



# 1 Web Services Reliable Messaging 2 (WS-ReliableMessaging)

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### 16 Abstract:

17 This specification (WS-ReliableMessaging) describes a protocol that allows messages to be transferred  
18 reliably between nodes implementing this protocol in the presence of software component, system, or  
19 network failures. The protocol is described in this specification in a transport-independent manner  
20 allowing it to be implemented using different network technologies. To support interoperable Web  
21 services, a SOAP binding is defined within this specification.

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

25 By using the XML [XML], SOAP [SOAP 1.1], [SOAP 1.2] and WSDL [WSDL 1.1] extensibility model,  
26 SOAP-based and WSDL-based specifications are designed to be composed with each other to define a  
27 rich Web services environment. As such, WS-ReliableMessaging by itself does not define all the features  
28 required for a complete messaging solution. WS-ReliableMessaging is a building block that is used in  
29 conjunction with other specifications and application-specific protocols to accommodate a wide variety of  
30 requirements and scenarios related to the operation of distributed Web services.

### 31 Status:

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34 This document is updated periodically on no particular schedule. Technical Committee members should  
35 send comments on this specification to the Technical Committee's email list. Others should send  
36 comments to the Technical Committee by using the "Send A Comment" button on the Technical  
37 Committee's web page at <http://www.oasis-open.org/committees/ws-rx>. For information on whether any  
38 patents have been disclosed that may be essential to implementing this specification, and any offers of  
39 patent licensing terms, please refer to the Intellectual Property Rights section of the Technical  
40 Committee web page (<http://www.oasis-open.org/committees/ws-rx/ipr.php>). The non-normative errata  
41 page for this specification is located at <http://www.oasis-open.org/committees/ws-rx>.

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# 109 1 Introduction

110 It is often a requirement for two Web services that wish to communicate to do so reliably in the presence  
111 of software component, system, or network failures. The primary goal of this specification is to create a  
112 modular mechanism for reliable transfer of messages. It defines a messaging protocol to identify, track,  
113 and manage the reliable transfer of messages between a source and a destination. It also defines a  
114 SOAP binding that is required for interoperability. Additional bindings can be defined.

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

## 119 1.1 Notational Conventions

120 The keywords "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD  
121 NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described  
122 in RFC 2119 [KEYWORDS].

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

- 124 • The syntax appears as an XML instance, but values in italics indicate data types instead of values.
- 125 • Characters are appended to elements and attributes to indicate cardinality:
  - 126 ○ "?" (0 or 1)
  - 127 ○ "\*" (0 or more)
  - 128 ○ "+" (1 or more)
- 129 • The character "|" is used to indicate a choice between alternatives.
- 130 • The characters "[" and "]" are used to indicate that contained items are to be treated as a group  
131 with respect to cardinality or choice.
- 132 • An ellipsis (i.e. "...") indicates a point of extensibility that allows other child or attribute content  
133 specified in this document. Additional children elements and/or attributes MAY be added at the  
134 indicated extension points but they MUST NOT contradict the semantics of the parent and/or  
135 owner, respectively. If an extension is not recognized it SHOULD be ignored.
- 136 • XML namespace prefixes (See Section 1.2) are used to indicate the namespace of the element  
137 being defined.

138 Elements and Attributes defined by this specification are referred to in the text of this document using  
139 XPath 1.0 [XPATH 1.0] expressions. Extensibility points are referred to using an extended version of this  
140 syntax:

- 141 • An element extensibility point is referred to using {any} in place of the element name. This  
142 indicates that any element name can be used, from any namespace other than the wsrn:  
143 namespace.
- 144 • An attribute extensibility point is referred to using @{any} in place of the attribute name. This  
145 indicates that any attribute name can be used, from any namespace other than the wsrn:  
146 namespace.

147 **1.2 Namespace**

148 The XML namespace [XML-ns] URI that MUST be used by implementations of this specification is:

149 <http://docs.oasis-open.org/ws-rx/wsrn/200608>

150 Dereferencing the above URI will produce the Resource Directory Description Language [RDDL 2.0]  
151 document that describes this namespace.

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

154 Table 1

Prefix	Namespace
S	(Either SOAP 1.1 or 1.2)
S11	<a href="http://schemas.xmlsoap.org/soap/envelope/">http://schemas.xmlsoap.org/soap/envelope/</a>
S12	<a href="http://www.w3.org/2003/05/soap-envelope">http://www.w3.org/2003/05/soap-envelope</a>
wsrn	<a href="http://docs.oasis-open.org/ws-rx/wsrn/200608">http://docs.oasis-open.org/ws-rx/wsrn/200608</a>
wsa	<a href="http://www.w3.org/2005/08/addressing">http://www.w3.org/2005/08/addressing</a>
wsaw	<a href="http://www.w3.org/2006/05/addressing/wsdl">http://www.w3.org/2006/05/addressing/wsdl</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>

155 The normative schema for WS-ReliableMessaging can be found linked from the namespace document  
156 that is located at the namespace URI specified above.

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

158 **1.3 Compliance**

159 An implementation is not compliant with this specification if it fails to satisfy one or more of the MUST or  
160 REQUIRED level requirements defined herein. A SOAP Node MUST NOT use the XML namespace  
161 identifier for this specification (listed in Section 1.2) within SOAP Envelopes unless it is compliant with this  
162 specification.

163 Normative text within this specification takes precedence over normative outlines, which in turn take  
164 precedence over the XML Schema [XML Schema Part 1, Part 2] descriptions.

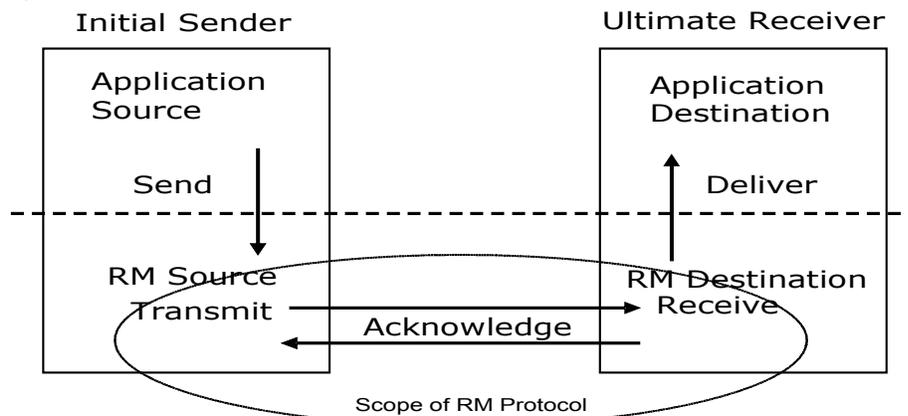
## 2 Reliable Messaging Model

166 Many errors can interrupt a conversation. Messages can be lost, duplicated or reordered. Further the host  
167 systems can experience failures and lose volatile state.

168 The WS-ReliableMessaging specification defines an interoperable protocol that enables a Reliable  
169 Messaging (RM) Source to accurately determine the disposition of each message it Transmits as  
170 perceived by the RM Destination, so as to allow it to resolve any in-doubt status regarding receipt of the  
171 message Transmitted. The protocol also enables an RM Destination to efficiently determine which of  
172 those messages it Receives have been previously Received, enabling it to filter out duplicate message  
173 transmissions caused by the retransmission, by the RM Source, of unacknowledged message. It also  
174 enables an RM Destination to Deliver the messages it Receives to the Application Destination in the order  
175 in which they were sent by an Application Source, in the event that they are Received out of order. Note  
176 that this specification places no restriction on the scope of the RM Source or RM Destination entities. For  
177 example, either can span multiple WSDL Ports or Endpoints.

178 The protocol enables the implementation of a broad range of reliability features which include ordered  
179 Delivery, duplicate elimination, and guaranteed receipt. The protocol can also be implemented with a  
180 range of robustness characteristics ranging from in-memory persistence that is scoped to a single process  
181 lifetime, to replicated durable storage that is recoverable in all but the most extreme circumstances. It is  
182 expected that the Endpoints will implement as many or as few of these reliability characteristics as  
183 necessary for the correct operation of the application using the protocol. Regardless of which of the  
184 reliability features is enabled, the wire protocol does not change.

185 Figure 1 below illustrates the entities and events in a simple reliable exchange of messages. First, the  
186 Application Source Sends a message for reliable transfer. The Reliable Messaging Source accepts the  
187 message and Transmits it one or more times. After accepting the message, the RM Destination  
188 Acknowledges it. Finally, the RM Destination Delivers the message to the Application Destination. The  
189 exact roles the entities play and the complete meaning of the events will be defined throughout this  
190 specification.



191 Figure 1: Reliable Messaging Model

### 2.1 Glossary

193 The following definitions are used throughout this specification:

194 **Accept:** The act of qualifying a message by the RM Destination such that it becomes eligible for Delivery  
195 and acknowledgement.

196 **Acknowledgement:** The communication from the RM Destination to the RM Source indicating the  
197 successful receipt of a message.

198 **Acknowledgement Message:** A message containing a `SequenceAcknowledgement` header block.  
199 Acknowledgement Messages may or may not contain a SOAP body.

200 **Acknowledgement Request:** A message containing a `AckRequested` header. Acknowledgement  
201 Requests may or may not contain a SOAP body.

202 **Application Destination:** The Endpoint to which a message is Delivered.

203 **Application Source:** The Endpoint that Sends a message.

204 **Deliver:** The act of transferring a message from the RM Destination to the Application Destination.

205 **Endpoint:** As defined in the WS-Addressing specification [[WS-Addressing](#)]; a Web service Endpoint is a  
206 (referenceable) entity, processor, or resource to which Web service messages can be addressed.  
207 Endpoint references convey the information needed to address a Web service Endpoint.

208 **Receive:** The act of reading a message from a network connection and accepting it.

209 **RM Destination:** The Endpoint that Receives messages Transmitted reliably from an RM Source.

210 **RM Protocol Header Block:** One of `Sequence`, `SequenceAcknowledgement`, or `AckRequested`.

211 **RM Source:** The Endpoint that Transmits messages reliably to an RM Destination.

212 **Send:** The act of transferring a message from the Application Source to the RM Source for reliable  
213 transfer.

214 **Sequence Lifecycle Message:** A message that contains one of: `CreateSequence`,  
215 `CreateSequenceResponse`, `CloseSequence`, `CloseSequenceResponse`, `TerminateSequence`,  
216 `TerminateSequenceResponse` as the child element of the SOAP body element.

217 **Sequence Traffic Message:** A message containing a `Sequence` header block.

218 **Transmit:** The act of writing a message to a network connection.

## 219 **2.2 Protocol Preconditions**

220 The correct operation of the protocol requires that a number of preconditions **MUST** be established prior  
221 to the processing of the initial sequenced message:

- 222 • For any single message exchange the RM Source **MUST** have an endpoint reference that uniquely  
223 identifies the RM Destination Endpoint.
- 224 • The RM Source **MUST** have successfully created a `Sequence` with the RM Destination.
- 225 • The RM Source **MUST** be capable of formulating messages that adhere to the RM Destination's  
226 policies.
- 227 • If a secure exchange of messages is **REQUIRED**, then the RM Source and RM Destination **MUST**  
228 have a security context.

## 229 **2.3 Protocol Invariants**

230 During the lifetime of a `Sequence`, two invariants are **REQUIRED** for correctness:

- 231 • The RM Source MUST assign each message within a Sequence a message number (defined
- 232 below) beginning at 1 and increasing by exactly 1 for each subsequent message. These numbers
- 233 MUST be assigned in the same order in which messages are sent by the Application Source.
- 234 • Within every Acknowledgement Message it issues, the RM Destination MUST include one or more
- 235 `AcknowledgementRange` child elements that contain, in their collective ranges, the message
- 236 number of every message accepted by the RM Destination. The RM Destination MUST exclude, in
- 237 the `AcknowledgementRange` elements, the message numbers of any messages it has not
- 238 accepted.

## 239 2.4 Example Message Exchange

240 Figure 2 illustrates a possible message exchange between two reliable messaging Endpoints A and B.

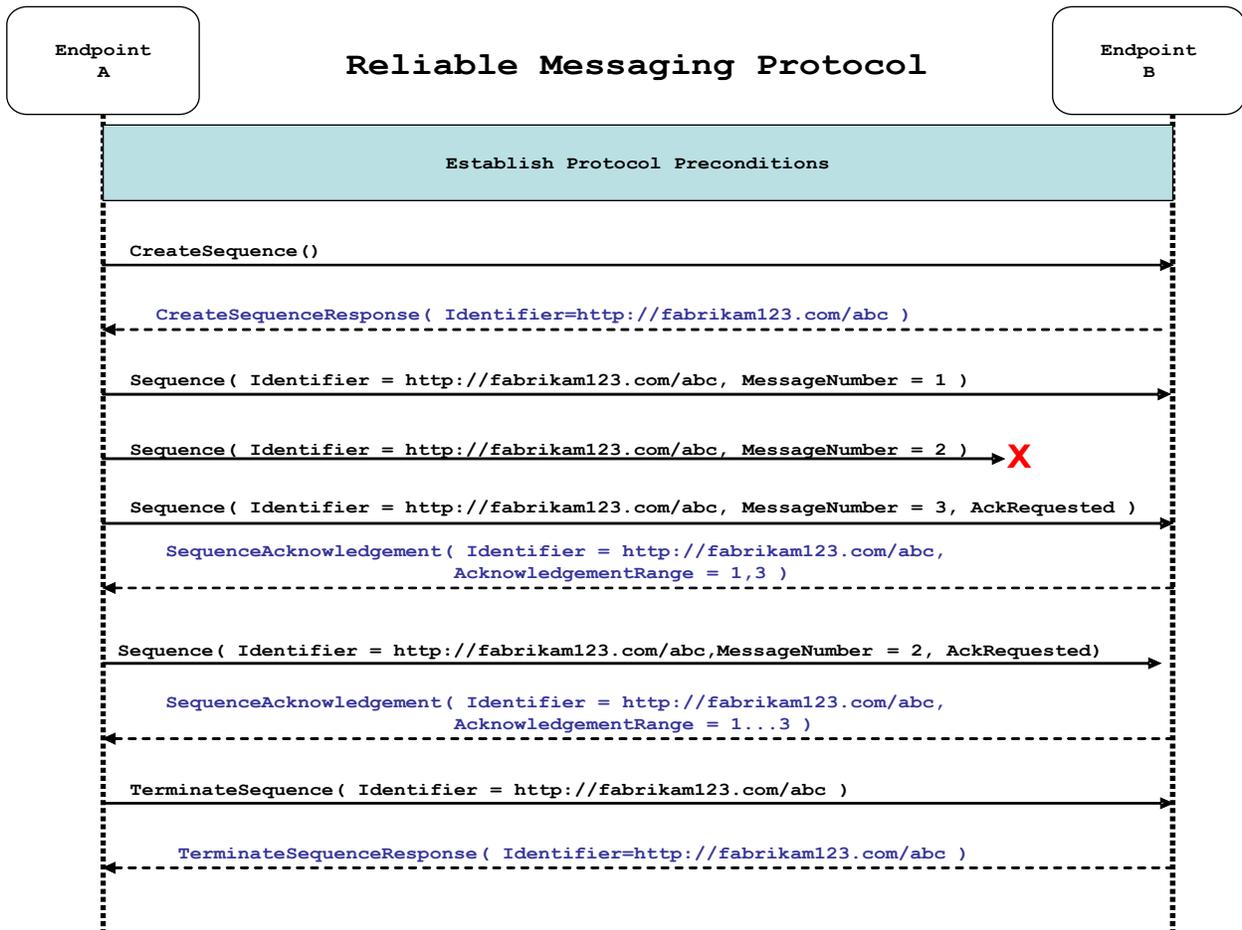


Figure 2: The WS-ReliableMessaging Protocol

- 241 1. The protocol preconditions are established. These include policy exchange, endpoint resolution,
- 242 and establishing trust.
- 243 2. The RM Source requests creation of a new Sequence.
- 244 3. The RM Destination creates a new Sequence and returns its unique identifier.
- 245 4. The RM Source begins Transmitting messages in the Sequence beginning with MessageNumber 1.
- 246 In the figure above, the RM Source sends 3 messages in the Sequence.

- 247 5. The 2<sup>nd</sup> message in the Sequence is lost in transit.
- 248 6. The 3<sup>rd</sup> message is the last in this Sequence and the RM Source includes an `AckRequested`  
249 header to ensure that it gets a timely `SequenceAcknowledgement` for the Sequence.
- 250 7. The RM Destination acknowledges receipt of message numbers 1 and 3 as a result of receiving the  
251 RM Source's `AckRequested` header.
- 252 8. The RM Source retransmits the unacknowledged message with `MessageNumber 2`. This is a new  
253 message from the perspective of the underlying transport, but it has the same `Sequence Identifier`  
254 and `MessageNumber` so the RM Destination can recognize it as a duplicate of the earlier message,  
255 in case the original and retransmitted messages are both Received. The RM Source includes an  
256 `AckRequested` header in the retransmitted message so the RM Destination will expedite an  
257 acknowledgement.
- 258 9. The RM Destination Receives the second transmission of the message with `MessageNumber 2`  
259 and acknowledges receipt of message numbers 1, 2, and 3.
- 260 10. The RM Source Receives this Acknowledgement and sends a `TerminateSequence` message to the  
261 RM Destination indicating that the Sequence is completed and reclaims any resources associated  
262 with the Sequence.
- 263 11. The RM Destination Receives the `TerminateSequence` message indicating that the RM Source will  
264 not be sending any more messages. The RM Destination sends a `TerminateSequenceResponse`  
265 message to the RM Source and and reclaims any resources associated with the Sequence.

266 The RM Source will expect to Receive Acknowledgements from the RM Destination during the course of a  
267 message exchange at occasions described in Section 3 below. Should an Acknowledgement not be  
268 Received in a timely fashion, the RM Source MUST re-transmit the message since either the message or  
269 the associated Acknowledgement might have been lost. Since the nature and dynamic characteristics of  
270 the underlying transport and potential intermediaries are unknown in the general case, the timing of re-  
271 transmissions cannot be specified. Additionally, over-aggressive re-transmissions have been  
272 demonstrated to cause transport or intermediary flooding which are counterproductive to the intention of  
273 providing a reliable exchange of messages. Consequently, implementers are encouraged to utilize  
274 adaptive mechanisms that dynamically adjust re-transmission time and the back-off intervals that are  
275 appropriate to the nature of the transports and intermediaries envisioned. For the case of TCP/IP  
276 transports, a mechanism similar to that described as RTTM in RFC 1323 [RTTM] SHOULD be  
277 considered.

278 Now that the basic model has been outlined, the details of the elements used in this protocol are now  
279 provided in Section 3.

## 280 **3 RM Protocol Elements**

281 The following sub-sections define the various RM protocol elements, and prescribe their usage by a  
282 conformant implementations.

### 283 **3.1 Considerations on the Use of Extensibility Points**

284 The following protocol elements define extensibility points at various places. Implementations MAY add  
285 child elements and/or attributes at the indicated extension points but MUST NOT contradict the semantics  
286 of the parent and/or owner, respectively. If a receiver does not recognize an extension, the receiver  
287 SHOULD ignore the extension.

### 288 **3.2 Considerations on the Use of "Piggy-Backing"**

289 Some RM header blocks may be added to messages that happen to be targeted to the same Endpoint to  
290 which those headers are to be sent (a concept often referred to as "piggy-backing"), thus saving the  
291 overhead of an additional message exchange. Reference parameters MUST be considered when  
292 determining whether two EPRs are targeted to the same Endpoint.

### 293 **3.3 Composition with WS-Addressing**

294 When the RM protocol, defined in this specification, is composed with the WS-Addressing specification,  
295 the following rules prescribe the constraints on the value of the `wsa:Action` header:

- 296 1. When an Endpoint generates a message that carries an RM protocol element, that is defined in  
297 section 3 below, in the body of a SOAP envelope that Endpoint MUST include in that envelope a  
298 `wsa:Action` SOAP header block whose value is an IRI that is a concatenation of the WS-RM  
299 namespace URI, followed by a "/", followed by the value of the local name of the child element of  
300 the SOAP body. For example, for a Sequence creation request message as described in section  
301 3.1 below, the value of the `wsa:Action` IRI would be:

```
302 http://docs.oasis-open.org/ws-rx/wsrn/200608/CreateSequence
```

- 303 2. When an Endpoint generates an Acknowledgement Message that has no element content in the  
304 SOAP body, then the value of the `wsa:Action` IRI MUST be:

```
305 http://docs.oasis-open.org/ws-rx/wsrn/200608/SequenceAcknowledgement
```

- 306 3. When an Endpoint generates an Acknowledgement Request that has no element content in the  
307 SOAP body, then the value of the `wsa:Action` IRI MUST be:

```
308 http://docs.oasis-open.org/ws-rx/wsrn/200608/AckRequested
```

- 309 4. When an Endpoint generates an RM fault as defined in section 4 below, the value of the  
310 `wsa:Action` IRI MUST be as defined in section 4 below.

### 311 **3.4 Sequence Creation**

312 The RM Source MUST request creation of an outbound Sequence by sending a `CreateSequence`  
313 element in the body of a message to the RM Destination which in turn responds either with a message  
314 containing `CreateSequenceResponse` or a `CreateSequenceRefused` fault. The RM Source MAY  
315 include an offer to create an inbound Sequence within the `CreateSequence` message. This offer is  
316 either accepted or rejected by the RM Destination in the `CreateSequenceResponse` message.

317 The SOAP version used for the CreateSequence message SHOULD be used for all subsequent  
318 messages in or for that Sequence, sent by either the RM Source or the RM Destination.

319 The following exemplar defines the CreateSequence syntax:

```
320 <wsrm:CreateSequence ...>
321   <wsrm:AcksTo> wsa:EndpointReferenceType </wsrm:AcksTo>
322   <wsrm:Expires ...> xs:duration </wsrm:Expires> ?
323   <wsrm:Offer ...>
324     <wsrm:Identifier ...> xs:anyURI </wsrm:Identifier>
325     <wsrm:Endpoint> wsa:EndpointReferenceType </wsrm:Endpoint>
326     <wsrm:Expires ...> xs:duration </wsrm:Expires> ?
327     <wsrm:IncompleteSequenceBehavior>
328       wsrml:IncompleteSequenceBehaviorType
329     </wsrm:IncompleteSequenceBehavior> ?
330     ...
331   </wsrm:Offer> ?
332   ...
333 </wsrm:CreateSequence>
```

334 /wsrm:CreateSequence

335 This element requests creation of a new Sequence between the RM Source that sends it, and the RM  
336 Destination to which it is sent. The RM Source MUST NOT send this element as a header block. The RM  
337 Destination MUST respond either with a CreateSequenceResponse response message or a  
338 CreateSequenceRefused fault.

339 /wsrm:CreateSequence/wsrm:AcksTo

340 The RM Source MUST include this element in any CreateSequence message it sends. This element is of  
341 type wsa:EndpointReferenceType (as specified by WS-Addressing). It specifies the endpoint  
342 reference to which messages containing SequenceAcknowledgement header blocks and faults related  
343 to the created Sequence are to be sent, unless otherwise noted in this specification (for example, see  
344 Section 3.2).

345 Implementations MUST NOT use an endpoint reference in the AcksTo element that would prevent the  
346 sending of Sequence Acknowledgements back to the RM Source. For example, using the WS-Addressing  
347 "http://www.w3.org/2005/08/addressing/none" IRI would make it impossible for the RM Destination to ever  
348 send Sequence Acknowledgements.

349 /wsrm:CreateSequence/wsrm:Expires

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

354 /wsrm:CreateSequence/wsrm:Expires/@{any}

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

357 /wsrm:CreateSequence/wsrm:Offer

358 This element, if present, enables an RM Source to offer a corresponding Sequence for the reliable  
359 exchange of messages Transmitted from RM Destination to RM Source.

360 /wsrm:CreateSequence/wsrm:Offer/wsrm:Identifier

361 The RM Source MUST set the value of this element to an absolute URI (conformant with RFC3986 [URI])  
362 that uniquely identifies the offered Sequence.

363 /wsmr:CreateSequence/wsmr:Offer/wsmr:Identifier/@{any}

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

366 /wsmr:CreateSequence/wsmr:Offer/wsmr:Endpoint

367 An RM Source MUST include this element, of type `wsa:EndpointReferenceType` (as specified by  
368 WS-Addressing). This element specifies the endpoint reference to which Sequence Lifecycle Messages,  
369 Sequence Traffic Messages, Acknowledgement Requests, and fault messages related to the offered  
370 Sequence are to be sent.

371 Implementations MUST NOT use an endpoint reference in the Endpoint element that would prevent the  
372 sending of Sequence Lifecycle Message, Sequence Traffic Message, etc. For example, using the WS-  
373 Addressing "http://www.w3.org/2005/08/addressing/none" IRI would make it impossible for the RM  
374 Destination to ever send Sequence Lifecycle Messages (e.g. `TerminateSequence`) to the RM Source  
375 for the Offered Sequence. Implementations MAY use the WS-RM anonymous URI template and doing so  
376 implies that messages will be retrieved using a mechanism such as the `MakeConnection` message (see  
377 section 3.7).

378 /wsmr:CreateSequence/wsmr:Offer/wsmr:Expires

379 This element, if present, of type `xs:duration` specifies the duration for the offered Sequence. A value of  
380 "PT0S" indicates that the offered Sequence will never expire. Absence of the element indicates an implied  
381 value of "PT0S".

382 /wsmr:CreateSequence/wsmr:Offer/wsmr:Expires/@{any}

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

385 /wsmr:CreateSequence/wsmr:Offer/wsmr:IncompleteSequenceBehavior

386 This element, if present, specifies the behavior that the destination will exhibit upon the closure or  
387 termination of an incomplete Sequence. For the purposes of defining the values used, the term "discard"  
388 refers to behavior equivalent to the Application Destination never processing a particular message.

389 A value of "DiscardEntireSequence" indicates that the entire Sequence MUST be discarded if the  
390 Sequence is closed, or terminated, when there are one or more gaps in the final  
391 `SequenceAcknowledgement`.

392 A value of "DiscardFollowingFirstGap" indicates that messages in the Sequence beyond the first gap  
393 MUST be discarded when there are one or more gaps in the final `SequenceAcknowledgement`.

394 The default value of "NoDiscard" indicates that no acknowledged messages in the Sequence will be  
395 discarded.

396 /wsmr:CreateSequence/wsmr:Offer/{any}

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

399 /wsmr:CreateSequence/wsmr:Offer/@{any}

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

402 /wsmr:CreateSequence/{any}

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

405 /wsmr:CreateSequence/@{any}

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

408 A `CreateSequenceResponse` is sent in the body of a response message by an RM Destination in  
409 response to receipt of a `CreateSequence` request message. It carries the `Identifier` of the created  
410 Sequence and indicates that the RM Source can begin sending messages in the context of the identified  
411 Sequence.

412 The following exemplar defines the `CreateSequenceResponse` syntax:

```
413 <wsmr:CreateSequenceResponse ...>  
414   <wsmr:Identifier ...> xs:anyURI </wsmr:Identifier>  
415   <wsmr:Expires ...> xs:duration </wsmr:Expires> ?  
416   <wsmr:IncompleteSequenceBehavior>  
417     wsmr:IncompleteSequenceBehaviorType  
418   </wsmr:IncompleteSequenceBehavior> ?  
419   <wsmr:Accept ...>  
420     <wsmr:AcksTo wsa:EndpointReferenceType </wsmr:AcksTo>  
421     ...  
422   </wsmr:Accept> ?  
423   ...  
424 </wsmr:CreateSequenceResponse>
```

425 /wsmr:CreateSequenceResponse

426 This element is sent in the body of the response message in response to a `CreateSequence` request  
427 message. It indicates that the RM Destination has created a new Sequence at the request of the RM  
428 Source. The RM Destination MUST NOT send this element as a header block.

429 /wsmr:CreateSequenceResponse/wsmr:Identifier

430 The RM Destination MUST include this element within any `CreateSequenceResponse` message it sends.  
431 The RM Destination MUST set the value of this element to the absolute URI (conformant with RFC3986)  
432 that uniquely identifies the Sequence that has been created by the RM Destination.

433 /wsmr:CreateSequenceResponse/wsmr:Identifier/@{any}

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

436 /wsmr:CreateSequenceResponse/wsmr:Expires

437 This element, if present, of type `xs:duration` accepts or refines the RM Source's requested duration for  
438 the Sequence. It specifies the amount of time after which any resources associated with the Sequence  
439 SHOULD be reclaimed thus causing the Sequence to be silently terminated. At the RM Destination this  
440 duration is measured from a point proximate to Sequence creation and at the RM Source this duration is  
441 measured from a point approximate to the successful processing of the `CreateSequenceResponse`. A  
442 value of "PT0S" indicates that the Sequence will never expire. Absence of the element indicates an  
443 implied value of "PT0S". The RM Destination MUST set the value of this element to be equal to or less  
444 than the value requested by the RM Source in the corresponding `CreateSequence` message.

445 /wsmr:CreateSequenceResponse/wsmr:Expires/@{any}

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

448 `/wsrm:CreateSequenceResponse/wsrm:IncompleteSequenceBehavior`

449 This element, if present, specifies the behavior that the destination will exhibit upon the closure or  
450 termination of an incomplete Sequence. For the purposes of defining the values used, the term "discard"  
451 refers to behavior equivalent to the Application Destination never processing a particular message.

452 A value of "DiscardEntireSequence" indicates that the entire Sequence MUST be discarded if the  
453 Sequence is closed, or terminated, when there are one or more gaps in the final  
454 `SequenceAcknowledgement`.

455 A value of "DiscardFollowingFirstGap" indicates that messages in the Sequence beyond the first gap  
456 MUST be discarded when there are one or more gaps in the final `SequenceAcknowledgement`.

457 The default value of "NoDiscard" indicates that no acknowledged messages in the Sequence will be  
458 discarded.

459 `/wsrm:CreateSequenceResponse/wsrm:Accept`

460 This element, if present, enables an RM Destination to accept the offer of a corresponding Sequence for  
461 the reliable exchange of messages Transmitted from RM Destination to RM Source.

462 **Note:** If a `CreateSequenceResponse` is returned without a child `Accept` in response to a  
463 `CreateSequence` that did contain a child `Offer`, then the RM Source MAY immediately reclaim any  
464 resources associated with the unused offered Sequence.

465 `/wsrm:CreateSequenceResponse/wsrm:Accept/wsrm:AcksTo`

466 The RM Destination MUST include this element, of type `wsa:EndpointReferenceType` (as specified  
467 by WS-Addressing). It specifies the endpoint reference to which messages containing  
468 `SequenceAcknowledgement` header blocks and faults related to the created Sequence are to be sent,  
469 unless otherwise noted in this specification (for example, see Section 3.2).

470 Implementations MUST NOT use an endpoint reference in the `AcksTo` element that would prevent the  
471 sending of Sequence Acknowledgements back to the RM Source. For example, using the WS-Addressing  
472 "http://www.w3.org/2005/08/addressing/none" IRI would make it impossible for the RM Destination to ever  
473 send Sequence Acknowledgements.

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

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

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

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

480 `/wsrm:CreateSequenceResponse/{any}`

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

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

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

## 486 3.5 Closing A Sequence

487 There are times during the use of an RM Sequence that the RM Source or RM Destination will wish to  
488 discontinue using a Sequence. Simply terminating the Sequence discards the state managed by the RM  
489 Destination, leaving the RM Source unaware of the final ranges of messages that were successfully  
490 transferred to the RM Destination. To ensure that the Sequence ends with a known final state either the  
491 RM Source or RM Destination MAY choose to close the Sequence before terminating it.

492 If the RM Source wishes to close the Sequence, then it sends a `CloseSequence` element, in the body of  
493 a message, to the RM Destination. This message indicates that the RM Destination MUST NOT accept  
494 any new messages for the specified Sequence, other than those already accepted at the time the  
495 `CloseSequence` element is interpreted by the RM Destination. Upon receipt of this message, or  
496 subsequent to the RM Destination closing the Sequence of its own volition, the RM Destination MUST  
497 include a final `SequenceAcknowledgement` (within which the RM Destination MUST include the `Final`  
498 element) header block on any messages associated with the Sequence destined to the RM Source,  
499 including the `CloseSequenceResponse` message or on any Sequence fault Transmitted to the RM  
500 Source.

501 While the RM Destination MUST NOT accept any new messages for the specified Sequence it MUST still  
502 process Sequence Lifecycle Messages and Acknowledgement Requests. For example, it MUST respond to  
503 `AckRequested`, `TerminateSequence` as well as `CloseSequence` messages. Note, subsequent  
504 `CloseSequence` messages have no effect on the state of the Sequence.

505 In the case where the RM Destination wishes to discontinue use of a Sequence it is RECOMMENDED  
506 that it close the Sequence. Please see `Final` and the `SequenceClosed` fault. Whenever possible the  
507 `SequenceClosed` fault SHOULD be used in place of the `SequenceTerminated` fault to allow the RM  
508 Source to still Receive Acknowledgements.

509 The following exemplar defines the `CloseSequence` syntax:

```
510 <wsrm:CloseSequence ...>  
511   <wsrm:Identifier ...> xs:anyURI </wsrm:Identifier>  
512   ...  
513 </wsrm:CloseSequence>
```

514 `/wsrm:CloseSequence`

515 This element is sent by an RM Source to indicate that the RM Destination MUST NOT accept any new  
516 messages for this Sequence. A `SequenceClosed` fault MUST be generated by the RM Destination when it  
517 Receives a message for a Sequence that is already closed.

518 `/wsrm:CloseSequence/wsrm:Identifier`

519 The RM Source MUST include this element in any `CloseSequence` messages it sends. The RM Source  
520 MUST set the value of this element to the absolute URI (conformant with RFC3986) of the Sequence that  
521 is being closed.

522 `/wsrm:CloseSequence/wsrm:Identifier/@{any}`

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

525 `/wsrm:CloseSequence/{any}`

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

528 `/wsrm:CloseSequence@{any}`

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

531 A `CloseSequenceResponse` is sent in the body of a response message by an RM Destination in  
532 response to receipt of a `CloseSequence` request message. It indicates that the RM Destination has  
533 closed the Sequence.

534 The following exemplar defines the `CloseSequenceResponse` syntax:

```
535 <wsm:CloseSequenceResponse ...>  
536   <wsm:Identifier ...> xs:anyURI </wsm:Identifier>  
537   ...  
538 </wsm:CloseSequenceResponse>
```

539 `/wsm:CloseSequenceResponse`

540 This element is sent in the body of a response message by an RM Destination in response to receipt of a  
541 `CloseSequence` request message. It indicates that the RM Destination has closed the Sequence.

542 `/wsm:CloseSequenceResponse/wsm:Identifier`

543 The RM Destination MUST include this element in any `CloseSequenceResponse` message it sends. The  
544 RM Destination MUST set the value of this element to the absolute URI (conformant with RFC3986) of the  
545 Sequence that is being closed.

546 `/wsm:CloseSequenceResponse/wsm:Identifier/@{any}`

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

549 `/wsm:CloseSequenceResponse/{any}`

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

552 `/wsm:CloseSequenceResponse@{any}`

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

## 555 **3.6 Sequence Termination**

556 When the RM Source has completed its use of the Sequence it sends a `TerminateSequence` element,  
557 in the body of a message, to the RM Destination to indicate that the Sequence is complete and that it will  
558 not be sending any further messages related to the Sequence. The RM Destination can safely reclaim any  
559 resources associated with the Sequence upon receipt of the `TerminateSequence` message. Under  
560 normal usage the RM Source will complete its use of the Sequence when all of the messages in the  
561 Sequence have been acknowledged. However, the RM Source is free to Terminate or Close a Sequence  
562 at any time regardless of the acknowledgement state of the messages.

563 The following exemplar defines the `TerminateSequence` syntax:

```
564 <wsm:TerminateSequence ...>  
565   <wsm:Identifier ...> xs:anyURI </wsm:Identifier>  
566   ...  
567 </wsm:TerminateSequence>
```

568 `/wsm:TerminateSequence`

569 This element is sent by an RM Source to indicate it has completed its use of the Sequence. It indicates  
570 that the RM Destination can safely reclaim any resources related to the identified Sequence. The RM  
571 Source MUST NOT send this element as a header block. The RM Source MAY retransmit this element.  
572 Once this element is sent, other than this element, the RM Source MUST NOT send any additional  
573 message to the RM Destination referencing this Sequence.

574 /wsmr:TerminateSequence/wsmr:Identifier

575 The RM Source MUST include this element in any TerminateSequence message it sends. The RM  
576 Source MUST set the value of this element to the absolute URI (conformant with RFC3986) of the  
577 Sequence that is being terminated.

578 /wsmr:TerminateSequence/wsmr:Identifier/@{any}

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

581 /wsmr:TerminateSequence/{any}

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

584 /wsmr:TerminateSequence/@{any}

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

587 A `TerminateSequenceResponse` is sent in the body of a response message by an RM Destination in  
588 response to receipt of a `TerminateSequence` request message. It indicates that the RM Destination has  
589 terminated the Sequence.

590 The following exemplar defines the `TerminateSequenceResponse` syntax:

```
591 <wsmr:TerminateSequenceResponse ...>  
592   <wsmr:Identifier ...> xs:anyURI </wsmr:Identifier>  
593   ...  
594 </wsmr:TerminateSequenceResponse>
```

595 /wsmr:TerminateSequenceResponse

596 This element is sent in the body of a response message by an RM Destination in response to receipt of a  
597 `TerminateSequence` request message. It indicates that the RM Destination has terminated the  
598 Sequence. The RM Destination MUST NOT send this element as a header block.

599 /wsmr:TerminateSequenceResponse/wsmr:Identifier

600 The RM Destination MUST include this element in any `TerminateSequenceResponse` message it  
601 sends. The RM Destination MUST set the value of this element to the absolute URI (conformant with  
602 RFC3986) of the Sequence that is being terminated.

603 /wsmr:TerminateSequenceResponse/wsmr:Identifier/@{any}

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

606 /wsmr:TerminateSequenceResponse/{any}

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

609 /wsmr:TerminateSequenceResponse/@{any}

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

612 On receipt of a `TerminateSequence` message an RM Destination MUST respond with a corresponding  
613 `TerminateSequenceResponse` message or generate a fault `UnknownSequenceFault` if the  
614 Sequence is not known.

### 615 **3.7 Sequences**

616 The RM protocol uses a `Sequence` header block to track and manage the reliable transfer of messages.  
617 The RM Source MUST include a `Sequence` header block in all messages for which reliable transfer is  
618 REQUIRED. The RM Source MUST identify Sequences with unique `Identifier` elements and the RM  
619 Source MUST assign each message within a `Sequence` a `MessageNumber` element that increments by 1  
620 from an initial value of 1. These values are contained within a `Sequence` header block accompanying  
621 each message being transferred in the context of a `Sequence`.

622 The RM Source MUST NOT include more than one `Sequence` header block in any message.

623 A following exemplar defines its syntax:

```
624 <wsrm:Sequence ...>  
625   <wsrm:Identifier ...> xs:anyURI </wsrm:Identifier>  
626   <wsrm:MessageNumber> wsrm:MessageNumberType </wsrm:MessageNumber>  
627   ...  
628 </wsrm:Sequence>
```

629 The following describes the content model of the `Sequence` header block.

630 `/wsrm:Sequence`

631 This protocol element associates the message in which it is contained with a previously established RM  
632 `Sequence`. It contains the `Sequence`'s unique identifier and the containing message's ordinal position  
633 within that `Sequence`. The RM Destination MUST understand the `Sequence` header block. The RM  
634 Source MUST assign a `mustUnderstand` attribute with a value `1/true` (from the namespace  
635 corresponding to the version of SOAP to which the `Sequence` SOAP header block is bound) to the  
636 `Sequence` header block element.

637 `/wsrm:Sequence/wsrm:Identifier`

638 An RM Source that includes a `Sequence` header block in a SOAP envelope MUST include this element in  
639 that header block. The RM Source MUST set the value of this element to the absolute URI (conformant  
640 with RFC3986) that uniquely identifies the `Sequence`.

641 `/wsrm:Sequence/wsrm:Identifier/@{any}`

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

644 `/wsrm:Sequence/wsrm:MessageNumber`

645 The RM Source MUST include this element within any `Sequence` headers it creates. This element is of  
646 type `MessageNumberType`. It represents the ordinal position of the message within a `Sequence`.  
647 `Sequence` message numbers start at 1 and monotonically increase by 1 throughout the `Sequence`. See  
648 Section 4.5 for Message Number Rollover fault.

649 `/wsrm:Sequence/{any}`

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

652 /wsmr:Sequence/@{any}

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

655 The following example illustrates a Sequence header block.

```
656 <wsmr:Sequence>  
657   <wsmr:Identifier>http://example.com/abc</wsmr:Identifier>  
658   <wsmr:MessageNumber>10</wsmr:MessageNumber>  
659 </wsmr:Sequence>
```

### 660 3.8 Request Acknowledgement

661 The purpose of the `AckRequested` header block is to signal to the RM Destination that the RM Source is  
662 requesting that a `SequenceAcknowledgement` be sent.

663 The RM Source MAY request an Acknowledgement Message from the RM Destination at any time by  
664 including an `AckRequested` header block in any message targeted to the RM Destination. An RM  
665 Destination that Receives a message that contains an `AckRequested` header block MUST send a  
666 message containing a `SequenceAcknowledgement` header block to the `AcksTo` endpoint reference  
667 (see Section 3.1) for a known Sequence or else generate an `UnknownSequence` fault. If a non-  
668 `mustUnderstand` fault occurs when processing an RM header that was piggy-backed on another  
669 message, a fault MUST be generated, but the processing of the original message MUST NOT be  
670 affected. It is RECOMMENDED that the RM Destination return a `AcknowledgementRange` or `None`  
671 element instead of a `Nack` element (see Section 3.6).

672 The following exemplar defines its syntax:

```
673 <wsmr:AckRequested ...>  
674   <wsmr:Identifier ...> xs:anyURI </wsmr:Identifier>  
675   ...  
676 </wsmr:AckRequested>
```

677 /wsmr:AckRequested

678 This element requests an Acknowledgement for the identified Sequence.

679 /wsmr:AckRequested/wsmr:Identifier

680 An RM Source that includes a `AckRequested` header block in a SOAP envelope MUST include this  
681 element in that header block. The RM Source MUST set the value of this element to the absolute URI,  
682 (conformant with RFC3986), that uniquely identifies the Sequence to which the request applies.

683 /wsmr:AckRequested/wsmr:Identifier/@{any}

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

686 /wsmr:AckRequested/{any}

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

689 /wsmr:AckRequested/@{any}

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

### 692 3.9 Sequence Acknowledgement

693 The RM Destination informs the RM Source of successful message receipt using a  
694 `SequenceAcknowledgement` header block. The RM Destination MAY Transmit the  
695 `SequenceAcknowledgement` header block independently or it MAY include the  
696 `SequenceAcknowledgement` header block on any message targeted to the `AcksTo` EPR.  
697 Acknowledgements can be explicitly requested using the `AckRequested` directive (see Section 3.5). If a  
698 non-mustUnderstand fault occurs when processing an RM header that was piggy-backed on another  
699 message, a fault MUST be generated, but the processing of the original message MUST NOT be  
700 affected.

701 A RM Destination MAY include a `SequenceAcknowledgement` header block on any SOAP envelope  
702 targetted to the endpoint referenced by the `AcksTo` EPR.

703 During creation of a Sequence the RM Source MAY specify the WS-Addressing anonymous IRI as the  
704 address of the `AcksTo` EPR for that Sequence. When the RM Source specifies the WS-Addressing  
705 anonymous IRI as the address of the `AcksTo` EPR, the RM Destination MUST Transmit any  
706 `SequenceAcknowledgement` headers for the created Sequence in a SOAP envelope to be Transmitted  
707 on the protocol binding-specific channel. Such a channel is provided by the context of a Received  
708 message containing a SOAP envelope that contains a `Sequence` header block and/or a `AckRequested`  
709 header block for that same Sequence identifier.

710 The following exemplar defines its syntax:

```
711 <wsrm:SequenceAcknowledgement ...>  
712   <wsrm:Identifier ...> xs:anyURI </wsrm:Identifier>  
713   [ [ [ <wsrm:AcknowledgementRange ...  
714     Upper="wsrm:MessageNumberType"  
715     Lower="wsrm:MessageNumberType"/> +  
716     | <wsrm:None/> ]  
717     <wsrm:Final/> ? ]  
718     | <wsrm:Nack> wsrm:MessageNumberType </wsrm:Nack> + ]  
719   ...  
720   ...  
721 </wsrm:SequenceAcknowledgement>
```

722 The following describes the content model of the `SequenceAcknowledgement` header block.

723 `/wsrm:SequenceAcknowledgement`

724 This element contains the Sequence Acknowledgement information.

725 `/wsrm:SequenceAcknowledgement/wsrm:Identifier`

726 An RM Destination that includes a `SequenceAcknowledgement` header block in a SOAP envelope  
727 MUST include this element in that header block. The RM Destination MUST set the value of this element  
728 to the absolute URI (conformant with RFC3986) that uniquely identifies the Sequence. The RM  
729 Destination MUST NOT include multiple `SequenceAcknowledgement` header blocks that share the  
730 same value for `Identifier` within the same SOAP envelope.

731 `/wsrm:SequenceAcknowledgement/wsrm:Identifier/@{any}`

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

734 /wsmr:SequenceAcknowledgement/wsmr:AcknowledgementRange  
735 The RM Destination MAY include one or more instances of this element within a  
736 SequenceAcknowledgement header block. It contains a range of Sequence MessageNumbers  
737 successfully accepted by the RM Destination. The ranges SHOULD NOT overlap. The RM Destination  
738 MUST NOT include this element if a sibling Nack or None element is also present as a child of  
739 SequenceAcknowledgement.

740 /wsmr:SequenceAcknowledgement/wsmr:AcknowledgementRange/@Upper  
741 The RM Destination MUST set the value of this attribute equal to the message number of the highest  
742 contiguous message in a Sequence range accepted by the RM Destination.

743 /wsmr:SequenceAcknowledgement/wsmr:AcknowledgementRange/@Lower  
744 The RM Destination MUST set the value of this attribute equal to the message number of the lowest  
745 contiguous message in a Sequence range accepted by the RM Destination.

746 /wsmr:SequenceAcknowledgement/wsmr:AcknowledgementRange/@{any}  
747 This is an extensibility mechanism to allow additional attributes, based on schemas, to be added to the  
748 element.

749 /wsmr:SequenceAcknowledgement/wsmr:None  
750 The RM Destination MUST include this element within a SequenceAcknowledgement header block if  
751 the RM Destination has not accepted any messages for the specified Sequence. The RM Destination  
752 MUST NOT include this element if a sibling AcknowledgementRange or Nack element is also present  
753 as a child of the SequenceAcknowledgement.

754 /wsmr:SequenceAcknowledgement/wsmr:Final  
755 The RM Destination MAY include this element within a SequenceAcknowledgement header block. This  
756 element indicates that the RM Destination is not receiving new messages for the specified Sequence. The  
757 RM Source can be assured that the ranges of messages acknowledged by this  
758 SequenceAcknowledgement header block will not change in the future. The RM Destination MUST  
759 include this element when the Sequence is closed. The RM Destination MUST NOT include this element  
760 when sending a Nack; it can only be used when sending AcknowledgementRange elements or a None.

761 /wsmr:SequenceAcknowledgement/wsmr:Nack  
762 The RM Destination MAY include this element within a SequenceAcknowledgement header block. If  
763 used, the RM Destination MUST set the value of this element to a MessageNumberType representing  
764 the MessageNumber of an unreceived message in a Sequence. The RM Destination MUST NOT include  
765 a Nack element if a sibling AcknowledgementRange or None element is also present as a child of  
766 SequenceAcknowledgement. Upon the receipt of a Nack, an RM Source SHOULD retransmit the  
767 message identified by the Nack. The RM Destination MUST NOT issue a SequenceAcknowledgement  
768 containing a Nack for a message that it has previously acknowledged within a  
769 AcknowledgementRange. The RM Source SHOULD ignore a SequenceAcknowledgement containing  
770 a Nack for a message that has previously been acknowledged within a AcknowledgementRange.

771 /wsmr:SequenceAcknowledgement/{any}  
772 This is an extensibility mechanism to allow different (extensible) types of information, based on a schema,  
773 to be passed.

774 /wsmr:SequenceAcknowledgement/@{any}

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

777 The following examples illustrate `SequenceAcknowledgement` elements:

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

```
779 <wsrm:SequenceAcknowledgement>  
780   <wsrm:Identifier>http://example.com/abc</wsrm:Identifier>  
781   <wsrm:AcknowledgementRange Upper="10" Lower="1"/>  
782 </wsrm:SequenceAcknowledgement>
```

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

```
785 <wsrm:SequenceAcknowledgement>  
786   <wsrm:Identifier>http://example.com/abc</wsrm:Identifier>  
787   <wsrm:AcknowledgementRange Upper="2" Lower="1"/>  
788   <wsrm:AcknowledgementRange Upper="6" Lower="4"/>  
789   <wsrm:AcknowledgementRange Upper="10" Lower="8"/>  
790 </wsrm:SequenceAcknowledgement>
```

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

```
792 <wsrm:SequenceAcknowledgement>  
793   <wsrm:Identifier>http://example.com/abc</wsrm:Identifier>  
794   <wsrm:Nack>3</wsrm:Nack>  
795 </wsrm:SequenceAcknowledgement>
```

### 796 3.10 MakeConnection

797 When an Endpoint is not directly addressable (e.g. behind a firewall or not able to allow incoming  
798 connections), an anonymous URI in the EPR address property can indicate such an Endpoint. The WS-  
799 Addressing anonymous URI is one such anonymous URI. This specification defines a URI template (the  
800 WS-RM anonymous URI) which may be used to uniquely identify anonymous Endpoints.

```
801 http://docs.oasis-open.org/ws-rx/wsr/200608/anonymous?id={uuid}
```

802 This URI template in an EPR indicates a protocol-specific back-channel will be established through a  
803 mechanism such as `MakeConnection`, defined below. When using this URI template, "{uuid}" MUST be  
804 replaced by a UUID value as defined by RFC4122[UUID]. This UUID value uniquely distinguishes the  
805 Endpoint. A sending Endpoint SHOULD Transmit messages at Endpoints identified with the URI template  
806 using a protocol-specific back-channel, including but not limited to those established with a  
807 `MakeConnection` message. Note, this URI is semantically similar to the WS-Addressing anonymous  
808 URI if a protocol-specific back-channel is available.

809 The `MakeConnection` is a one-way operation that establishes a contextualized back-channel for the  
810 transmission of messages according to matching criteria (defined below). In the non-faulting case, if no  
811 matching message is available then no SOAP envelopes will be returned on the back-channel. A common  
812 usage will be a client RM Destination sending `MakeConnection` to a server RM Source for the purpose  
813 of receiving asynchronous response messages.

814 The following exemplar defines the `MakeConnection` syntax:

```
815 <wsrm:MakeConnection ...>  
816   <wsrm:Identifier ...> xs:anyURI </wsrm:Identifier> ?  
817   <wsrm:Address ...> xs:anyURI </wsrm:Address> ?  
818   ...  
819 </wsrm:MakeConnection>
```

820 /wsrm:MakeConnection

821 This element allows the sender to create a transport-specific back-channel that can be used to return a  
822 message that matches the selection criteria. Endpoints MUST NOT send this element as a header block.

823 /wsrm:MakeConnection/wsrm:Identifier

824 This element specifies the WS-RM Sequence Identifier that establishes the context for the transport-  
825 specific back-channel. The Sequence Identifier should be compared with the Sequence Identifiers  
826 associated with the messages held by the sending Endpoint, and if there is a matching message it will be  
827 returned. If this element is omitted from the message then the *Address* MUST be included in the  
828 message.

829 /wsrm:MakeConnection/wsrm:Identifier/@{any}

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

832 /wsrm:MakeConnection/wsrm:Address

833 This element specifies the URI (*wsa:Address*) of the initiating Endpoint. Endpoints MUST NOT return  
834 messages on the transport-specific back-channel unless they have been addressed to this URI. This  
835 *Address* property and a message's WS-Addressing destination property are considered identical when  
836 they are exactly the same character-for-character. Note that URIs which are not identical in this sense  
837 may in fact be functionally equivalent. Examples include URI references which differ only in case, or  
838 which are in external entities which have different effective base URIs. If this element is omitted from the  
839 message then the *Identifier* MUST be included in the message.

840 /wsrm:MakeConnection/wsrm:Address/@{any}

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

843 /wsrm:MakeConnection/{any}

844 This is an extensibility mechanism to allow different (extensible) types of information, based on a schema,  
845 to be passed. This allows fine-tuning of the messages to be returned, additional selection criteria included  
846 here are logically ANDed with the *Address* and/or *Identifier*. If an extension is not supported by the  
847 Endpoint then it should return a *UnsupportedSelection fault*.

848 /wsrm:MakeConnection/@{any}

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

851 If both *Identifier* and *Address* are present, then the Endpoint processing the *MakeConnection*  
852 message MUST insure that any SOAP Envelope flowing on the backchannel MUST be associated with  
853 the given Sequence and MUST be addressed to the given URI.

854 The management of messages that are awaiting the establishment of a back-channel to their receiving  
855 Endpoint is an implementation detail that is outside the scope of this specification. Note, however, that  
856 these messages form a class of asynchronous messages that is not dissimilar from "ordinary"  
857 asynchronous messages that are waiting for the establishment of a connection to their destination  
858 Endpoints.

859 This specification places no constraint on the types of messages that can be returned on the transport-  
860 specific back-channel. As in an asynchronous environment, it is up to the recipient of the  
861 *MakeConnection* message to decide which messages are appropriate for transmission to any particular

862 Endpoint. However, the Endpoint processing the `MakeConnection` message MUST insure that the  
863 messages match the selection criteria as specified by the child elements of the `MakeConnection`  
864 element.

### 865 **3.11 MessagePending**

866 When `MakeConnection` is used, and a message is returned on the transport-specific back-channel, the  
867 `MessagePending` header SHOULD be included on the returned message as an indicator whether there  
868 are additional messages waiting to be retrieved using the same selection criteria that was specified in the  
869 `MakeConnection` element.

870 The following exemplar defines the `MessagePending` syntax:

```
871 <wsrm:MessagePending pending="xs:boolean" ...>  
872   ...  
873 </wsrm:MessagePending>
```

874 `/wsrm:MessagePending`

875 This element indicates whether additional messages are waiting to be retrieved.

876 `/wsrm:MessagePending@pending`

877 This attribute, when set to "true", indicates that there is at least one message waiting to be retrieved.

878 When this attribute is set to "false" it indicates there are currently no messages waiting to be retrieved.

879 `/wsrm:MessagePending/{any}`

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

882 `/wsrm:MessagePending/@{any}`

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

885 The absence of the `MessagePending` header has no implication as to whether there are additional  
886 messages waiting to be retrieved.

## 887 4 Faults

888 Faults for the `CreateSequence` message exchange are treated as defined in WS-Addressing. Create  
889 Sequence Refused is a possible fault reply for this operation. Unknown Sequence is a fault generated by  
890 Endpoints when messages carrying RM header blocks targeted at unrecognized or terminated Sequences  
891 are detected. WSRM Required is a fault generated an RM Destination that requires the use of WS-RM on  
892 a Received message that did not use the protocol. All other faults in this section relate to known  
893 Sequences. RM Destinations that generate Sequence faults SHOULD send those faults to the same  
894 [destination] as Acknowledgement Messages.

895 Entities that generate WS-ReliableMessaging faults MUST include as the [action] property the default fault  
896 action IRI defined below. The value from the W3C Recommendation is below for informational purposes:

897 `http://docs.oasis-open.org/ws-rx/wsrn/200608/fault`

898 The faults defined in this section are generated if the condition stated in the preamble is met. Fault  
899 handling rules are defined in section 6 of WS-Addressing SOAP Binding.

900 The definitions of faults use the following properties:

901 [Code] The fault code.

902 [Subcode] The fault subcode.

903 [Reason] The English language reason element.

904 [Detail] The detail element(s). If absent, no detail element is defined for the fault. If more than one detail  
905 element is defined for a fault, implementations MUST include the elements in the order that they are  
906 specified.

907 Entities that generate WS-ReliableMessaging faults MUST set the [Code] property to either "Sender" or  
908 "Receiver". These properties are serialized into text XML as follows:

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

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

```
910 <S:Envelope>
911   <S:Header>
912     <wsa:Action>
913       http://docs.oasis-open.org/ws-rx/wsrn/200608/fault
914     </wsa:Action>
915     <!-- Headers elided for clarity. -->
916   </S:Header>
917   <S:Body>
918     <S:Fault>
919       <S:Code>
920         <S:Value> [Code] </S:Value>
921         <S:Subcode>
922           <S:Value> [Subcode] </S:Value>
923         </S:Subcode>
924       </S:Code>
925       <S:Reason>
926         <S:Text xml:lang="en"> [Reason] </S:Text>
927       </S:Reason>
928       <S:Detail>
929         [Detail]
```

```
930     ...
931     </S:Detail>
932 </S:Fault>
933 </S:Body>
934 </S:Envelope>
```

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

```
937 <S11:Envelope>
938   <S11:Header>
939     <wsrm:SequenceFault>
940       <wsrm:FaultCode> wsrm:FaultCodes </wsrm:FaultCode>
941       <wsrm:Detail> [Detail] </wsrm:Detail>
942       ...
943     </wsrm:SequenceFault>
944     <!-- Headers elided for clarity. -->
945   </S11:Header>
946   <S11:Body>
947     <S11:Fault>
948       <faultcode> [Code] </faultcode>
949       <faultstring> [Reason] </faultstring>
950     </S11:Fault>
951   </S11:Body>
952 </S11:Envelope>
```

953 The properties bind to a SOAP 1.1 fault as follows when the fault is generated as a result of processing a  
954 CreateSequence request message:

```
955 <S11:Envelope>
956   <S11:Body>
957     <S11:Fault>
958       <faultcode> [Subcode] </faultcode>
959       <faultstring> [Reason] </faultstring>
960     </S11:Fault>
961   </S11:Body>
962 </S11:Envelope>
```

## 963 4.1 SequenceFault Element

964 The purpose of the `SequenceFault` element is to carry the specific details of a fault generated during  
965 the reliable messaging specific processing of a message belonging to a Sequence. WS-  
966 ReliableMessaging nodes MUST use the `SequenceFault` container only in conjunction with the SOAP  
967 1.1 fault mechanism. WS-ReliableMessaging nodes MUST NOT use the `SequenceFault` container in  
968 conjunction with the SOAP 1.2 binding.

969 The following exemplar defines its syntax:

```
970 <wsrm:SequenceFault ...>
971   <wsrm:FaultCode> wsrm:FaultCodes </wsrm:FaultCode>
972   <wsrm:Detail> ... </wsrm:Detail> ?
973   ...
974 </wsrm:SequenceFault>
```

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

976 /wsrm:SequenceFault

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

978 /wsrm:SequenceFault/wsrm:FaultCode

979 WS-ReliableMessaging nodes that generate a `SequenceFault` MUST set the value of this element to a  
980 qualified name from the set of fault [Subcodes] defined below.

981 `/wsrm:SequenceFault/wsrm:Detail`

982 This element, if present, carries application specific error information related to the fault being described.

983 `/wsrm:SequenceFault/wsrm:Detail/{any}`

984 The application specific error information related to the fault being described.

985 `/wsrm:SequenceFault/wsrm:Detail/@{any}`

986 The application specific error information related to the fault being described.

987 `/wsrm:SequenceFault/{any}`

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

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

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

## 993 4.2 Sequence Terminated

994 The Endpoint that generates this fault SHOULD make every reasonable effort to notify the corresponding  
995 Endpoint of this decision.

996 Properties:

997 [Code] Sender or Receiver

998 [Subcode] `wsrm:SequenceTerminated`

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

1000 [Detail]

1001 `<wsrm:Identifier ...> xs:anyURI </wsrm:Identifier>`

Generated by	Condition	Action Upon Generation	Action Upon Receipt
RM Source or RM Destination.	Encountering an unrecoverable condition or detection of violation of the protocol.	Sequence termination.	MUST terminate the Sequence if not otherwise terminated.

## 1002 4.3 Unknown Sequence

1003 Properties:

1004 [Code] Sender

1005 [Subcode] `wsrm:UnknownSequence`

1006 [Reason] The value of wsrn:Identifier is not a known Sequence identifier.

1007 [Detail]

1008 `<wsrm:Identifier ...> xs:anyURI </wsrm:Identifier>`

Generated by	Condition	Action Upon Generation	Action Upon Receipt
RM Source or RM Destination.	In response to a message containing an unknown or terminated Sequence identifier.	None.	MUST terminate the Sequence if not otherwise terminated.

#### 1009 **4.4 Invalid Acknowledgement**

1010 An example of when this fault is generated is when a message is Received by the RM Source containing  
1011 a SequenceAcknowledgement covering messages that have not been sent.

1012 [Code] Sender

1013 [Subcode] wsrn:InvalidAcknowledgement

1014 [Reason] The SequenceAcknowledgement violates the cumulative Acknowledgement invariant.

1015 [Detail]

1016 `<wsrm:SequenceAcknowledgement ...> ... </wsrm:SequenceAcknowledgement>`

Generated by	Condition	Action Upon Generation	Action Upon Receipt
RM Source.	In response to a SequenceAcknowledgement that violate the invariants stated in 2.3 or any of the requirements in 3.6 about valid combinations of AckRange, Nack and None in a single SequenceAcknowledgement element or with respect to already Received such elements.	Unspecified.	Unspecified.

#### 1017 **4.5 Message Number Rollover**

1018 If the condition listed below is reached, the RM Destination MUST generate this fault.

1019 Properties:

1020 [Code] Sender

1021 [Subcode] wsrn:MessageNumberRollover

1022 [Reason] The maximum value for wsrn:MessageNumber has been exceeded.

1023 [Detail]

```
1024 <wsrm:Identifier ...> xs:anyURI </wsrm:Identifier>  
1025 <wsrm:MaxMessageNumber> wsrm:MessageNumberType </wsrm:MaxMessageNumber>
```

Generated by	Condition	Action Upon Generation	Action Upon Receipt
RM Destination.	Message number in /wsrm:Sequence/wsrm:MessageNumber of a Received message exceeds the internal limitations of an RM Destination or reaches the maximum value of 9,223,372,036,854,775,807.	RM Destination SHOULD continue to accept undelivered messages until the Sequence is closed or terminated.	RM Source SHOULD continue to retransmit undelivered messages until the Sequence is closed or terminated.

## 1026 4.6 Create Sequence Refused

1027 Properties:

1028 [Code] Sender

1029 [Subcode] wsrm:CreateSequenceRefused

1030 [Reason] The create Sequence request has been refused by the RM Destination.

1031 [Detail]

```
1032 xs:any
```

Generated by	Condition	Action Upon Generation	Action Upon Receipt
RM Destination.	In response to a CreateSequence message when the RM Destination does not wish to create a new Sequence.	Unspecified.	Sequence terminated.

## 1033 4.7 Sequence Closed

1034 This fault is generated by an RM Destination to indicate that the specified Sequence has been closed.

1035 This fault MUST be generated when an RM Destination is asked to accept a message for a Sequence that  
1036 is closed or when an RM Destination is asked to close a Sequence that is already closed.

1037 Properties:

1038 [Code] Sender

1039 [Subcode] wsrm:SequenceClosed

1040 [Reason] The Sequence is closed and can not accept new messages.

1041 [Detail]

1042 `<wsrm:Identifier...> xs:anyURI </wsrm:Identifier>`

Generated by	Condition	Action Upon Generation	Action Upon Receipt
RM Destination.	In response to a message that belongs to a Sequence that is already closed.	Unspecified.	Sequence closed.

#### 1043 **4.8 WSRM Required**

1044 If an RM Destination requires the use of WS-RM, this fault is generated when it Receives an incoming  
1045 message that did not use this protocol.

1046 Properties:

1047 [Code] Sender

1048 [Subcode] wsrm:WSRMRequired

1049 [Reason] The RM Destination requires the use of WSRM.

1050 [Detail]

1051 `xs:any`

Generated by	Condition	Action Upon Generation	Action Upon Receipt
RM Destination.	On receipt of a message that does not use this protocol and for which this protocol is required.	Unspecified.	Unspecified.

#### 1052 **4.9 Unsupported Selection**

1053 The QName of the unsupported element(s) are included in the detail.

1054 Properties:

1055 [Code] Receiver

1056 [Subcode] wsrm:UnsupportedSelection

1057 [Reason] The extension element used in the message selection is not supported by the RM Source

1058 [Detail]

1059 `<wsrm:UnsupportedElement> xs:QName </wsrm:UnsupportedElement>+`

Generated by	Condition	Action Upon Generation	Action Upon Receipt
RM Source or RM Destination.	In response to a <code>MakeConnection</code> message containing a selection criteria in the extensibility section of the message that is not support.ed	Unspecified.	Unspecified.

## 1060 **5 Security Threats and Countermeasures**

1061 This specification considers two sets of security requirements, those of the applications that use the WS-  
1062 RM protocol and those of the protocol itself.

1063 This specification makes no assumptions about the security requirements of the applications that use WS-  
1064 RM. However, once those requirements have been satisfied within a given operational context, the  
1065 addition of WS-RM to this operational context should not undermine the fulfillment of those requirements;  
1066 the use of WS-RM should not create additional attack vectors within an otherwise secure system.

1067 There are many other security concerns that one may need to consider when implementing or using this  
1068 protocol. The material below should not be considered as a "check list". Implementers and users of this  
1069 protocol are urged to perform a security analysis to determine their particular threat profile and the  
1070 appropriate responses to those threats.

1071 Implementers are also advised that there is a core tension between security and reliable messaging that  
1072 can be problematic if not addressed by implementations; one aspect of security is to prevent message  
1073 replay but one of the invariants of this protocol is to resend messages until they are acknowledged.  
1074 Consequently, if the security sub-system processes a message but a failure occurs before the reliable  
1075 messaging sub-system Receives that message, then it is possible (and likely) that the security sub-system  
1076 will treat subsequent copies as replays and discard them. At the same time, the reliable messaging sub-  
1077 system will likely continue to expect and even solicit the missing message(s). Care should be taken to  
1078 avoid and prevent this condition.

### 1079 **5.1 Threats and Countermeasures**

1080 The primary security requirement of this protocol is to protect the specified semantics and protocol  
1081 invariants against various threats. The following sections describe several threats to the integrity and  
1082 operation of this protocol and provide some general outlines of countermeasures to those threats.  
1083 Implementers and users of this protocol should keep in mind that all threats are not necessarily applicable  
1084 to all operational contexts.

#### 1085 **5.1.1 Integrity Threats**

1086 In general, any mechanism which allows an attacker to alter the information in a Sequence Traffic  
1087 Message, Sequence Lifecycle Message, Acknowledgement Messages, Acknowledgement Request, or  
1088 Sequence-related fault, or which allows an attacker to alter the correlation of a RM Protocol Header Block  
1089 to its intended message represents a threat to the WS-RM protocol.

1090 For example, if an attacker is able to swap `Sequence` headers on messages in transit between the RM  
1091 Source and RM Destination then they have undermined the implementation's ability to guarantee the first  
1092 invariant described in Section 2.3. The result is that there is no way of guaranteeing that messages will be  
1093 Delivered to the Application Destination in the same order that they were sent by the Application Source.

##### 1094 **5.1.1.1 Countermeasures**

1095 Integrity threats are generally countered via the use of digital signatures some level of the communication  
1096 protocol stack. Note that, in order to counter header swapping attacks, the signature SHOULD include  
1097 both the SOAP body and any relevant SOAP headers (e.g. `Sequence` header). Because some headers  
1098 (`AckRequested`, `SequenceAcknowledgement`) are independent of the body of the SOAP message in which  
1099 they occur, implementations MUST allow for signatures that cover only these headers.

## 1100 **5.1.2 Resource Consumption Threats**

1101 The creation of a Sequence with an RM Destination consumes various resources on the systems used to  
1102 implement that RM Destination. These resources can include network connections, database tables,  
1103 message queues, etc. This behavior can be exploited to conduct denial of service attacks against an RM  
1104 Destination. For example, a simple attack is to repeatedly send `CreateSequence` messages to an RM  
1105 Destination. Another attack is to create a Sequence for a service that is known to require in-order  
1106 message Delivery and use this Sequence to send a stream of very large messages to that service,  
1107 making sure to omit message number “1” from that stream.

### 1108 **5.1.2.1 Countermeasures**

1109 There are a number of countermeasures against the described resource consumption threats. The  
1110 technique advocated by this specification is for the RM Destination to restrict the ability to create a  
1111 Sequence to a specific set of entities/principals. This reduces the number of potential attackers and, in  
1112 some cases, allows the identity of any attackers to be determined.

1113 The ability to restrict Sequence creation depends, in turn, upon the RM Destination's ability identify and  
1114 authenticate the RM Source that issued the `CreateSequence` message.

## 1115 **5.1.3 Sequence Spoofing Threats**

1116 Sequence spoofing is a class of threats in which the attacker uses knowledge of the `Identifier` for a  
1117 particular Sequence to forge Sequence Lifecycle or Traffic Messages. For example the attacker creates a  
1118 fake `TerminateSequence` message that references the target Sequence and sends this message to the  
1119 appropriate RM Destination. Some sequence spoofing attacks also require up-to-date knowledge of the  
1120 current `MessageNumber` for their target Sequence.

1121 In general any Sequence Lifecycle Message, RM Protocol Header Block, or sequence-correlated SOAP  
1122 fault (e.g. `InvalidAcknowledgement`) can be used by someone with knowledge of the Sequence identifier  
1123 to attack the Sequence. These attacks are “two-way” in that an attacker may choose to target the RM  
1124 Source by, for example, inserting a fake `SequenceAcknowledgement` header into a message that it sends  
1125 to the `AcksTo` EPR of an RM Source.

### 1126 **5.1.3.1 Sequence Hijacking**

1127 Sequence hijacking is a specific case of a sequence spoofing attack. The attacker attempts to inject  
1128 Sequence Traffic Messages into an existing Sequence by inserting fake `Sequence` headers into those  
1129 messages.

1130 Note that “sequence hijacking” should not be equated with “security session hijacking”. Although a  
1131 Sequence may be bound to some form of a security session in order to counter the threats described in  
1132 this section, applications MUST NOT rely on WS-RM-related information to make determinations about  
1133 the identity of the entity that created a message; applications SHOULD rely only upon information that is  
1134 established by the security infrastructure to make such determinations. Failure to observe this rule  
1135 creates, among other problems, a situation in which the absence of WS-RM may deprive an application of  
1136 the ability to authenticate its peers even though the necessary security processing has taken place.

### 1137 **5.1.3.2 Countermeasures**

1138 There are a number of countermeasures against sequence spoofing threats. The technique advocated by  
1139 this specification is to consider the Sequence to be a shared resource that is jointly owned by the RM

1140 Source that initiated its creation (i.e. that sent the `CreateSequence` message) and the RM Destination that  
1141 serves as its terminus (i.e. that sent the `CreateSequenceResponse` message). To counter sequence  
1142 spoofing attempts the RM Destination SHOULD ensure that every message or fault that it Receives that  
1143 refers to a particular Sequence originated from the RM Source that jointly owns the referenced Sequence.  
1144 For its part the RM Source SHOULD ensure that every message or fault that it Receives that refers to a  
1145 particular Sequence originated from the RM Destination that jointly owns the referenced Sequence.

1146 For the RM Destination to be able to identify its sequence peer it MUST be able to identify and  
1147 authenticate the entity that sent the `CreateSequence` message. Similarly for the RM Source to identify its  
1148 sequence peer it MUST be able to identify and authenticate the entity that sent the  
1149 `CreateSequenceResponse` message. For either the RM Destination or the RM Source to determine if a  
1150 message was sent by its sequence peer it MUST be able to identify and authenticate the initiator of that  
1151 message and, if necessary, correlate this identity with the sequence peer identity established at sequence  
1152 creation time.

## 1153 **5.2 Security Solutions and Technologies**

1154 The security threats described in the previous sections are neither new nor unique. The solutions that  
1155 have been developed to secure other SOAP-based protocols can be used to secure WS-RM as well. This  
1156 section maps the facilities provided by common web services security solutions against countermeasures  
1157 described in the previous sections.

1158 Before continuing this discussion, however, some examination of the underlying requirements of the  
1159 previously described countermeasures is necessary. Specifically it should be noted that the technique  
1160 described in Section 5.1.2.1 has two components. Firstly, the RM Destination identifies and authenticates  
1161 the issuer of a `CreateSequence` message. Secondly, the RM Destination to performs an authorization  
1162 check against this authenticated identity and determines if the RM Source is permitted to create  
1163 Sequences with the RM Destination. Since the facilities for performing this authorization check (runtime  
1164 infrastructure, policy frameworks, etc.) lie completely within the domain of individual implementations, any  
1165 discussion of such facilities is considered to be beyond the scope of this specification.

### 1166 **5.2.1 Transport Layer Security**

1167 This section describes how the the facilities provided by SSL/TLS [RFC 4346] can be used to implement  
1168 the countermeasures described in the previous sections. The use of SSL/TLS is subject to the constraints  
1169 defined in Section 4 of the Basic Security Profile 1.0 [BSP 1.0].

1170 The description provided here is general in nature and is not intended to serve as a complete definition on  
1171 the use of SSL/TLS to protect WS-RM. In order to interoperate implementations need to agree on the  
1172 choice of features as well as the manner in which they will be used. The mechanisms described in the  
1173 Web Services Security Policy Language [SecurityPolicy] MAY be used by services to describe the  
1174 requirements and constraints of the use of SSL/TLS.

#### 1175 **5.2.1.1 Model**

1176 The basic model for using SSL/TLS is as follows:

- 1177 1. The RM Source establishes an SSL/TLS session with the RM Destination.
- 1178 2. The RM Source uses this SSL/TLS session to send a `CreateSequence` message to the RM  
1179 Destination.

- 1180 3. The RM Destination establishes an SSL/TLS session with the RM Source and sends an  
1181 asynchronous `CreateSequenceResponse` using this session. Alternately it may respond with a  
1182 synchronous `CreateSequenceResponse` using the session established in (1).
- 1183 4. For the lifetime of the Sequence the RM Source uses the SSL/TLS session from (1) to Transmit  
1184 any and all messages or faults that refer to that Sequence.
- 1185 5. For the lifetime of the Sequence the RM Destination either uses the SSL/TLS session established  
1186 in (3) to Transmit any and all messages or faults that refer to that Sequence or, for synchronous  
1187 exchanges, the RM Destination uses the SSL/TLS session established in (1).

### 1188 5.2.1.2 Countermeasure Implementation

1189 Used in its simplest fashion (without relying upon any authentication mechanisms), SSL/TLS provides the  
1190 necessary integrity qualities to counter the threats described in Section 5.1.1. Note, however, that the  
1191 nature of SSL/TLS limits the scope of this integrity protection to a single transport level session. If  
1192 SSL/TLS is the only mechanism used to provide integrity, any intermediaries between the RM Source and  
1193 the RM Destination MUST be trusted to preserve the integrity of the messages that flow through them.

1194 As noted, the technique described in Sections 5.1.2.1 involves the use of authentication. This specification  
1195 advocates either of two mechanisms for authenticating entities using SSL/TLS. In both of these methods  
1196 the SSL/TLS server (the party accepting the SSL/TLS connection) authenticates itself to the SSL/TLS  
1197 client using an X.509 certificate that is exchanged during the SSL/TLS handshake.

- 1198 • **HTTP Basic Authentication:** This method of authentication presupposes that a SOAP/HTTP  
1199 binding is being used as part of the protocol stack beneath WS-RM. Subsequent to the  
1200 establishment of the the SSL/TLS session, the sending party authenticates itself to the receiving  
1201 party using HTTP Basic Authentication [RFC 2617]. For example, a RM Source might  
1202 authenticate itself to a RM Destination (e.g. when transmitting a Sequence Traffic Message) using  
1203 BasicAuth. Similarly the RM Destination might authenticate itself to the RM Source (e.g. when  
1204 sending an Acknowledgement) using BasicAuth.
- 1205 • **SSL/TLS Client Authentication:** In this method of authentication, the party initiating the  
1206 connection authenticates itself to the party accepting the connection using an X.509 certificate  
1207 that is exchanged during the SSL/TLS handshake.

1208 To implement the countermeasures described in section 5.1.2.1 the RM Source must authenticate itself  
1209 using one the above mechanisms. The authenticated identity can then be used to determine if the RM  
1210 Source is authorized to create a Sequence with the RM Destination.

1211 This specification advocates implementing the countermeasures described in section 5.1.3.2 by requiring  
1212 an RM node's Sequence peer to be equivalent to their SSL/TLS session peer. This allows the  
1213 authorization decisions described in section 5.1.3.2 to be based on SSL/TLS session identity rather than  
1214 on authentication information. For example, an RM Destination can determine that a Sequence Traffic  
1215 Message rightfully belongs to its referenced Sequence if that message arrived over the same SSL/TLS  
1216 session that was used to carry the `CreateSequence` message for that Sequence. Note that requiring a  
1217 one-to-one relationship between SSL/TLS session peer and Sequence peer constrains the lifetime of a  
1218 SSL/TLS-protected Sequence to be less than or equal to the lifetime of the SSL/TLS session that is used  
1219 to protect that Sequence.

1220 This specification does not preclude the use of other methods of using SSL/TLS to implement the  
1221 countermeasures (such as associating specific authentication information with a Sequence) although such  
1222 methods are not covered by this document.

1223 Issues specific to the life-cycle management of SSL/TLS sessions (such as the resumption of a SSL/TLS  
1224 session) are outside the scope of this specification.

## 1225 **5.2.2 SOAP Message Security**

1226 The mechanisms described in WS-Security may be used in various ways to implement the  
1227 countermeasures described in the previous sections. This specification advocates using the protocol  
1228 described by WS-SecureConversation [[SecureConversation](#)] (optionally in conjunction with WS-Trust  
1229 [[Trust](#)]) as a mechanism for protecting Sequences. The use of WS-Security (as an underlying component  
1230 of WS-SecureConversation) is subject to the constraints defined in the Basic Security Profile 1.0.

1231 The description provided here is general in nature and is not intended to serve as a complete definition on  
1232 the use of WS-SecureConversation/WS-Trust to protect WS-RM. In order to interoperate implementations  
1233 need to agree on the choice of features as well as the manner in which they will be used. The  
1234 mechanisms described in the Web Services Security Policy Language MAY be used by services to  
1235 describe the requirements and constraints of the use of WS-SecureConversation.

### 1236 **5.2.2.1 Model**

1237 The basic model for using WS-SecureConversation is as follows:

- 1238 1. The RM Source and the RM Destination create a WS-SecureConversation security context. This  
1239 may involve the participation of third parties such as a security token service. The tokens  
1240 exchanged may contain authentication claims (e.g. X.509 certificates or Kerberos service tickets).
- 1241 2. During the `CreateSequence` exchange, the RM Source SHOULD explicitly identify the security  
1242 context that will be used to protect the Sequence. This is done so that, in cases where the  
1243 `CreateSequence` message is signed by more than one security context, the RM Source can  
1244 indicate which security context should be used to protect the newly created Sequence.
- 1245 3. For the lifetime of the Sequence the RM Source and the RM Destination use the session key(s)  
1246 associated with the security context to sign (as defined by WS-Security) at least the body and any  
1247 relevant WS-RM-defined headers of any and all messages or faults that refer to that Sequence.

### 1248 **5.2.2.2 Countermeasure Implementation**

1249 Without relying upon any authentication information, the per-message signatures provide the necessary  
1250 integrity qualities to counter the threats described in Section 5.1.1.

1251 To implement the countermeasures described in section 5.1.2.1 some mutually agreed upon form of  
1252 authentication claims must be provided by the RM Source to the RM Destination during the establishment  
1253 of the Security Context. These claims can then be used to determine if the RM Source is authorized to  
1254 create a Sequence with the RM Destination.

1255 This specification advocates implementing the countermeasures described in section 5.1.3.2 by requiring  
1256 an RM node's Sequence peer to be equivalent to their security context session peer. This allows the  
1257 authorization decisions described in section 5.1.3.2 to be based on the identity of the message's security  
1258 context rather than on any authentication claims that may have been established during security context  
1259 initiation. Note that other methods of using WS-SecurityConversation to implement the countermeasures  
1260 (such as associating specific authentication claims to a Sequence) are possible but not covered by this  
1261 document.

1262 As with transport security, the requisite equivalence of a security context peer and with a Sequence peer  
1263 limits the lifetime of a Sequence to the lifetime of the protecting security context. Unlike transport security,

1264 the association between a Sequence and its protecting security context cannot always be established  
1265 implicitly at Sequence creation time. This is due to the fact that the `CreateSequence` and  
1266 `CreateSequenceResponse` messages may be signed by more than one security context.

1267 Issues specific to the life-cycle management of WS-SecurityConversation security contexts (such as  
1268 amending or renewing contexts) are outside the scope of this specification.

## 1269 6 Securing Sequences

1270 As noted in Section 5, the RM Source and RM Destination should be able to protect their shared  
1271 Sequences against the threat of Sequence Spoofing attacks. There are a number of OPTIONAL means of  
1272 achieving this objective depending upon the underlying security infrastructure.

### 1273 6.1 Securing Sequences Using WS-Security

1274 One mechanism for protecting a Sequence is to include a security token using a  
1275 `wsse:SecurityTokenReference` element from WS-Security (see section 9 in WS-  
1276 SecureConversation) in the `CreateSequence` element. This establishes an association between the  
1277 created (and, if present, offered) Sequence(s) and the referenced security token, such that the RM Source  
1278 and Destination MUST use the security token as the basis for authorization of all subsequent interactions  
1279 related to the Sequence(s). The `wsse:SecurityTokenReference` explicitly identifies the token as  
1280 there may be more than one token on a `CreateSequence` message or inferred from the communication  
1281 context (e.g. transport protection).

1282 It is RECOMMENDED that a message independent referencing mechanism be used to identify the token,  
1283 if the token being referenced supports such mechanism.

1284 The following exemplar defines the `CreateSequence` syntax when extended to include a  
1285 `wsse:SecurityTokenReference`:

```
1286 <wsrm:CreateSequence ...>  
1287   <wsrm:AcksTo> wsa:EndpointReferenceType </wsrm:AcksTo>  
1288   <wsrm:Expires ...> xs:duration </wsrm:Expires> ?  
1289   <wsrm:Offer ...>  
1290     <wsrm:Identifier ...> xs:anyURI </wsrm:Identifier>  
1291     <wsrm:Endpoint> wsa:EndpointReferenceType </wsrm:Endpoint>  
1292     <wsrm:Expires ...> xs:duration </wsrm:Expires> ?  
1293     <wsrm:IncompleteSequenceBehavior>  
1294       wsrml:IncompleteSequenceBehaviorType  
1295     </wsrm:IncompleteSequenceBehavior> ?  
1296     ...  
1297   </wsrm:Offer> ?  
1298   ...  
1299   <wsse:SecurityTokenReference>  
1300     ...  
1301   </wsse:SecurityTokenReference> ?  
1302   ...  
1303 </wsrm:CreateSequence>
```

1304 `/wsrm:CreateSequence/wsse:SecurityTokenReference`

1305 This element uses the extensibility mechanism defined for the `CreateSequence` element (defined in  
1306 section 3.1) to communicate an explicit reference to the security token, using a  
1307 `wsse:SecurityTokenReference` as documented in WS-Security, that the RM Source and Destination  
1308 MUST use to authorize messages for the created (and, if present, the offered) Sequence(s). All  
1309 subsequent messages related to the created (and, if present, the offered) Sequence(s) MUST  
1310 demonstrate proof-of-possession of the secret associated with the token (e.g., by using or deriving from a  
1311 private or secret key).

1312 When a RM Source Transmits a `CreateSequence` that has been extended to include a  
1313 `wsse:SecurityTokenReference` it SHOULD ensure that the RM Destination both understands and  
1314 will conform with the requirements listed above. In order to achieve this, the RM Source SHOULD include  
1315 the `UsesSequenceSTR` element as a SOAP header block within the `CreateSequence` message. This  
1316 element MUST include a `soap:mustUnderstand` attribute with a value of 'true'. Thus the RM Source

1317 can be assured that a RM Destination that responds with a `CreateSequenceResponse` understands  
1318 and conforms with the requirements listed above. Note that an RM Destination understanding this header  
1319 does not mean that it has processed and understood any WS-Security headers, the fault behavior defined  
1320 in WS-Security still applies.

1321 The following exemplar defines the `UsesSequenceSTR` syntax:

```
1322 <wsm:UsesSequenceSTR ... />
```

1323 /wsm:UsesSequenceSTR

1324 This element SHOULD be included as a SOAP header block in `CreateSequence` messages that use the  
1325 extensibility mechanism described above in this section. The `soap:mustUnderstand` attribute value  
1326 MUST be 'true'. The receiving RM Destination MUST understand and correctly implement the extension  
1327 described above or else generate a `soap:MustUnderstand` fault, thus aborting the requested  
1328 Sequence creation.

1329 The following is an example of a `CreateSequence` message using the

1330 `wsse:SecurityTokenReference` extension and the `UsesSequenceSTR` header block:

```
1331 <soap:Envelope ...>  
1332   <soap:Header>  
1333     ...  
1334     <wsm:UsesSequenceSTR soap:mustUnderstand='true' />  
1335     ...  
1336   </soap:Header>  
1337   <soap:Body>  
1338     <wsm:CreateSequence>  
1339       <wsm:AcksTo>  
1340         <wsa:Address>http://Business456.com/serviceA/789</wsa:Address>  
1341       </wsm:AcksTo>  
1342       <wsse:SecurityTokenReference>  
1343         ...  
1344       </wsse:SecurityTokenReference>  
1345     </wsm:CreateSequence>  
1346   </soap:Body>  
1347 </soap:Envelope>
```

## 1348 6.2 Securing Sequences Using SSL/TLS

1349 One mechanism for protecting a Sequence is to bind the Sequence to the underlying SSL/TLS session(s).  
1350 The RM Source indicates to the RM Destination that a Sequence is to be bound to the underlying  
1351 SSL/TLS session(s) via the `UsesSequenceSSL` header block. If the RM Source wishes to bind a  
1352 Sequence to the underlying SSL/TLS sessions(s) it MUST include the `UsesSequenceSSL` element as a  
1353 SOAP header block within the `CreateSequence` message.

1354 The following exemplar defines the `UsesSequenceSSL` syntax:

```
1355 <wsm:UsesSequenceSSL soap:mustUnderstand="true" ... />
```

1356 /wsm:UsesSequenceSSL

1357 The RM Source MAY include this element as a SOAP header block of a `CreateSequence` message to  
1358 indicate to the RM Destination that the resulting Sequence is to be bound to the SSL/TLS session that was  
1359 used to carry the `CreateSequence` message. If included, the RM Source MUST mark this header with a  
1360 `soap:mustUnderstand` attribute with a value of 'true'. The receiving RM Destination MUST understand  
1361 and correctly implement the functionality described in Section 5.2.1 or else generate a  
1362 `soap:MustUnderstand` fault, thus aborting the requested Sequence creation.

1363 Note that the use inclusion of the above header by the RM Source implies that all Sequence-related  
1364 information (Sequence Lifecycle or Acknowledgment messages or Sequence-related faults) flowing from  
1365 the RM Destination to the RM Source will be bound to the SSL/TLS session that is used to carry the  
1366 `CreateSequenceResponse` message.

## 1367 **7 References**

### 1368 **7.1 Normative**

#### 1369 **[KEYWORDS]**

1370 S. Bradner, "[Key words for use in RFCs to Indicate Requirement Levels](#)," RFC 2119, Harvard University,  
1371 March 1997

#### 1372 **[SOAP 1.1]**

1373 W3C Note, "[SOAP: Simple Object Access Protocol 1.1](#)," 08 May 2000.

#### 1374 **[SOAP 1.2]**

1375 W3C Recommendation, "[SOAP Version 1.2 Part 1: Messaging Framework](#)" June 2003.

#### 1376 **[URI]**

1377 T. Berners-Lee, R. Fielding, L. Masinter, "[Uniform Resource Identifiers \(URI\): Generic Syntax](#)," RFC 3986,  
1378 MIT/LCS, U.C. Irvine, Xerox Corporation, January 2005.

#### 1379 **[UUID]**

1380 P. Leach, M. Mealling, R. Salz, "[A Universally Unique Identifier \(UUID\) URN Namespace](#)," RFC 4122,  
1381 Microsoft, Refactored Networks - LLC, DataPower Technology Inc, July 2005

#### 1382 **[XML]**

1383 W3C Recommendation, "[Extensible Markup Language \(XML\) 1.0 \(Second Edition\)](#)", October 2000.

#### 1384 **[XML-ns]**

1385 W3C Recommendation, "[Namespaces in XML](#)," 14 January 1999.

#### 1386 **[XML-Schema Part1]**

1387 W3C Recommendation, "[XML Schema Part 1: Structures](#)," 2 May 2001.

#### 1388 **[XML-Schema Part2]**

1389 W3C Recommendation, "[XML Schema Part 2: Datatypes](#)," 2 May 2001.

#### 1390 **[XPath 1.0]**

1391 W3C Recommendation, "[XML Path Language \(XPath\) Version 1.0](#)," 16 November 1999.

#### 1392 **[WSDL 1.1]**

1393 W3C Note, "[Web Services Description Language \(WSDL 1.1\)](#)," 15 March 2001.

#### 1394 **[WS-Addressing]**

1395 W3C Recommendation, "[Web Services Addressing 1.0 - Core](#)", May 2006.

1396 W3C Recommendation, "[Web Services Addressing 1.0 – SOAP Binding](#)", May 2006.

### 1397 **7.2 Non-Normative**

#### 1398 **[BSP 1.0]**

1399 WS-I Working Group Draft. "[Basic Security Profile Version 1.0](#)," March 2006

#### 1400 **[RDDL 2.0]**

- 1401 Johnathan Borden, Tim Bray, eds. "[Resource Directory Description Language \(RDDL\) 2.0](#)," January 2004
- 1402 **[RFC 2617]**
- 1403 J. Franks, P. Hallam-Baker, J. Hostetler, S. Lawrence, P. Leach, A. Loutonen, L. Stewart, "[HTTP](#)
- 1404 [Authentication: Basic and Digest Access Authentication](#)," June 1999.
- 1405 **[RFC 4346]**
- 1406 T. Dierks, E. Rescorla, "[The Transport Layer Security \(TLS\) Protocol Version 1.1](#)," April 2006.
- 1407 **[WS-Policy]**
- 1408 W3C Member Submission, "[Web Services Policy Framework \(WS-Policy\)](#)," April 2006.
- 1409 **[WS-PolicyAttachment]**
- 1410 W3C Member Submission, "[Web Services Policy Attachment \(WS-PolicyAttachment\)](#)," April 2006.
- 1411 **[WS-Security]**
- 1412 Anthony Nadalin, Chris Kaler, Phillip Hallam-Baker, Ronald Monzillo, eds. "[OASIS Web Services Security:](#)
- 1413 [SOAP Message Security 1.0 \(WS-Security 2004\)](#)", OASIS Standard 200401, March 2004.
- 1414 Anthony Nadalin, Chris Kaler, Phillip Hallam-Baker, Ronald Monzillo, eds. "[OASIS Web Services Security:](#)
- 1415 [SOAP Message Security 1.1 \(WS-Security 2004\)](#)", OASIS Standard 200602, February 2006.
- 1416 **[RTTM]**
- 1417 V. Jacobson, R. Braden, D. Borman, "[TCP Extensions for High Performance](#)", RFC 1323, May
- 1418 1992.
- 1419 **[SecurityPolicy]**
- 1420 G. Della-Libra, et. al. "[Web Services Security Policy Language \(WS-SecurityPolicy\)](#)", July 2005
- 1421 **[SecureConversation]**
- 1422 S. Anderson, et al, "[Web Services Secure Conversation Language \(WS-SecureConversation\)](#)," February
- 1423 2005.
- 1424 **[Trust]**
- 1425 S. Anderson, et al, "[Web Services Trust Language \(WS-Trust\)](#)," February 2005.

## 1426 Appendix A. Schema

1427 The normative schema that is defined for WS-ReliableMessaging using [XML-Schema Part1] and [XML-  
1428 Schema Part2] is located at:

1429 <http://docs.oasis-open.org/ws-rx/wsrn/200608/wsrn-1.1-schema-200608.xsd>

1430 The following copy is provided for reference.

```
1431 <?xml version="1.0" encoding="UTF-8"?>
1432 <!--
1433 OASIS takes no position regarding the validity or scope of any intellectual
1434 property or other rights that might be claimed to pertain to the
1435 implementation or use of the technology described in this document or the
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1463 NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT
1464 INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS
1465 FOR A PARTICULAR PURPOSE.
1466 -->
1467 <xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
1468 xmlns:wsa="http://www.w3.org/2005/08/addressing"
1469 xmlns:wsrm="http://docs.oasis-open.org/ws-rx/wsrn/200608"
1470 targetNamespace="http://docs.oasis-open.org/ws-rx/wsrn/200608"
1471 elementFormDefault="qualified" attributeFormDefault="unqualified">
1472   <xs:import namespace="http://www.w3.org/2005/08/addressing"
1473   schemaLocation="http://www.w3.org/2006/03/addressing/ws-addr.xsd"/>
1474   <!-- Protocol Elements -->
1475   <xs:complexType name="SequenceType">
1476     <xs:sequence>
1477       <xs:element ref="wsrm:Identifier"/>
1478       <xs:element name="MessageNumber" type="wsrm:MessageNumberType"/>
1479       <xs:any namespace="##other" processContents="lax" minOccurs="0"
1480 maxOccurs="unbounded"/>
1481     </xs:sequence>
```

```

1482     <xs:anyAttribute namespace="##other" processContents="lax"/>
1483 </xs:complexType>
1484 <xs:element name="Sequence" type="wsrm:SequenceType"/>
1485 <xs:element name="SequenceAcknowledgement">
1486   <xs:complexType>
1487     <xs:sequence>
1488       <xs:element ref="wsrm:Identifier"/>
1489       <xs:choice>
1490         <xs:sequence>
1491           <xs:choice>
1492             <xs:element name="AcknowledgementRange" maxOccurs="unbounded">
1493               <xs:complexType>
1494                 <xs:sequence/>
1495                 <xs:attribute name="Upper" type="xs:unsignedLong"
1496 use="required"/>
1497                 <xs:attribute name="Lower" type="xs:unsignedLong"
1498 use="required"/>
1499               <xs:anyAttribute namespace="##other" processContents="lax"/>
1500             </xs:complexType>
1501           </xs:element>
1502           <xs:element name="None">
1503             <xs:complexType>
1504               <xs:sequence/>
1505             </xs:complexType>
1506           </xs:element>
1507         </xs:choice>
1508         <xs:element name="Final" minOccurs="0">
1509           <xs:complexType>
1510             <xs:sequence/>
1511           </xs:complexType>
1512         </xs:element>
1513       </xs:sequence>
1514       <xs:element name="Nack" type="xs:unsignedLong"
1515 maxOccurs="unbounded"/>
1516     </xs:choice>
1517     <xs:any namespace="##other" processContents="lax" minOccurs="0"
1518 maxOccurs="unbounded"/>
1519   </xs:sequence>
1520   <xs:anyAttribute namespace="##other" processContents="lax"/>
1521 </xs:complexType>
1522 </xs:element>
1523 <xs:complexType name="AckRequestedType">
1524   <xs:sequence>
1525     <xs:element ref="wsrm:Identifier"/>
1526     <xs:any namespace="##other" processContents="lax" minOccurs="0"
1527 maxOccurs="unbounded"/>
1528   </xs:sequence>
1529   <xs:anyAttribute namespace="##other" processContents="lax"/>
1530 </xs:complexType>
1531 <xs:element name="AckRequested" type="wsrm:AckRequestedType"/>
1532 <xs:complexType name="MessagePendingType">
1533   <xs:sequence>
1534     <xs:any namespace="##other" processContents="lax" minOccurs="0"
1535 maxOccurs="unbounded"/>
1536   </xs:sequence>
1537   <xs:attribute name="pending" type="xs:boolean"/>
1538   <xs:anyAttribute namespace="##other" processContents="lax"/>
1539 </xs:complexType>
1540 <xs:element name="MessagePending" type="wsrm:MessagePendingType"/>
1541 <xs:element name="Identifier">
1542   <xs:complexType>
1543     <xs:annotation>
1544       <xs:documentation>

```

```

1545         This type is for elements whose [children] is an anyURI and can have
1546 arbitrary attributes.
1547         </xs:documentation>
1548     </xs:annotation>
1549     <xs:simpleContent>
1550         <xs:extension base="xs:anyURI">
1551             <xs:anyAttribute namespace="##other" processContents="lax"/>
1552         </xs:extension>
1553     </xs:simpleContent>
1554 </xs:complexType>
1555 </xs:element>
1556 <xs:element name="Address">
1557     <xs:complexType>
1558         <xs:simpleContent>
1559             <xs:extension base="xs:anyURI">
1560                 <xs:anyAttribute namespace="##other" processContents="lax"/>
1561             </xs:extension>
1562         </xs:simpleContent>
1563     </xs:complexType>
1564 </xs:element>
1565 <xs:complexType name="MakeConnectionType">
1566     <xs:sequence>
1567         <xs:element ref="wsrm:Identifier" minOccurs="0" maxOccurs="1"/>
1568         <xs:element ref="wsrm:Address" minOccurs="0" maxOccurs="1"/>
1569         <xs:any namespace="##other" processContents="lax" minOccurs="0"
1570 maxOccurs="unbounded"/>
1571     </xs:sequence>
1572     <xs:anyAttribute namespace="##other" processContents="lax"/>
1573 </xs:complexType>
1574 <xs:element name="MakeConnection" type="wsrm:MakeConnectionType"/>
1575 <xs:simpleType name="MessageNumberType">
1576     <xs:restriction base="xs:unsignedLong">
1577         <xs:minInclusive value="1"/>
1578         <xs:maxInclusive value="9223372036854775807"/>
1579     </xs:restriction>
1580 </xs:simpleType>
1581 <!-- Fault Container and Codes -->
1582 <xs:simpleType name="FaultCodes">
1583     <xs:restriction base="xs:QName">
1584         <xs:enumeration value="wsrm:SequenceTerminated"/>
1585         <xs:enumeration value="wsrm:UnknownSequence"/>
1586         <xs:enumeration value="wsrm:InvalidAcknowledgement"/>
1587         <xs:enumeration value="wsrm:MessageNumberRollover"/>
1588         <xs:enumeration value="wsrm:CreateSequenceRefused"/>
1589         <xs:enumeration value="wsrm:SequenceClosed"/>
1590         <xs:enumeration value="wsrm:WSRMRequired"/>
1591         <xs:enumeration value="wsrm:UnsupportedSelection"/>
1592     </xs:restriction>
1593 </xs:simpleType>
1594 <xs:complexType name="SequenceFaultType">
1595     <xs:sequence>
1596         <xs:element name="FaultCode" type="wsrm:FaultCodes"/>
1597         <xs:element name="Detail" type="wsrm:DetailType" minOccurs="0"/>
1598         <xs:any namespace="##other" processContents="lax" minOccurs="0"
1599 maxOccurs="unbounded"/>
1600     </xs:sequence>
1601     <xs:anyAttribute namespace="##other" processContents="lax"/>
1602 </xs:complexType>
1603 <xs:complexType name="DetailType">
1604     <xs:sequence>
1605         <xs:any namespace="##other" processContents="lax" minOccurs="0"
1606 maxOccurs="unbounded"/>
1607     </xs:sequence>

```

```

1608     <xs:anyAttribute namespace="##other" processContents="lax"/>
1609 </xs:complexType>
1610 <xs:element name="SequenceFault" type="wsrm:SequenceFaultType"/>
1611 <xs:element name="CreateSequence" type="wsrm:CreateSequenceType"/>
1612 <xs:element name="CreateSequenceResponse"
1613 type="wsrm:CreateSequenceResponseType"/>
1614 <xs:element name="CloseSequence" type="wsrm:CloseSequenceType"/>
1615 <xs:element name="CloseSequenceResponse"
1616 type="wsrm:CloseSequenceResponseType"/>
1617 <xs:element name="TerminateSequence" type="wsrm:TerminateSequenceType"/>
1618 <xs:element name="TerminateSequenceResponse"
1619 type="wsrm:TerminateSequenceResponseType"/>
1620 <xs:complexType name="CreateSequenceType">
1621 <xs:sequence>
1622 <xs:element ref="wsrm:AcksTo"/>
1623 <xs:element ref="wsrm:Expires" minOccurs="0"/>
1624 <xs:element name="Offer" type="wsrm:OfferType" minOccurs="0"/>
1625 <xs:any namespace="##other" processContents="lax" minOccurs="0"
1626 maxOccurs="unbounded">
1627 <xs:annotation>
1628 <xs:documentation>
1629 It is the authors intent that this extensibility be used to
1630 transfer a Security Token Reference as defined in WS-Security.
1631 </xs:documentation>
1632 </xs:annotation>
1633 </xs:any>
1634 </xs:sequence>
1635 <xs:anyAttribute namespace="##other" processContents="lax"/>
1636 </xs:complexType>
1637 <xs:complexType name="CreateSequenceResponseType">
1638 <xs:sequence>
1639 <xs:element ref="wsrm:Identifier"/>
1640 <xs:element ref="wsrm:Expires" minOccurs="0"/>
1641 <xs:element name="IncompleteSequenceBehavior"
1642 type="wsrm:IncompleteSequenceBehaviorType" minOccurs="0"/>
1643 <xs:element name="Accept" type="wsrm:AcceptType" minOccurs="0"/>
1644 <xs:any namespace="##other" processContents="lax" minOccurs="0"
1645 maxOccurs="unbounded"/>
1646 </xs:sequence>
1647 <xs:anyAttribute namespace="##other" processContents="lax"/>
1648 </xs:complexType>
1649 <xs:complexType name="CloseSequenceType">
1650 <xs:sequence>
1651 <xs:element ref="wsrm:Identifier"/>
1652 <xs:any namespace="##other" processContents="lax" minOccurs="0"
1653 maxOccurs="unbounded"/>
1654 </xs:sequence>
1655 <xs:anyAttribute namespace="##other" processContents="lax"/>
1656 </xs:complexType>
1657 <xs:complexType name="CloseSequenceResponseType">
1658 <xs:sequence>
1659 <xs:element ref="wsrm:Identifier"/>
1660 <xs:any namespace="##other" processContents="lax" minOccurs="0"
1661 maxOccurs="unbounded"/>
1662 </xs:sequence>
1663 <xs:anyAttribute namespace="##other" processContents="lax"/>
1664 </xs:complexType>
1665 <xs:complexType name="TerminateSequenceType">
1666 <xs:sequence>
1667 <xs:element ref="wsrm:Identifier"/>
1668 <xs:any namespace="##other" processContents="lax" minOccurs="0"
1669 maxOccurs="unbounded"/>
1670 </xs:sequence>

```

```

1671     <xs:anyAttribute namespace="##other" processContents="lax"/>
1672 </xs:complexType>
1673 <xs:complexType name="TerminateSequenceResponseType">
1674   <xs:sequence>
1675     <xs:element ref="wsrm:Identifier"/>
1676     <xs:any namespace="##other" processContents="lax" minOccurs="0"
1677 maxOccurs="unbounded"/>
1678   </xs:sequence>
1679   <xs:anyAttribute namespace="##other" processContents="lax"/>
1680 </xs:complexType>
1681 <xs:element name="AcksTo" type="wsa:EndpointReferenceType"/>
1682 <xs:complexType name="OfferType">
1683   <xs:sequence>
1684     <xs:element ref="wsrm:Identifier"/>
1685     <xs:element name="Endpoint" type="wsa:EndpointReferenceType"/>
1686     <xs:element ref="wsrm:Expires" minOccurs="0"/>
1687     <xs:element name="IncompleteSequenceBehavior"
1688 type="wsrm:IncompleteSequenceBehaviorType" minOccurs="0"/>
1689     <xs:any namespace="##other" processContents="lax" minOccurs="0"
1690 maxOccurs="unbounded"/>
1691   </xs:sequence>
1692   <xs:anyAttribute namespace="##other" processContents="lax"/>
1693 </xs:complexType>
1694 <xs:complexType name="AcceptType">
1695   <xs:sequence>
1696     <xs:element ref="wsrm:AcksTo"/>
1697     <xs:any namespace="##other" processContents="lax" minOccurs="0"
1698 maxOccurs="unbounded"/>
1699   </xs:sequence>
1700   <xs:anyAttribute namespace="##other" processContents="lax"/>
1701 </xs:complexType>
1702 <xs:element name="Expires">
1703   <xs:complexType>
1704     <xs:simpleContent>
1705       <xs:extension base="xs:duration">
1706         <xs:anyAttribute namespace="##other" processContents="lax"/>
1707       </xs:extension>
1708     </xs:simpleContent>
1709   </xs:complexType>
1710 </xs:element>
1711 <xs:simpleType name="IncompleteSequenceBehaviorType">
1712   <xs:restriction base="xs:string">
1713     <xs:enumeration value="DiscardEntireSequence"/>
1714     <xs:enumeration value="DiscardFollowingFirstGap"/>
1715     <xs:enumeration value="NoDiscard"/>
1716   </xs:restriction>
1717 </xs:simpleType>
1718 <xs:element name="UsesSequenceSTR">
1719   <xs:sequence/>
1720   <xs:anyAttribute namespace="##other" processContents="lax"/>
1721 </xs:element>
1722 <xs:element name="UsesSequenceSSL">
1723   <xs:sequence/>
1724   <xs:anyAttribute namespace="##other" processContents="lax"/>
1725 </xs:element>
1726 <xs:element name="UnsupportedElement">
1727   <xs:simpleType>
1728     <xs:restriction base="xs:QName"/>
1729   </xs:simpleType>
1730 </xs:element>
1731 </xs:schema>

```

## 1732 Appendix B. WSDL

1733 The normative WSDL 1.1 definition for WS-ReliableMessaging is located at:

1734 <http://docs.oasis-open.org/ws-rx/wsrn/200608/wsd/wsrn-1.1-wsd-200608.wsd>

1735 The following non-normative copy is provided for reference.

```
1736 <?xml version="1.0" encoding="utf-8"?>
1737 <!--
1738 OASIS takes no position regarding the validity or scope of any intellectual
1739 property or other rights that might be claimed to pertain to the
1740 implementation or use of the technology described in this document or the
1741 extent to which any license under such rights might or might not be available;
1742 neither does it represent that it has made any effort to identify any such
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1744 specifications can be found at the OASIS website. Copies of claims of rights
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1768 NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT
1769 INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS
1770 FOR A PARTICULAR PURPOSE.
1771 -->
1772 <wsdl:definitions xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
1773 xmlns:xs="http://www.w3.org/2001/XMLSchema"
1774 xmlns:wsa="http://www.w3.org/2005/08/addressing" xmlns:rm="http://docs.oasis-
1775 open.org/ws-rx/wsrn/200608" xmlns:tns="http://docs.oasis-open.org/ws-
1776 rx/wsrn/200608/wsd" targetNamespace="http://docs.oasis-open.org/ws-
1777 rx/wsrn/200608/wsd">
1778   <wsdl:types>
1779     <xs:schema
1780       <xs:import namespace="http://docs.oasis-open.org/ws-rx/wsrn/200608"
1781       schemaLocation="http://docs.oasis-open.org/ws-rx/wsrn/200608/wsrn-1.1-schema-
1782       200608.xsd"/>
1783     </xs:schema>
1784   </wsdl:types>
1785   <wsdl:message name="CreateSequence">
1786     <wsdl:part name="create" element="rm:CreateSequence"/>
```

```

1787 </wsdl:message>
1788 <wsdl:message name="CreateSequenceResponse">
1789   <wsdl:part name="createResponse" element="rm:CreateSequenceResponse"/>
1790 </wsdl:message>
1791 <wsdl:message name="CloseSequence">
1792   <wsdl:part name="close" element="rm:CloseSequence"/>
1793 </wsdl:message>
1794 <wsdl:message name="CloseSequenceResponse">
1795   <wsdl:part name="closeResponse" element="rm:CloseSequenceResponse"/>
1796 </wsdl:message>
1797 <wsdl:message name="TerminateSequence">
1798   <wsdl:part name="terminate" element="rm:TerminateSequence"/>
1799 </wsdl:message>
1800 <wsdl:message name="TerminateSequenceResponse">
1801   <wsdl:part name="terminateResponse"
1802 element="rm:TerminateSequenceResponse"/>
1803 </wsdl:message>
1804 <wsdl:message name="MakeConnection">
1805   <wsdl:part name="makeConnection" element="rm:MakeConnection"/>
1806 </wsdl:message>

1807 <wsdl:portType name="SequenceAbstractPortType">
1808   <wsdl:operation name="CreateSequence">
1809     <wsdl:input message="tns:CreateSequence" wsaw:Action="http://docs.oasis-
1810 open.org/ws-rx/wsrn/200608/CreateSequence"/>
1811     <wsdl:output message="tns:CreateSequenceResponse"
1812 wsaw:Action="http://docs.oasis-open.org/ws-
1813 rx/wsrn/200608/CreateSequenceResponse"/>
1814   </wsdl:operation>
1815   <wsdl:operation name="CloseSequence">
1816     <wsdl:input message="tns:CloseSequence" wsaw:Action="http://docs.oasis-
1817 open.org/ws-rx/wsrn/200608/CloseSequence"/>
1818     <wsdl:output message="tns:CloseSequenceResponse"
1819 wsaw:Action="http://docs.oasis-open.org/ws-
1820 rx/wsrn/200608/CloseSequenceResponse"/>
1821   </wsdl:operation>
1822   <wsdl:operation name="TerminateSequence">
1823     <wsdl:input message="tns:TerminateSequence"
1824 wsaw:Action="http://docs.oasis-open.org/ws-rx/wsrn/200608/TerminateSequence"/>
1825     <wsdl:output message="tns:TerminateSequenceResponse"
1826 wsaw:Action="http://docs.oasis-open.org/ws-
1827 rx/wsrn/200608/TerminateSequenceResponse"/>
1828   </wsdl:operation>
1829   <wsdl:operation name="MakeConnection">
1830     <wsdl:input message="tns:MakeConnection" wsaw:Action="http://docs.oasis-
1831 open.org/ws-rx/wsrn/200608/MakeConnection"/>
1832   </wsdl:operation>
1833 </wsdl:portType>
1834 </wsdl:definitions>

```

## 1835 Appendix C. Message Examples

### 1836 Appendix C.1 Create Sequence

#### 1837 Create Sequence

```
1838 <?xml version="1.0" encoding="UTF-8"?>
1839 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
1840 xmlns:wsmr="http://docs.oasis-open.org/ws-rx/wsmr/200608"
1841 xmlns:wsa="http://www.w3.org/2005/08/addressing">
1842   <S:Header>
1843     <wsa:MessageID>
1844       http://Business456.com/guid/0baaf88d-483b-4ecf-a6d8-a7c2eb546817
1845     </wsa:MessageID>
1846     <wsa:To>http://example.com/serviceB/123</wsa:To>
1847     <wsa:Action>http://docs.oasis-open.org/ws-
1848 rx/wsmr/200608/CreateSequence</wsa:Action>
1849     <wsa:ReplyTo>
1850     <wsa:Address>http://Business456.com/serviceA/789</wsa:Address>
1851     </wsa:ReplyTo>
1852   </S:Header>
1853   <S:Body>
1854     <wsmr:CreateSequence>
1855       <wsmr:AcksTo>
1856         <wsa:Address>http://Business456.com/serviceA/789</wsa:Address>
1857       </wsmr:AcksTo>
1858     </wsmr:CreateSequence>
1859   </S:Body>
1860 </S:Envelope>
```

#### 1861 Create Sequence Response

```
1862 <?xml version="1.0" encoding="UTF-8"?>
1863 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
1864 xmlns:wsmr="http://docs.oasis-open.org/ws-rx/wsmr/200608"
1865 xmlns:wsa="http://www.w3.org/2005/08/addressing">
1866   <S:Header>
1867     <wsa:To>http://Business456.com/serviceA/789</wsa:To>
1868     <wsa:RelatesTo>
1869       http://Business456.com/guid/0baaf88d-483b-4ecf-a6d8a7c2eb546817
1870     </wsa:RelatesTo>
1871     <wsa:Action>
1872       http://docs.oasis-open.org/ws-rx/wsmr/200608/CreateSequenceResponse
1873     </wsa:Action>
1874   </S:Header>
1875   <S:Body>
1876     <wsmr:CreateSequenceResponse>
1877       <wsmr:Identifier>http://Business456.com/RM/ABC</wsmr:Identifier>
1878     </wsmr:CreateSequenceResponse>
1879   </S:Body>
1880 </S:Envelope>
```

### 1881 Appendix C.2 Initial Transmission

1882 The following example WS-ReliableMessaging headers illustrate the message exchange in the above  
1883 figure. The three messages have the following headers; the third message is identified as the last  
1884 message in the Sequence:

1885 **Message 1**

```
1886 <?xml version="1.0" encoding="UTF-8"?>
1887 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
1888 xmlns:wsmr="http://docs.oasis-open.org/ws-rx/wsmr/200608"
1889 xmlns:wsa="http://www.w3.org/2005/08/addressing">
1890   <S:Header>
1891     <wsa:MessageID>
1892       http://Business456.com/guid/71e0654e-5ce8-477b-bb9d-34f05cfc9e
1893     </wsa:MessageID>
1894     <wsa:To>http://example.com/serviceB/123</wsa:To>
1895     <wsa:From>
1896       <wsa:Address>http://Business456.com/serviceA/789</wsa:Address>
1897     </wsa:From>
1898     <wsa:Action>http://example.com/serviceB/123/request</wsa:Action>
1899     <wsmr:Sequence>
1900       <wsmr:Identifier>http://Business456.com/RM/ABC</wsmr:Identifier>
1901       <wsmr:MessageNumber>1</wsmr:MessageNumber>
1902     </wsmr:Sequence>
1903   </S:Header>
1904   <S:Body>
1905     <!-- Some Application Data -->
1906   </S:Body>
1907 </S:Envelope>
```

1908 **Message 2**

```
1909 <?xml version="1.0" encoding="UTF-8"?>
1910 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
1911 xmlns:wsmr="http://docs.oasis-open.org/ws-rx/wsmr/200608"
1912 xmlns:wsa="http://www.w3.org/2005/08/addressing">
1913   <S:Header>
1914     <wsa:MessageID>
1915       http://Business456.com/guid/daa7d0b2-c8e0-476e-a9a4-d164154e38de
1916     </wsa:MessageID>
1917     <wsa:To>http://example.com/serviceB/123</wsa:To>
1918     <wsa:From>
1919       <wsa:Address>http://Business456.com/serviceA/789</wsa:Address>
1920     </wsa:From>
1921     <wsa:Action>http://example.com/serviceB/123/request</wsa:Action>
1922     <wsmr:Sequence>
1923       <wsmr:Identifier>http://Business456.com/RM/ABC</wsmr:Identifier>
1924       <wsmr:MessageNumber>2</wsmr:MessageNumber>
1925     </wsmr:Sequence>
1926   </S:Header>
1927   <S:Body>
1928     <!-- Some Application Data -->
1929   </S:Body>
1930 </S:Envelope>
```

1931 **Message 3**

```
1932 <?xml version="1.0" encoding="UTF-8"?>
1933 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
1934 xmlns:wsmr="http://docs.oasis-open.org/ws-rx/wsmr/200608"
1935 xmlns:wsa="http://www.w3.org/2005/08/addressing">
1936   <S:Header>
1937     <wsa:MessageID>
1938       http://Business456.com/guid/0baaf88d-483b-4ecf-a6d8-a7c2eb546819
1939     </wsa:MessageID>
1940     <wsa:To>http://example.com/serviceB/123</wsa:To>
1941     <wsa:From>
1942       <wsa:Address>http://Business456.com/serviceA/789</wsa:Address>
```

```

1943 </wsa:From>
1944 <wsa:Action>http://example.com/serviceB/123/request</wsa:Action>
1945 <wsrm:Sequence>
1946 <wsrm:Identifier>http://Business456.com/RM/ABC</wsrm:Identifier>
1947 <wsrm:MessageNumber>3</wsrm:MessageNumber>
1948 </wsrm:Sequence>
1949 <wsrm:AckRequested>
1950 <wsrm:Identifier>http://Business456.com/RM/ABC</wsrm:Identifier>
1951 </wsrm:AckRequested>
1952 </S:Header>
1953 <S:Body>
1954 <!-- Some Application Data -->
1955 </S:Body>
1956 </S:Envelope>

```

### 1957 **Appendix C.3 First Acknowledgement**

1958 Message number 2 has not been accepted by the RM Destination due to some transmission error so it  
1959 responds with an Acknowledgement for messages 1 and 3:

```

1960 <?xml version="1.0" encoding="UTF-8"?>
1961 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
1962 xmlns:wsrm="http://docs.oasis-open.org/ws-rx/wsrn/200608"
1963 xmlns:wsa="http://www.w3.org/2005/08/addressing">
1964 <S:Header>
1965 <wsa:MessageID>
1966 http://example.com/guid/0baaf88d-483b-4ecf-a6d8-a7c2eb546810
1967 </wsa:MessageID>
1968 <wsa:To>http://Business456.com/serviceA/789</wsa:To>
1969 <wsa:From>
1970 <wsa:Address>http://example.com/serviceB/123</wsa:Address>
1971 </wsa:From>
1972 <wsa:Action>
1973 http://docs.oasis-open.org/ws-rx/wsrn/200608/SequenceAcknowledgement
1974 </wsa:Action>
1975 <wsrm:SequenceAcknowledgement>
1976 <wsrm:Identifier>http://Business456.com/RM/ABC</wsrm:Identifier>
1977 <wsrm:AcknowledgementRange Upper="1" Lower="1"/>
1978 <wsrm:AcknowledgementRange Upper="3" Lower="3"/>
1979 </wsrm:SequenceAcknowledgement>
1980 </S:Header>
1981 <S:Body/>
1982 </S:Envelope>

```

### 1983 **Appendix C.4 Retransmission**

1984 The RM Sourcediscovers that message number 2 was not accepted so it resends the message and  
1985 requests an Acknowledgement:

```

1986 <?xml version="1.0" encoding="UTF-8"?>
1987 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
1988 xmlns:wsrm="http://docs.oasis-open.org/ws-rx/wsrn/200608"
1989 xmlns:wsa="http://www.w3.org/2005/08/addressing">
1990 <S:Header>
1991 <wsa:MessageID>
1992 http://Business456.com/guid/daa7d0b2-c8e0-476e-a9a4-d164154e38de
1993 </wsa:MessageID>
1994 <wsa:To>http://example.com/serviceB/123</wsa:To>
1995 <wsa:From>
1996 <wsa:Address>http://Business456.com/serviceA/789</wsa:Address>
1997 </wsa:From>

```

```

1998 <wsa:Action>http://example.com/serviceB/123/request</wsa:Action>
1999 <wsrm:Sequence>
2000 <wsrm:Identifier>http://Business456.com/RM/ABC</wsrm:Identifier>
2001 <wsrm:MessageNumber>2</wsrm:MessageNumber>
2002 </wsrm:Sequence>
2003 <wsrm:AckRequested>
2004 <wsrm:Identifier>http://Business456.com/RM/ABC</wsrm:Identifier>
2005 </wsrm:AckRequested>
2006 </S:Header>
2007 <S:Body>
2008 <!-- Some Application Data -->
2009 </S:Body>
2010 </S:Envelope>

```

## 2011 **Appendix C.5 Termination**

2012 The RM Destination now responds with an Acknowledgement for the complete Sequence which can then  
2013 be terminated:

```

2014 <?xml version="1.0" encoding="UTF-8"?>
2015 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
2016 xmlns:wsrm="http://docs.oasis-open.org/ws-rx/wsrn/200608"
2017 xmlns:wsa="http://www.w3.org/2005/08/addressing">
2018 <S:Header>
2019 <wsa:MessageID>
2020 http://example.com/guid/0baaf88d-483b-4ecf-a6d8-a7c2eb546811
2021 </wsa:MessageID>
2022 <wsa:To>http://Business456.com/serviceA/789</wsa:To>
2023 <wsa:From>
2024 <wsa:Address>http://example.com/serviceB/123</wsa:Address>
2025 </wsa:From>
2026 <wsa:Action>
2027 http://docs.oasis-open.org/ws-rx/wsrn/200608/SequenceAcknowledgement
2028 </wsa:Action>
2029 <wsrm:SequenceAcknowledgement>
2030 <wsrm:Identifier>http://Business456.com/RM/ABC</wsrm:Identifier>
2031 <wsrm:AcknowledgementRange Upper="3" Lower="1"/>
2032 </wsrm:SequenceAcknowledgement>
2033 </S:Header>
2034 <S:Body/>
2035 </S:Envelope>

```

### 2036 **Terminate Sequence**

```

2037 <?xml version="1.0" encoding="UTF-8"?>
2038 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
2039 xmlns:wsrm="http://docs.oasis-open.org/ws-rx/wsrn/200608"
2040 xmlns:wsa="http://www.w3.org/2005/08/addressing">
2041 <S:Header>
2042 <wsa:MessageID>
2043 http://Business456.com/guid/0baaf88d-483b-4ecf-a6d8-a7c2eb546812
2044 </wsa:MessageID>
2045 <wsa:To>http://example.com/serviceB/123</wsa:To>
2046 <wsa:Action>
2047 http://docs.oasis-open.org/ws-rx/wsrn/200608/TerminateSequence
2048 </wsa:Action>
2049 <wsa:From>
2050 <wsa:Address>http://Business456.com/serviceA/789</wsa:Address>
2051 </wsa:From>
2052 </S:Header>
2053 <S:Body>
2054 <wsrm:TerminateSequence>

```

```

2055     <wsrm:Identifier>http://Business456.com/RM/ABC</wsrm:Identifier>
2056     </wsrm:TerminateSequence>
2057   </S:Body>
2058 </S:Envelope>

```

## 2059 Terminate Sequence Response

```

2060 <?xml version="1.0" encoding="UTF-8"?>
2061 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
2062   xmlns:wsmr="http://docs.oasis-open.org/ws-rx/wsmr/200608"
2063   xmlns:wsa="http://www.w3.org/2005/08/addressing">
2064   <S:Header>
2065     <wsa:MessageID>
2066       http://Business456.com/guid/0baaf88d-483b-4ecf-a6d8-a7c2eb546813
2067     </wsa:MessageID>
2068     <wsa:To>http://example.com/serviceA/789</wsa:To>
2069     <wsa:Action>
2070       http://docs.oasis-open.org/ws-rx/wsmr/200608/TerminateSequenceResponse
2071     </wsa:Action>
2072     <wsa:RelatesTo>
2073       http://Business456.com/guid/0baaf88d-483b-4ecf-a6d8-a7c2eb546812
2074     </wsa:RelatesTo>
2075     <wsa:From>
2076       <wsa:Address>http://Business456.com/serviceA/789</wsa:Address>
2077     </wsa:From>
2078   </S:Header>
2079   <S:Body>
2080     <wsrm:TerminateSequenceResponse>
2081       <wsrm:Identifier>http://Business456.com/RM/ABC</wsrm:Identifier>
2082     </wsrm:TerminateSequenceResponse>
2083   </S:Body>
2084 </S:Envelope>

```

## 2085 Appendix C.6 MakeConnection

2086 To illustrate how a `MakeConnection` message exchange can be used to deliver messages to an  
 2087 Endpoint that is not addressable, consider the case of a pub/sub scenario in which the Endpoint to which  
 2088 notifications are to be delivered (the "event consumer") is not addressable by the notification sending  
 2089 Endpoint (the "event producer"). In this scenario the event consumer must initiate the connections in order  
 2090 for the notifications to be delivered. One possible set of message exchanges (using HTTP) that  
 2091 demonstrate how this can be achieved using `MakeConnection` is shown below.

2092 **Step 1** – During a "subscribe" operation, the event consumer's EPR specifies the RM anonymous URI  
 2093 and the RM Policy Assertion to indicate whether or not RM is required:

```

2094 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
2095   xmlns:wsmr="http://docs.oasis-open.org/ws-rx/wsmr/200608"
2096   xmlns:wsmrp="http://docs.oasis-open.org/ws-rx/wsmrp/200608"
2097   xmlns:wsa="http://www.w3.org/2005/08/addressing">
2098   <S:Header>
2099     <wsa:To> http://example.org/subscriptionService </wsa:To>
2100     <wsa:MessageID> http://client456.org/id-a6d8-a7c2eb546813</wsa:MessageID>
2101     <wsa:ReplyTo>
2102       <wsa:To> http://client456.org/response </wsa:To>
2103     </wsa:ReplyTo>
2104   </S:Header>
2105   <S:Body>
2106     <sub:Subscribe xmlns:sub="http://example.org/subscriptionService">
2107       <!-- subscription service specific data -->
2108       <targetEPR>

```

```

2109     <wsa:Address>http://docs.oasis-open.org/ws-
2110 rx/wsrn/200608/anonymous?id=550e8400-e29b-11d4-a716-446655440000</wsa:Address>
2111     <wsa:Metadata>
2112         <wsp:Policy wsu:Id="MyPolicy">
2113             <wsrmp:RMAssertion/>
2114         </wsp:Policy>
2115     </wsa:Metadata>
2116     </targetEPR>
2117 </sub:Subscribe>
2118 </S:Body>
2119 </S:Envelope>

```

2120 In this example the `subscribe` and `targetEPR` elements are simply examples of what a subscription  
2121 request message might contain. Note: the `wsa:Address` element contains the RM anonymous URI  
2122 indicating that the notification producer needs to queue the messages until they are requested using the  
2123 `MakeConnection` message exchange. The EPR also contains the RM Policy Assertion indicating the RM  
2124 must be used when notifications related to this subscription are sent.

2125 **Step 2** – Once the subscription is established, the event consumer checks for a pending message:

```

2126 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
2127 xmlns:wsrm="http://docs.oasis-open.org/ws-rx/wsrn/200608"
2128 xmlns:wsa="http://www.w3.org/2005/08/addressing">
2129   <S:Header>
2130     <wsa:Action>http://docs.oasis-open.org/ws-
2131 rx/wsrn/200608/MakeConnection</wsa:Action>
2132     <wsa:To> http://example.org/subscriptionService </wsa:To>
2133   </S:Header>
2134   <S:Body>
2135     <wsrm:MakeConnection>
2136       <wsrm:Address>http://docs.oasis-open.org/ws-
2137 rx/wsrn/200608/anonymous?id=550e8400-e29b-11d4-a716-
2138 446655440000</wsrm:Address>
2139     </wsrm:MakeConnection>
2140   </S:Body>
2141 </S:Envelope>

```

2142 **Step 3** – If there are messages waiting to be delivered then a message will be returned back to the event  
2143 consumer. However, because WS-RM is being used to deliver the messages, the first message returned  
2144 is a `CreateSequence`:

```

2145 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
2146 xmlns:wsrm="http://docs.oasis-open.org/ws-rx/wsrn/200608"
2147 xmlns:wsa="http://www.w3.org/2005/08/addressing">
2148   <S:Header>
2149     <wsa:Action>http://docs.oasis-open.org/ws-
2150 rx/wsrn/200608/CreateSequence</wsa:Action>
2151     <wsa:To>http://docs.oasis-open.org/ws-
2152 rx/wsrn/200608/anonymous?id=550e8400-e29b-11d4-a716-446655440000</wsa:To>
2153     <wsa:ReplyTo> http://example.org/subscriptionService </wsa:ReplyTo>
2154     <wsa:MessageID> http://example.org/id-123-456 </wsa:MessageID>
2155   </S:Header>
2156   <S:Body>
2157     <wsrm:CreateSequence>
2158       <wsrm:AcksTo>
2159         <wsa:Address> http://example.org/subscriptionService </wsa:Address>
2160       </wsrm:AcksTo>
2161     </wsrm:CreateSequence>
2162   </S:Body>

```

2163 </S:Envelope>

2164 Notice from the perspective of how the RM Source on the event producer interacts with the RM  
2165 Destination of those messages, nothing new is introduced by the use of the `MakeConnection`, the use  
2166 of RM protocol is the same as the case where the event consumer is addressable.

2167 **Step 4** – The event consumer will respond with a `CreateSequenceResponse` message per normal WS-  
2168 Addressing rules:

```
2169 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"  
2170 xmlns:wsmr="http://docs.oasis-open.org/ws-rx/wsmr/200608"  
2171 xmlns:wsa="http://www.w3.org/2005/08/addressing">  
2172   <S:Header>  
2173     <wsa:Action>http://docs.oasis-open.org/ws-  
2174 rx/wsmr/200608/CreateSequenceResponse</wsa:Action>  
2175     <wsa:To> http://example.org/subscriptionService </wsa:To>  
2176     <wsa:RelatesTo> http://example.org/id-123-456 </wsa:RelatesTo>  
2177   </S:Header>  
2178   <S:Body>  
2179     <wsmr:CreateSequenceResponse>  
2180       <wsmr:Identifier> http://example.org/rmid-456 </wsmr:Identifier>  
2181     </wsmr:CreateSequenceResponse>  
2182   </S:Body>  
2183 </S:Envelope>
```

2184 Note, this message is carried on an HTTP request directed to the `wsa:ReplyTo` EPR, and the HTTP  
2185 response will be an HTTP 202.

2186 **Step 5** – The event consumer checks for another message pending:

```
2187 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"  
2188 xmlns:wsmr="http://docs.oasis-open.org/ws-rx/wsmr/200608"  
2189 xmlns:wsa="http://www.w3.org/2005/08/addressing">  
2190   <S:Header>  
2191     <wsa:Action>http://docs.oasis-open.org/ws-  
2192 rx/wsmr/200608/MakeConnection</wsa:Action>  
2193     <wsa:To> http://example.org/subscriptionService </wsa:To>  
2194   </S:Header>  
2195   <S:Body>  
2196     <wsmr:MakeConnection>  
2197       <wsmr:Address>http://docs.oasis-open.org/ws-  
2198 rx/wsmr/200608/anonymous?id=550e8400-e29b-11d4-a716-  
2199 446655440000</wsmr:Address>  
2200     </wsmr:MakeConnection>  
2201   </S:Body>  
2202 </S:Envelope>
```

2203 Notice this is the same message as the one sent in step 2.

2204 **Step 6** – If there is a message pending for this destination then it is returned on the HTTP response:

```
2205 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"  
2206 xmlns:wsmr="http://docs.oasis-open.org/ws-rx/wsmr/200608"  
2207 xmlns:wsa="http://www.w3.org/2005/08/addressing">  
2208   <S:Header>  
2209     <wsa:Action> http://example.org/eventType1 </wsa:Action>  
2210     <wsa:To>http://docs.oasis-open.org/ws-  
2211 rx/wsmr/200608/anonymous?id=550e8400-e29b-11d4-a716-446655440000</wsa:To>
```

```

2212     <wsrm:Sequence>
2213         <wsrm:Identifier> http://example.org/rmid-456 </wsrm:Identifier>
2214     </wsrm:Sequence>
2215     <wsrm:MessagePending pending="true"/>
2216 </S:Header>
2217 <S:Body>
2218     <!-- event specific data -->
2219 </S:Body>
2220 </S:Envelope>

```

2221 As noted in step 3, the use of the RM protocol does not change when using `MakeConnection`. The  
 2222 format of the messages, the order of the messages sent and the timing of when to send it remains the  
 2223 same.

2224 **Step 7** – At some later interval, or immediately due to the `MessagePending` header's "pending"  
 2225 attribute being set to "true", the event consumer will poll again:

```

2226 <S:Envelope xmlns:S="http://www.w3.org/2003/05/soap-envelope"
2227 xmlns:wsrm="http://docs.oasis-open.org/ws-rx/wsr/200608"
2228 xmlns:wsa="http://www.w3.org/2005/08/addressing">
2229     <S:Header>
2230         <wsa:Action>http://docs.oasis-open.org/ws-
2231 rx/wsr/200608/MakeConnection</wsa:Action>
2232         <wsa:To> http://example.org/subscriptionService </wsa:To>
2233     </S:Header>
2234     <S:Body>
2235         <wsrm:MakeConnection>
2236             <wsrm:Address>http://docs.oasis-open.org/ws-
2237 rx/wsr/200608/anonymous?id=550e8400-e29b-11d4-a716-
2238 446655440000</wsrm:Address>
2239         </wsrm:MakeConnection>
2240     </S:Body>
2241 </S:Envelope>

```

2242 Notice this is the same message as the one sent in steps 2 and 5. As in steps 3 and 6, the response to  
 2243 the `MakeConnection` can be any message destined to the specified Endpoint. This allows the event  
 2244 producer to send not only application messages but RM protocol messages (e.g. `CloseSequence`,  
 2245 `TerminateSequence` or even additional `CreateSequences`) as needed.

2246 **Step 8** – If at any point in time there are no messages pending, in response to a `MakeConnection` the  
 2247 event producer returns an HTTP 202 back to the event consumer. The process then repeats (back to step  
 2248 7) until the subscription ends.

## 2249 Appendix D. State Tables

2250 This appendix specifies the non-normative state transition tables for RM Source and RM Destination.

2251 The state tables describe the lifetime of a sequence in both the RM Source and the RM Destination

2252 Legend:

2253 The first column of these tables contains the motivating event and has the following format:

Event
<i>Event name</i> [source] {ref}

2254 Where:

- 2255 ● Event Name: indicates the name of the event. Event Names surrounded by "<>" are optional as  
2256 described by the specification.
- 2257 ● [source]: indicates the source of the event; one of:
  - 2258 ● [msg] a Received message
  - 2259 ● [int]: an internal event such as the firing of a timer
  - 2260 ● [app]: the application
  - 2261 ● [unspec]: the source is unspecified

2262 Each event / state combination cell in the tables in this appendix has the following format:

State Name
<i>Action to take</i> [next state] {ref}

2263 Where:

- 2264 ● action to take: indicates that the state machine performs the following action. Actions surrounded  
2265 by "<>" are optional as described by the specification. "Xmit" is used as a short form for the word  
2266 "Transmit"
- 2267 ● [next state]: indicates the state to which the state machine will advance upon the performance of  
2268 the action. For ease of reading the next state "same" indicates that the state does not change.
- 2269 ● {ref} is a reference to the document section describing the behavior in this cell

2270 "N/A" in a cell indicates a state / event combination self-inconsistent with the state machine; should these  
2271 conditions occur, it would indicate an implementation error. A blank cell indicates that the behavior is not  
2272 described in this specification and does not indicate normal protocol operation. Implementations MAY  
2273 generate a Sequence Terminated fault (see section 4.2) in these circumstances. Robust implementations  
2274 MUST be able to operate in a stable manner despite the occurrence of unspecified event / state  
2275 combinations.

2276 Table 1 RM Source Sequence State Transition Table

Events	Sequence States					
	None	Creating	Created	Closing	Closed	Terminating
<b>Create Sequence</b> [unspec] {3.1}	Xmit Create Sequence [Creating] {3.1}	N/A	N/A	N/A	N/A	N/A
<b>Create Sequence Response</b> [msg] {3.1}		Process Create Sequence Response [Created] {3.1}				
<b>Create Sequence Refused Fault</b> [msg] {3.1}		No action [None] {4.6}				
<b>Send message</b> [app] {2.1}	N/A	N/A	Xmit message [Same] {2}	No action [Same] {2}	N/A	N/A
<b>Retransmit of un-ack'd message</b> [int]	N/A	N/A	Xmit message [Same] {2.4}	Xmit message [Same] {2.4}	N/A	N/A
<b>SeqAck (non-final)</b> [msg] {3.6}	Generate Unknown Sequence Fault [Same] {4.3}	Generate Unknown Sequence Fault [Same] {4.3}	Process Ack ranges [Same] {3.6}	Process Ack ranges [Same] {3.6}	Process Ack ranges [Same] {3.6}	Process Ack ranges [Same] {3.6}
<b>Nack</b> [msg] {3.6}	Generate Unknown Sequence Fault [Same] {4.3}	Generate Unknown Sequence Fault [Same] {4.3}	<Xmit message(s)> [Same] {3.6}	<Xmit message(s)> [Same] {3.6}	No action [Same]	No action [Same]
<b>Message Number Rollover Fault</b> [msg]	Generate Unknown Sequence Fault [Same] {4.3}	Generate Unknown Sequence Fault [Same] {4.3}	No action [Rollover]	No action [Same]	No action [Same]	No action [Same]
<b>&lt;Close Sequence&gt;</b> [int] {3.2}	N/A		Xmit Close Sequence [Closing] {3.2}	N/A	N/A	N/A
<b>Close Sequence Response</b> [msg] {3.2}	Generate Unknown Sequence Fault [Same] {4.3}	Generate Unknown Sequence Fault [Same] {4.3}		No action [Closed] {3.2}	No action [Same] {3.2}	No action [Same] {3.2}
<b>SeqAck (final)</b> [msg] {3.6}	Generate Unknown Sequence Fault [Same] {4.3}	Generate Unknown Sequence Fault [Same] {4.3}	Process Ack ranges [Closed] {3.6}	Process Ack ranges [Closed] {3.6}	Process Ack ranges [Same]	Process Ack ranges [Same]
<b>Sequence Closed Fault</b> [msg]	Generate Unknown Sequence Fault	Generate Unknown Sequence Fault	No action [Closed] {4.7}	No action [Closed] {4.7}	No action [Same]	No action [Same]

Events	Sequence States					
	None	Creating	Created	Closing	Closed	Terminating
{4.7}	[Same] {4.3}	[Same] {4.3}				
<b>Unknown Sequence Fault</b> [msg] {4.3}			Terminate Sequence [None] {4.3}	Terminate Sequence [None] {4.3}	Terminate Sequence [None] {4.3}	Terminate Sequence [None] {4.3}
<b>Sequence Terminated Fault</b> [msg] {4.2}	N/A		Terminate Sequence [None] {4.2}	Terminate Sequence [None] {4.2}	Terminate Sequence [None] {4.2}	Terminate Sequence [None] {4.2}
<b>Terminate Sequence</b> [int]	N/A	No action [None] {unspec}	Xmit Terminate Sequence [Terminating]	Xmit Terminate Sequence [Terminating]	Xmit Terminate Sequence [Terminating]	N/A
<b>Terminate Sequence Response</b> [msg]	Generate Unknown Sequence Fault [Same] {4.3}	Generate Unknown Sequence Fault [Same] {4.3}				Terminate Sequence [None] {3.3}
<b>Expires exceeded</b> [int]	N/A	Terminate Sequence [None] {3.4}	Terminate Sequence [None] {3.4}	Terminate Sequence [None] {3.4}	Terminate Sequence [None] {3.4}	Terminate Sequence [None] {3.4}
<b>Invalid Acknowledgment</b> [msg] {4.4}	Generate Unknown Sequence Fault [Same] {4.3}	Generate Unknown Sequence Fault [Same] {4.3}	Generate Invalid Acknowledgment Fault [Same] {4.4}			

2277 Table 2 RM Destination Sequence State Transition Table

Events	Sequence States		
	None	Created	Closed
<b>CreateSequence (successful)</b> [msg/int] {3.1}	Xmit Create Sequence Response [Created] {3.1}	N/A	N/A
<b>CreateSequence (unsuccessful)</b> [msg/int] {3.1}	Generate Create Sequence Refused Fault [None] {3.1}	N/A	N/A
<b>Message (with message number within range)</b> [msg]	Generate Unknown Sequence Fault [Same] {4.3}	Accept Message; <Xmit SeqAck> [Same]	Generate Sequence Closed Fault (with SeqAck+Final) [Same] {3.2}
<b>Message (with message number outside of range)</b> [msg]	Generate Unknown Sequence Fault [Same] {4.3}	Xmit Message Number Rollover Fault [Same] {3.4}{4.5}	Generate Sequence Closed Fault (with SeqAck+Final) [Same] {3.2}
<b>&lt;AckRequested&gt;</b> [msg] {3.5}	Generate Unknown Seq Fault [Same] {4.3}	Xmit SeqAck [Same] {3.5}	Xmit SeqAck+Final [Same] {3.6}

Events	Sequence States		
	None	Created	Closed
<b>CloseSequence</b> [msg] {3.2}	Generate Unknown Sequence Fault [Same] {4.3}	Xmit CloseSequence Response with SeqAck+Final [Closed] {3.2}	Generate Sequence Closed Fault [Same] {4.7}
<b>&lt;CloseSequence autonomously&gt;</b> [int]	N/A	No Action [Closed]	N/A
<b>TerminateSequence</b> [msg] {3.3}	Generate Unknown Sequence Fault [Same] {4.3}	Xmit Terminate Sequence Response [None] {3.3}	Xmit Terminate Sequence Response [None] {3.3}
<b>UnknownSequence Fault</b> [msg] {4.3}		Terminate Sequence [None] {4.3}	Terminate Sequence [None] {4.3}
<b>SequenceTerminated Fault</b> [msg] {4.2}		Terminate Sequence [None] {4.2}	Terminate Sequence [None] {4.2}
<b>Invalid Acknowledgement Fault</b> [msg] {4.4}	N/A		
<b>Expires exceeded</b> [int]	N/A	Terminate Sequence [None] {3.4}	Terminate Sequence [None] {3.4}
<b>&lt;Seq Acknowledgement autonomously&gt;</b> [int] {3.6}	N/A	Xmit SeqAck [Same] {3.6}	Xmit SeqAck+Final [Same] {3.6}
<b>Non WSRM message when WSRM required</b> [msg] {4.8}	Generate WSRMRequired Fault [Same] {4.8}	Generate WSRMRequired Fault [Same] {4.8}	Generate WSRMRequired Fault [Same] {4.8}

2278 The following two tables apply only if the `MakeConnection` mechanism is utilized.

2279 Table 3 Sending Endpoint Message Transfer Engine

Event	None	Queued n=1	Queued, n>1
Message destined to anon Endpoint when channel unavailable [int] {3.7}	Queue message [Queued n=1]	Queue message [Queued n>1]	Queue message [Queued n>1]
MakeConnection [msg] {3.7}		Send message [none]	Xmit message with MessagePending [if n=2 then (Queued n=1) else (Queued n>1)]

2280 Table 4 Receiving Endpoint Message Transfer Engine

Event	None	Polling
Expectation of unreceived message [int, unspecified]	No Action [Polling]	No Action [Same]
Polling trigger [int, unspecified]		Xmit MakeConnection [Polling] (3.7)

## 2281 **Appendix E. Acknowledgments**

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## Appendix F. 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 (PT0S) 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 'optiona'/'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)
wd-06	2005-11-02	Gilbert Pilz	Start wd-06 by changing title page from cd-01.
wd-06	2005-11-03	Gilbert Pilz	i047 (Reorder spec sections)
wd-07	2005-11-17	Gilbert Pilz	Start wd-07
wd-07	2005-11-28	Doug Davis	i071 – except for period in Appendix headings
wd-07	2005-11-28	Doug Davis	i10
wd-07	2005-11-28	Doug Davis	i030
wd-07	2005-11-28	Doug Davis	i037
wd-07	2005-11-28	Doug Davis	i038
wd-07	2005-11-28	Doug Davis	i041
wd-07	2005-11-28	Doug Davis	i043
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wd-07	2005-11-28	Doug Davis	i048
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wd-07	2005-11-28	Doug Davis	i062
wd-07	2005-11-28	Doug Davis	i063
wd-07	2005-11-28	Doug Davis	i065
wd-07	2005-11-28	Doug Davis	i067
wd-07	2005-11-28	Doug Davis	i068
wd-07	2005-11-28	Doug Davis	i069
wd-07	2005-11-28	Doug Davis	Fix bulleted list (#2) in section 2.3
wd-07	2005-11-29	Gilbert Pilz	i074 (Use of [tcShortName] in artifact locations namespaces, etc)
wd-07	2005-11-29	Gilbert Pilz	i071 – Fixed styles and formatting for TOC. Fixed styles of the appendix headings.
wd-07	2005-11-30	Doug Davis	Removed dup definition of "Receive"
wd-07	2005-11-30	Gilbert Pilz	Fixed lost formatting from heading for Namespace section. Fixed style of text body elements to match OASIS example documents. Fixed tables to match OASIS example documents.
wd-07	2005-12-01	Gilbert Pilz	Updated fix for i074 to eliminate trailing '/'. Added corresponding text around action IRI composition.
wd-07	2005-12-01	Gilbert Pilz	Use non-fixed fields for date values on both title page and body footers.
wd-07	2005-12-01	Doug Davis	Alphabetize the glossary
wd-07	2005-12-02	Doug Davis	i064
wd-07	2005-12-02	Doug Davis	i066
wd-08	2005-12-15	Doug Davis	Add back in RM Source to glossary
wd-08	2005-12-15	Steve Winkler	Doug added Steve's editorial nits
wd-08	2005-12-21	Doug Davis	i050
wd-08	2005-12-21	Doug Davis	i081
wd-08	2005-12-21	Doug Davis	i080 – but i050 negates the need for any changes
wd-08	2005-12-21	Doug Davis	i079
wd-08	2005-12-21	Doug Davis	i076 – didn't add text about "replies" since the RMD to RMS sequence could be used for any message not just replies
wd-08	2005-12-21	Umit Yalcinalp	Action Su03: removed wsse from Table 1
wd-08	2005-12-21	Umit Yalcinalp	i057 per Sunnyvale F2F 2005, Cleaned up some formatting errors in contributors
wd-08	2005-12-27	Doug Davis	i060
wd-08	2005-12-27	Gilbert Pilz	Moved schema and WSDL files to their own artifacts. Converted source document to

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			OpenDocument Text format. Changed line numbers to be a single style.
wd-08	2005-12-28	Anish Karmarkar	Included a section link to c:\temp\wsrm-1.1-schema-200510.xsd and to c:\temp\wsrm-1.1-wsdl-200510.wsdl
wd-08	2006-01-04	Gilbert Pilz	Fixed formatting for included sections.
wd-08	2006-01-05	Gilbert Pilz	Created links for unused references. Fixed exemplars for CloseSequence and CloseSequenceResponse.
wd-09	2006-01-11	Doug Davis	Minor tweaks to text/typos.
wd-10	2006-01-23	Doug Davis	Accept all changes from wd-09  Make some minor editorial tweaks from Marc's comments.
wd-10	2006-02-14	Doug Davis	Issue 082 resolution
wd-10	2006-02-14	Doug Davis	Issue 083 resolution
wd-10	2006-02-14	Doug Davis	Issue 085 resolution
wd-10	2006-02-14	Doug Davis	Issues 086, 087 resolutions  Defined MessageNumberType
wd-10	2006-02-15	Doug Davis	Issue 078 resolution
wd-10	2006-02-15	Doug Davis	Issue 094 resolution
wd-10	2006-02-15	Doug Davis	Issue 095 resolution
wd-10	2006-02-15	Gilbert Pilz	Issue 088 – added namespace URI link to namespace URI; added text explaining that this URI could be dereferenced to produce the RDDDL doc; added non-normative reference to RDDDL 2.0
wd-10	2006-02-17	Anish Karmarkar	Namespace changed to 200602 for both WSDL and XSD docs.
wd-10	2006-02-17	Anish Karmarkar	Issue i087 as it applies to WSRM spec.
wd-10	2006-02-17	Anish Karmarkar	Added titles and minor text for state table (issue i058).
wd-11	2006-02-22	Doug Davis	Accept all changes for new WD  Minor typos fixed
wd-11	2006-02-23	Doug Davis	s'/close'/close/g – per Marc Goodner  Added first ref to [URI] – per Marc G again
wd-11	2006-02-27	Doug Davis	Issue i061 applied
wd-11	2006-02-28	Doug Davis	Fixed typo around the use of "above" and "below"
wd-11	2006-03-01	Doug Davis	Minor typos found by Marc Goodner
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wd-11	2006-03-08	Doug Davis	Issue 100 applied

Rev	Date	By Whom	What
wd-12	2006-03-20	Doug Davis	Added space in "SOAP1.x" – PaulCotton
wd-12	2006-04-11	Doug Davis	Issue 007 applied
wd-12	2006-04-11	Doug Davis	Issue 090 applied
wd-12	2006-04-11	Doug Davis	Issue 098 applied
wd-12	2006-04-11	Doug Davis	Issue 099 applied
wd-12	2006-04-11	Doug Davis	Issue 101 applied
wd-12	2006-04-11	Doug Davis	Issue 103 applied
wd-12	2006-04-11	Doug Davis	Issue 104 applied
wd-12	2006-04-11	Doug Davis	Issue 105 applied
wd-12	2006-04-11	Doug Davis	Issue 107 applied
wd-12	2006-04-11	Doug Davis	Issue 109 applied
wd-12	2006-04-11	Doug Davis	Issue 110 applied
wd-12	2006-04-12	Doug Davis	Used "generated" instead of "issue" or "send" when talking about faults.
wd-12	2006-04-24	Gilbert Pilz	Update references to WS-Addressing to the Proposed Recommendations; update WS-RM namespace to "200604".
wd-13	2006-05-08	Gilbert Pilz	i093 part 1; more work needed
wd-13	2006-05-10	Doug Davis	Issue 096 applied
wd-13	2006-05-26	Gilbert Pilz	i093 part 2; reflects decisions from 2006-05-25 meeting
wd-13	2006-05-28	Gilbert Pilz	Issue 106 applied
wd-13	2006-05-29	Gilbert Pilz	Issue 118 applied
wd-13	2006-05-29	Gilbert Pilz	Issue 120 applied
wd-13	2006-05-30	Gilbert Pilz	Issue 114 applied
wd-13	2006-05-30	Gilbert Pilz	Issue 116 applied
wd-14	2006-06-05	Gilbert Pilz	Accept all changes; bump WD number
wd-14	2006-06-07	Doug Davis	Applied lots of minor edits from Marc Goodner
wd-14	2006-06-07	Doug Davis	Change a couple of period/sp/sp to period/sp
wd-14	2006-06-07	Doug Davis	Added a space in "URI]of" – per Marc Goodner
wd-14	2006-06-07	Doug Davis	Issue 131 applied
wd-14	2006-06-07	Doug Davis	Issue 132 applied
wd-14	2006-06-07	Doug Davis	Issue 119 applied
wd-14	2006-06-07	Doug Davis	Applied lots of minor edits from Doug Davis
wd-14	2006-06-07	Doug Davis	s/"none"/"full-uri"/ - per Marc Goodner
wd-14	2006-06-12	Doug Davis	Complete i106
wd-14	2006-06-12	Doug Davis	Issues 089 applied
wd-14	2006-06-12	Doug Davis	Fix for several RFC2119 keywords – per Anish
wd-15	2006-06-12	Doug Davis	Accept all changed, dump WD number
wd-15	2006-06-12	Doug Davis	Move WSDL after Schema
wd-15	2006-06-12	Doug Davis	Nits – remove tabs, extra [yyy]'s ...
wd-15	2006-06-14	Doug Davis	Remove extra "OPTIONAL"s – Matt Lovett

Rev	Date	By Whom	What
wd-15	2006-06-14	Doug Davis	Remove blank rows/columns from state table. Fix italics in state table
wd-15	2006-06-15	Doug Davis	Typo – section D was empty
wd-15	2006-06-16	Doug Davis	Issue 125 applied
wd-15	2006-06-16	Doug Davis	Issue 126 applied
wd-15	2006-06-16	Doug Davis	Issue 127 applied
wd-15	2006-06-16	Doug Davis	Issue 133 applied
wd-15	2006-06-16	Doug Davis	Issue 136 applied
wd-15	2006-06-16	Doug Davis	Issue 138 applied
wd-15	2006-06-16	Doug Davis	Issue 135 applied
wd-15	2006-06-20	Doug Davis	Added all TC members to the ack list
wd-15	2006-06-22	Doug Davis	Issue 129 applied
wd-15	2006-06-22	Doug Davis	Issue 130 applied
wd-15	2006-06-22	Doug Davis	Issue 137 applied
wd-15	2006-06-26	Doug Davis	Issue 111 applied
wd-15	2006-06-26	Doug Davis	Missed a part of issue 129
wd-15	2006-06-30	Doug Davis	Fixed a typo in schema
wd-15	2006-06-30	Doug Davis	Issue 141 applied
wd-15	2006-06-30	Doug Davis	Issue 142 applied
wd-15	2006-06-30	Doug Davis	Issue 148 applied
wd-15	2006-06-30	Doug Davis	Issue 149 applied
wd-15	2006-06-30	Doug Davis	Issue 150 applied
wd-15	2006-07-06	Doug Davis	Issue 121 applied
wd-15	2006-07-21	Doug Davis	Issue 139 applied
wd-15	2006-07-21	Doug Davis	Issue 144 applied
wd-15	2006-07-21	Doug Davis	Issue 147 applied
wd-15	2006-07-21	Doug Davis	Issues 122-124 applied
wd-15	2006-07-27	Doug Davis	Updated list of oasis TC members (i134)
wd-15	2006-07-27	Doug Davis	Issue 140 applied
wd-15	2006-07-27	Doug Davis	Issue 145 applied
wd-15	2006-07-27	Doug Davis	Issue 143 applied
wd-15	2006-07-28	Doug Davis	Lots of minor typos found by Matt L.
wd-15	2006-07-28	Doug Davis	Issue 113 applied
wd-15	2006-08-04	Doug Davis	Update old namespaces – found by PaulC
wd-15	2006-08-04	Doug Davis	Issue 150 applied
wd-15	2006-08-04	Doug Davis	Minor typos – found by PeterN
wd-15	2006-08-04	Doug Davis	Verify all [refs]
wd-15	2006-08-04	Doug Davis	Change namespace to 2006/08
wd-15	2006-08-04	Doug Davis	Issue 148 applied
wd-15	2006-08-07	Doug Davis	Add some new glossary terms – per GilP
cd-04	2006-08-10	Gilbert Pilz	Formatting changes for better HTML rendering.

<b>Rev</b>	<b>Date</b>	<b>By Whom</b>	<b>What</b>
cd-04	2006-08-11	Doug Davis	Issue 158 applied
cd-04	2006-08-11	Doug Davis	Issue 153 applied
cd-04	2006-08-11	Doug Davis	Issue 156 applied
cd-04	2006-08-15	Gilbert Pilz	More formatting changes for better HTML rendering.

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