com/guid/71e0654e-5ce8-477b-bb9d-34f05cfc9e
1215     </wsa:MessageID>
1216     <wsa:To>http://example.com/serviceB/123</wsa:To>
1217     <wsa:From>
1218       <wsa:Address>http://Business456.com/serviceA/789</wsa:Address>
1219     </wsa:From>
1220     <wsa:Action>http://example.com/serviceB/123/request</wsa:Action>
1221     <wsm:Sequence>
1222       <wsm:Identifier>http://Business456.com/RM/ABC</wsm:Identifier>
1223       <wsm:MessageNumber>1</wsm:MessageNumber>
1224     </wsm:Sequence>
1225   </S:Header>
1226   <S:Body>
1227     <!-- Some Application Data -->
1228   </S:Body>
1229 </S:Envelope>
```

### 1230 Message 2

```
1231 <?xml version="1.0" encoding="UTF-8"?>
1232 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
1233 xmlns:wsm="http://docs.oasis-open.org/wsm/200510/"
1234 xmlns:wsa="http://schemas.xmlsoap.org/ws/2004/08/addressing">
1235   <S:Header>
1236     <wsa:MessageID>
1237       http://Business456.com/guid/daa7d0b2-c8e0-476e-a9a4-d164154e38de
1238     </wsa:MessageID>
1239     <wsa:To>http://example.com/serviceB/123</wsa:To>
```

```
1240     <wsa:From>
1241         <wsa:Address>http://Business456.com/serviceA/789</wsa:Address>
1242     </wsa:From>
1243     <wsa:Action>http://example.com/serviceB/123/request</wsa:Action>
1244     <wsrm:Sequence>
1245         <wsrm:Identifier>http://Business456.com/RM/ABC</wsrm:Identifier>
1246         <wsrm:MessageNumber>2</wsrm:MessageNumber>
1247     </wsrm:Sequence>
1248 </S:Header>
1249 <S:Body>
1250     <!-- Some Application Data -->
1251 </S:Body>
1252 </S:Envelope>
```

### 1253 Message 3

```
1254 <?xml version="1.0" encoding="UTF-8"?>
1255 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
1256 xmlns:wsrm="http://docs.oasis-open.org/wsrn/200510/"
1257 xmlns:wsa="http://schemas.xmlsoap.org/ws/2004/08/addressing">
1258     <S:Header>
1259         <wsa:MessageID>
1260             http://Business456.com/guid/0baaf88d-483b-4ecf-a6d8-a7c2eb546819
1261         </wsa:MessageID>
1262         <wsa:To>http://example.com/serviceB/123</wsa:To>
1263         <wsa:From>
1264             <wsa:Address>http://Business456.com/serviceA/789</wsa:Address>
1265         </wsa:From>
1266         <wsa:Action>http://example.com/serviceB/123/request</wsa:Action>
1267         <wsrm:Sequence>
1268             <wsrm:Identifier>http://Business456.com/RM/ABC</wsrm:Identifier>
1269             <wsrm:MessageNumber>3</wsrm:MessageNumber>
1270             <wsrm:LastMessage/>
1271         </wsrm:Sequence>
1272     </S:Header>
1273     <S:Body>
1274         <!-- Some Application Data -->
1275     </S:Body>
1276 </S:Envelope>
```

## 1277 B.3.First Acknowledgement

1278 Message number 2 has not been received by the RM Destination due to some  
1279 transmission error so it responds with an acknowledgement for messages 1 and 3:

```
1280 <?xml version="1.0" encoding="UTF-8"?>
1281 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
1282 xmlns:wsmr="http://docs.oasis-open.org/wsmr/200510/"
1283 xmlns:wsa="http://schemas.xmlsoap.org/ws/2004/08/addressing">
1284   <S:Header>
1285     <wsa:MessageID>
1286       http://example.com/guid/0baaf88d-483b-4ecf-a6d8-a7c2eb546810
1287     </wsa:MessageID>
1288     <wsa:To>http://Business456.com/serviceA/789</wsa:To>
1289     <wsa:From>
1290       <wsa:Address>http://example.com/serviceB/123</wsa:Address>
1291     </wsa:From>
1292     <wsa:Action>
1293       http://docs.oasis-open.org/wsmr/200510/SequenceAcknowledgement
1294     </wsa:Action>
1295     <wsmr:SequenceAcknowledgement>
1296       <wsmr:Identifier>http://Business456.com/RM/ABC</wsmr:Identifier>
1297       <wsmr:AcknowledgementRange Upper="1" Lower="1"/>
1298       <wsmr:AcknowledgementRange Upper="3" Lower="3"/>
1299     </wsmr:SequenceAcknowledgement>
1300   </S:Header>
1301   <S:Body/>
1302 </S:Envelope>
```

## 1303 B.4.Retransmission

1304 The ~~sending-endpoint~~RM Source discovers that message number 2 was not received  
1305 so it resends the message and requests an acknowledgement:

```
1306 <?xml version="1.0" encoding="UTF-8"?>
1307 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
1308 xmlns:wsmr="http://docs.oasis-open.org/wsmr/200510/"
1309 xmlns:wsa="http://schemas.xmlsoap.org/ws/2004/08/addressing">
1310   <S:Header>
1311     <wsa:MessageID>
1312       http://Business456.com/guid/daa7d0b2-c8e0-476e-a9a4-d164154e38de
1313     </wsa:MessageID>
1314     <wsa:To>http://example.com/serviceB/123</wsa:To>
1315     <wsa:From>
1316       <wsa:Address>http://Business456.com/serviceA/789</wsa:Address>
1317     </wsa:From>
1318     <wsa:Action>http://example.com/serviceB/123/request</wsa:Action>
1319     <wsmr:Sequence>
1320       <wsmr:Identifier>http://Business456.com/RM/ABC</wsmr:Identifier>
1321       <wsmr:MessageNumber>2</wsmr:MessageNumber>
1322     </wsmr:Sequence>
1323     <wsmr:AckRequested>
1324       <wsmr:Identifier>http://Business456.com/RM/ABC</wsmr:Identifier>
1325     </wsmr:AckRequested>
1326   </S:Header>
1327   <S:Body>
1328     <!-- Some Application Data -->
1329   </S:Body>
1330 </S:Envelope>
```

## 1331 B.5.Termination

1332 The RM Destination now responds with an acknowledgement for the complete  
1333 sequence which can then be terminated:

```
1334 <?xml version="1.0" encoding="UTF-8"?>
1335 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
1336 xmlns:wsmr="http://docs.oasis-open.org/wsmr/200510/"
1337 xmlns:wsa="http://schemas.xmlsoap.org/ws/2004/08/addressing">
1338   <S:Header>
1339     <wsa:MessageID>
1340       http://example.com/guid/0baaf88d-483b-4ecf-a6d8-a7c2eb546811
1341     </wsa:MessageID>
1342     <wsa:To>http://Business456.com/serviceA/789</wsa:To>
1343     <wsa:From>
1344       <wsa:Address>http://example.com/serviceB/123</wsa:Address>
1345     </wsa:From>
1346     <wsa:Action>
1347       http://docs.oasis-open.org/wsmr/200510/SequenceAcknowledgement
1348     </wsa:Action>
1349     <wsmr:SequenceAcknowledgement>
1350       <wsmr:Identifier>http://Business456.com/RM/ABC</wsmr:Identifier>
1351       <wsmr:AcknowledgementRange Upper="3" Lower="1"/>
1352     </wsmr:SequenceAcknowledgement>
1353   </S:Header>
1354   <S:Body/>
1355 </S:Envelope>
```

### 1356 Terminate Sequence

```
1357 <?xml version="1.0" encoding="UTF-8"?>
1358 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
1359 xmlns:wsmr="http://docs.oasis-open.org/wsmr/200510/"
1360 xmlns:wsa="http://schemas.xmlsoap.org/ws/2004/08/addressing">
1361   <S:Header>
1362     <wsa:MessageID>
1363       http://Business456.com/guid/0baaf88d-483b-4ecf-a6d8-a7c2eb546812
1364     </wsa:MessageID>
1365     <wsa:To>http://example.com/serviceB/123</wsa:To>
1366     <wsa:Action>
1367       http://docs.oasis-open.org/wsmr/200510/TerminateSequence
1368     </wsa:Action>
```

```
1369     <wsa:From>
1370     <wsa:Address>http://Business456.com/serviceA/789</wsa:Address>
1371     </wsa:From>
1372 </S:Header>
1373 <S:Body>
1374     <wsrm:TerminateSequence>
1375     <wsrm:Identifier>http://Business456.com/RM/ABC</wsrm:Identifier>
1376     </wsrm:TerminateSequence>
1377 </S:Body>
1378 </S:Envelope>
```

## 1379 Appendix C.WSDL

1380 The non-normative WSDL 1.1 definition for WS-ReliableMessaging is located at:

1381 <http://docs.oasis-open.org/wsrn/200510/wSDL/wsrn.wSDL>

1382 The following non-normative copy is provided for reference.

```
1383 <wSDL:definitions xmlns:wSDL="http://schemas.xmlsoap.org/wSDL/"
1384 xmlns:xs="http://www.w3.org/2001/XMLSchema"
1385 xmlns:wsa="http://schemas.xmlsoap.org/ws/2004/08/addressing"
1386 xmlns:rm="http://docs.oasis-open.org/wsrn/200510/"
1387 xmlns:tns="http://docs.oasis-open.org/wsrn/200510/wSDL"
1388 targetNamespace="http://docs.oasis-open.org/wsrn/200510/wSDL">
1389 <wSDL:types>
1390   <xs:schema>
1391     <xs:import namespace="http://docs.oasis-open.org/wsrn/200510/"
1392     schemaLocation="http://docs.oasis-open.org/wsrn/200510/wsrn.xsd"/>
1393     <xs:import
1394     namespace="http://schemas.xmlsoap.org/ws/2004/08/addressing"
1395     schemaLocation="http://schemas.xmlsoap.org/ws/2004/08/addressing"/>
1396   </xs:schema>
1397 </wSDL:types>
1398 <wSDL:message name="CreateSequence">
1399   <wSDL:part name="create" element="rm:CreateSequence"/>
1400 </wSDL:message>
1401 <wSDL:message name="CreateSequenceResponse">
1402   <wSDL:part name="createResponse"
1403   element="rm:CreateSequenceResponse"/>
1404 </wSDL:message>
1405 <wSDL:message name="CloseSequence">
1406   <wSDL:part name="close" element="rm:CloseSequence"/>
1407 </wSDL:message>
1408 <wSDL:message name="CloseSequenceResponse">
1409   <wSDL:part name="closeResponse" element="rm:CloseSequenceResponse"/>
1410 </wSDL:message>
1411 <wSDL:message name="TerminateSequence">
1412   <wSDL:part name="terminate" element="rm:TerminateSequence"/>
1413 </wSDL:message>
1414 <wSDL:portType name="SequenceAbstractPortType">
1415   <wSDL:operation name="CreateSequence">
```

```
1416     <wsdl:input message="tns:CreateSequence"
1417 wsa:Action="http://docs.oasis-open.org/wsrn/200510/CreateSequence"/>
1418     <wsdl:output message="tns:CreateSequenceResponse"
1419 wsa:Action="http://docs.oasis-
1420 open.org/wsrn/200510/CreateSequenceResponse"/>
1421 </wsdl:operation>
1422 <wsdl:operation name="CloseSequence">
1423     <wsdl:input name="tns:CloseSequence"
1424 wsa:Action="http://docs.oasis-open.org/wsrn/200510/CloseSequence"/>
1425     <wsdl:output name="tns:CloseSequenceResponse"
1426 wsa:Action="http://docs.oasis-
1427 open.org/wsrn/200510/CloseSequenceResponse"/>
1428 </wsdl:operation>
1429 <wsdl:operation name="TerminateSequence">
1430     <wsdl:input message="tns:TerminateSequence"
1431 wsa:Action="http://docs.oasis-
1432 open.org/wsrn/200510/CreateSequenceResponse"/>
1433 </wsdl:operation>
1434 </wsdl:portType>
1435 </wsdl:definitions>
```

## 1436 **Appendix D.Acknowledgments**

1437 This document is based on initial contribution to OASIS WS-RX Technical Committee by the  
1438 following authors: Ruslan Bilorusets, BEA, Don Box, Microsoft, Luis Felipe Cabrera, Microsoft,  
1439 Doug Davis, IBM, Donald Ferguson, IBM, Christopher Ferris, IBM (Editor), Tom Freund, IBM,  
1440 Mary Ann Hondo, IBM, John Ibbotson, IBM, Lei Jin, BEA, Chris Kaler, Microsoft, David  
1441 Langworthy, Microsoft (Editor), Amelia Lewis, TIBCO Software, Rodney Limprecht, Microsoft,  
1442 Steve Lucco, Microsoft, Don Mullen, TIBCO Software, Anthony Nadalin, IBM, Mark Nottingham,  
1443 BEA, David Orchard, BEA, Jamie Roots, IBM, Shivajee Samdarshi, TIBCO Software, John  
1444 Shewchuk, Microsoft, Tony Storey, IBM

1445 The following individuals have provided invaluable input into the initial contribution:

1446 Keith Ballinger, Microsoft, Stefan Batres, Microsoft, Allen Brown, Microsoft, Michael Conner, IBM,  
1447 George Copeland, Microsoft, Francisco Curbera, IBM, Paul Fremantle, IBM, Steve Graham, IBM,  
1448 Pat Helland, Microsoft, Rick Hill, Microsoft, Scott Hinkelman, IBM, Tim Holloway, IBM, Efim Hudis,  
1449 Microsoft, Gopal Kakivaya, Microsoft, Johannes Klein, Microsoft, Frank Leymann, IBM, Martin  
1450 Nally, IBM, Peter Niblett, IBM, Jeffrey Schlimmer, Microsoft, James Snell, IBM, Keith Stobie,  
1451 Microsoft, Satish Thatte, Microsoft, Stephen Todd, IBM, Sanjiva Weerawarana, IBM, Roger  
1452 Wolter, Microsoft

1453 The following individuals were members of the committee during the development of this  
1454 specification:

1455 TBD

## 1456 Appendix E.Revision History

Rev	Date	By Whom	What
wd-01	2005-07-07	Christopher Ferris	Initial version created based on submission by the authors.
ws-02	2005-07-21	Doug Davis	I011 (PTOS) added
wd-02	2005-08-16	Anish Karmarkar	Trivial editorial changes
ws-03	2005-09-15	Doug Davis	I019 and i028 (CloseSeq) added
wd-05	2005-09-26	Gilbert Pilz	i005 (Source resend of nacks messages when ack already received) added.
wd-05	2005-09-27	Doug Davis	i027 (InOrder delivery assurance spanning multiple sequences) added
wd-05	2005-09-27	Doug Davis	i020 (Semantics of "At most once" Delivery Assurance) added
wd-05	2005-09-27	Doug Davis	i034 (Fault while processing a piggy-backed RM header) added
wd-05	2005-09-27	Doug Davis	i033 (Processing model of NACKs) added
wd-05	2005-09-27	Doug Davis	i031 (AckRequested schema inconsistency) added
wd-05	2005-09-27	Doug Davis	i025 (SeqAck/None) added
wd-05	2005-09-27	Doug Davis	i029 (Remove dependency on WS-Security) added
wd-05	2005-09-27	Doug Davis	i039 (What does 'have a mU attribute' mean) added
wd-05	2005-09-27	Doug Davis	i040 (Change 'optional'/'required' to 'OPTIONAL'/'REQUIRED') added
wd-05	2005-09-30	Anish Karmarkar	i017 (Change NS to <a href="http://docs.oasis-open.org/wsrn/200510/">http://docs.oasis-open.org/wsrn/200510/</a> )
wd-05	2005-09-30	Anish Karmarkar	i045 (Include SecureConversation as a reference and move it to non-normative citation)
wd-05	2005-09-30	Anish Karmarkar	i046 (change the type of wsrn:FaultCode element)

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