Web Services Resource Lifetime (WS-ResourceLifetime)

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Abstract

The definition of a WS-Resource, which is expressed in terms of a stateful resource and its relationship with a Web service, is defined in the document titled “Modeling Stateful Resources with Web services” [State Paper]. This specification defines

message exchanges to standardize the means by which a WS-Resource may be destroyed, and resource properties [WS-ResourceProperties] that may be used to inspect and monitor the lifetime of a WS-Resource. This specification defines two means of destroying a WS-Resource: immediate destruction and time-based, scheduled destruction.

Status

This WS-ResourceLifetime specification is an initial draft release and is provided for review and evaluation only. The Companies hope to solicit your contributions and suggestions in the near future. The Companies make no warranties or representations regarding the specification in any manner whatsoever.

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1 Introduction

In this document, we consider a distributed computing environment consisting of WS-Resources. The definition of WS-Resource, in terms of a stateful resource and its relationship with a Web service, is detailed in "Modeling Stateful Resources with Web services" [State Paper].

The lifecycle of a WS-Resource is defined as the period between its instantiation and its destruction. The WS-ResourceLifetime specification standardizes the means by which a WS-Resource can be destroyed. The specification also defines the means by which the lifetime of a WS-Resource can be monitored. However, this specification does not prescribe (nor proscribe) the means by which a WS-Resource is created.

Normally, a service requestor's interest in a WS-Resource is for some period of time, rarely is it indefinite. In many scenarios, it is appropriate for clients of a WS-Resource to cause its immediate destruction. The immediate destruction of a WS-Resource may be accomplished using the message exchanges defined in this specification.

In addition, this specification defines the means by which a resource may be destroyed after a period of time. In a distributed computing environment, a client may become disconnected from the service provider's endpoint and therefore may be unable to, or unwilling to cause the immediate destruction of the WS-Resource. This specification defines the means by which any client of a WS-Resource may establish and extend the scheduled termination time of a WS-Resource. If that time expires, the WS-Resource may *self destruct* without the need for an explicit destroy request message from a client. Periodically extending the termination time of a WS-Resource can serve to extend its lifetime. WS-ResourceLifetime defines a standard message exchange by which a service requestor can establish and renew a scheduled termination time for the WS-Resource, and defines the circumstances under which a service requestor can determine that this termination time has elapsed.

A service requestor may want to determine the current time and the termination time of a WS-Resource. WS-ResourceLifetime defines resource properties, as defined in [WS-ResourceProperties] for accessing this information.

WS-ResourceLifetime is inspired by a portion of the Global Grid Forum's "Open Grid Services Infrastructure (OGSI) Version 1.0" specification [OGSI].

1.1 Goals and Requirements

The goal of WS-ResourceLifetime is to standardize the terminology, concepts, message exchanges, WSDL and XML needed to monitor the lifetime of, and destroy WS-Resources as defined in [State Paper].

1.1.1 Requirements

This specification intends to meet the following requirements:

- Define the standard message exchange by which a requestor can request the immediate destruction of a WS-Resource.
- Define the means by which a service requestor can set an initial termination time for the scheduled termination of a WS-Resource.
- Define the means by which a service requestor can update the termination time associated with a WS-Resource that is scheduled for termination.

- Define the means by which a service requestor can determine the current termination time as known by a WS-Resource.

This specification MUST NOT require entities in the system to share synchronized clocks.

1.1.2 Non-Goals

The following topics are outside the scope of this specification:

- It is not an objective of this specification to define the message exchanges representing the function of a WS-Resource factory. Factory requirements are too varied to allow a general-purpose factory message exchange to be usefully defined. However, the factory pattern is described in more detail in [State Paper].

1.2 Notational Conventions

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

When describing abstract data models, this specification uses the notational convention used by the [XML Infoset]. Specifically, abstract property names always appear in square brackets (e.g., [some property]).

When describing concrete XML schemas, this specification uses the notational convention of [WS-Security]. Specifically, each member of an element’s [children] or [attributes] property is described using an XPath-like notation (e.g., /x:MyHeader/x:SomeProperty/@value1). The use of {any} indicates the presence of an element wildcard (<xsd:any/>). The use of @{any} indicates the presence of an attribute wildcard (<xsd:anyAttribute/>).

1.3 Namespaces

The following namespaces are used in this document:

Prefix	**Namespace**
s12	http://www.w3.org/2003/05/soap-envelope
wsp	http://schemas.xmlsoap.org/ws/2002/12/policy
wsa	http://schemas.xmlsoap.org/ws/2003/02/addressing
wsnt	http://www.ibm.com/xmlns/stdwip/web-services/WS-BaseNotification
wsrp	http://www.ibm.com/xmlns/stdwip/web-services/WS-ResourceProperties
wsrl (this spec)	http://www.ibm.com/xmlns/stdwip/web-services/WS-ResourceLifetime
wstop	http://www.ibm.com/xmlns/stdwip/web-services/WS-Topics

xsd	http://www.w3.org/2001/XMLSchema
xsi	http://www.w3.org/2001/XMLSchema-instance

2 Terminology and Concepts

This section specifies the notations, namespaces, and terminology used in this specification.

WS-Resource:

- A Web service having an association with a stateful resource, where the stateful resource is defined by a resource properties document and the association is expressed by means of an attachment of the resource properties document to the WSDL port type of the service.

Implied Resource Pattern:

- The way WS-Addressing must be used to designate the stateful resource component of the WS-Resource to be used in the execution of message exchanges.
- An EndpointReference that follows the implied resource pattern may include a ReferenceProperties child element that identifies the stateful resource component of the WS-Resource to be used in the execution of all message exchanges performed using this EndpointReference.
- A message that follows the implied resource pattern MUST be sent to a Web service referred to by an EndpointReference that follows the implied resource pattern, and MUST include the ReferenceProperties information from that EndpointReference, if present, as specified by WS-Addressing.
- A Web service that follows the implied resource pattern MAY use the ReferenceProperties information from a message that follows the implied resource pattern in order to identify the stateful resource to be used in the execution requested by that message.

WS-Resource Qualified Endpoint Reference:

- An Endpoint Reference used to refer to a WS-Resource composed of a Web service and a stateful resource.
- A stateful resource identifier MAY be contained within the ReferenceProperties element of the Endpoint Reference.
- The address of the Web service associated with the WS-Resource must be contained in the Address element of the Endpoint Reference.

Resource Property:

- A resource property is a piece of information defined as part of the state model of a WS-Resource.
- A resource property may reflect a part of the resource’s state, meta-data, manageability information, etc.

Resource Properties Document:

- The XML document representing a logical composition of resource property elements. The resource properties document defines a particular view or projection of the state data implemented by the WS-Resource.

- The *type* (e.g. the XML Schema definition of the root element) of a resource properties document is associated with the WSDL portType defining the Web service interface. This association is the basis of the WS-Resource definition. All instances of a particular WS-Resource type MUST implement a logical resource properties document of the type declared in the WSDL portType.

Resource Property Element:

- The XML representation of a resource property.
- A resource property element must appear as the immediate child of the root element of a resource properties document.
- A resource property element must be an XML global element definition (GED), and is uniquely identified by QName.

Resource Property Value:

- The value(s) associated with a resource property..

3 Example

Consider the case of a subscription entity within a notification system such as WS-Notification [WS-Notification]. This situation is depicted in the following figure:

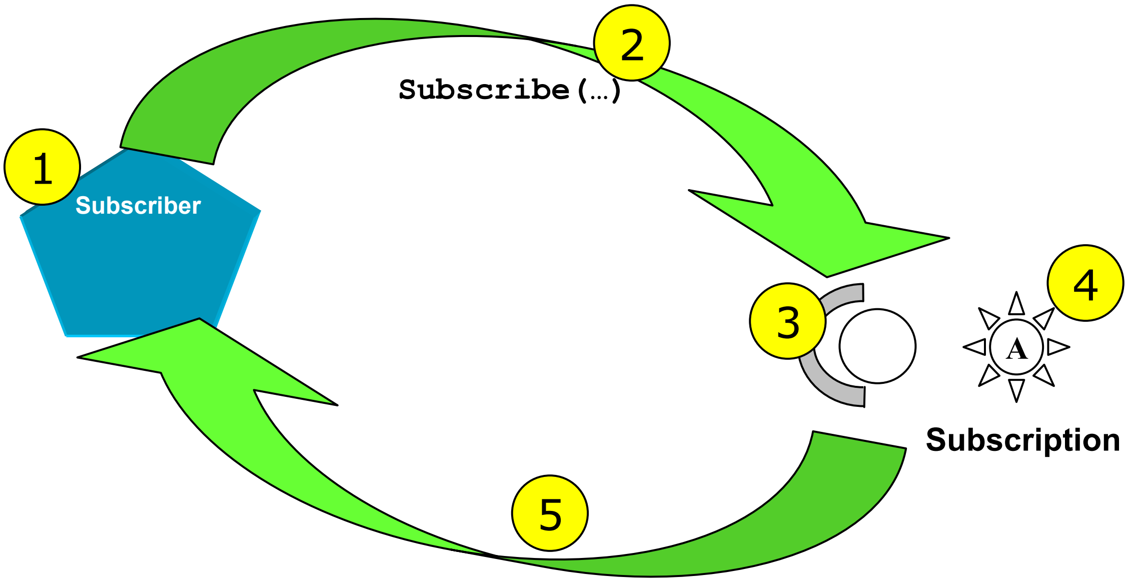

Figure 1 - Example WS-Resource Creation

A service requestor (1), playing the role of a subscriber, sends a subscribe message (2) to a NotificationProducer (3) because it wishes to receive notifications related to a particular situation such as a failure of a component. A subscription WS-Resource (4) is created as a result of the subscribe message, and a WS-Resource qualified EndpointReference (5) [State Paper] is returned to the requestor. As part of the application-specific understanding of the subscribe message exchange, both the requestor and provider understand that part of the semantics of processing a subscribe message is the creation (usually for a limited period of time) of a subscription WS-Resource. The subscribe request message contains the initial scheduled termination time of the subscription WS-Resource.

The endpoint reference that is returned as a result of the subscribe message is a WS-Resource qualified endpoint reference as described in [State Paper]. It contains a stateful resource identifier that refers to the newly created subscription state represented by the WS-Resource. The endpoint reference also contains the address of the Web service component of the WS-Resource that implements the message exchanges defined by WS-Notification's SubscriptionManager interface.

Subsequent to the creation of the subscription WS-Resource, the application specific behavior of delivering notifications continues. Occasionally, the subscriber may examine the subscription WS-Resource using standard WS-ResourceLifetime resource properties to inquire about the remaining time before the subscription WS-Resource may be destroyed. If the subscriber wishes to extend the lifetime of the subscription WS-Resource beyond its scheduled termination time, it sends a specific WS-ResourceLifetime message to the subscription WS-Resource identified by its EndpointReference, prior to the expiration of its current scheduled termination time. The response to this message contains the (potentially unchanged) termination time associated with the subscription WS-Resource.

When the subscriber no longer wishes to receive notifications, it may cause the immediate destruction of the subscription WS-Resource by sending another WS-ResourceLifetime message to the WS-Resource through use of its EndpointReference. As another option, it may simply allow the termination time of the subscription WS-Resource to expire, at which time the subscription WS-Resource may be destroyed.

4 Immediate Destruction

A WS-Resource MAY support a message exchange pattern that allows a service requestor to request its immediate destruction.

The format of the destroy request message is:

```
…
  <wsrl:Destroy/>
…
```

The Destroy request message MUST follow the implied resource pattern, as defined in Section 2.

If the WS-Resource accepts the Destroy request message, upon receipt of this message the WS-Resource MUST either (1) destroy the implied stateful resource component of the WS-Resource and return the following DestroyResponse message to acknowledge successful destruction, or (2) return a fault message indicating failure. Note that the destruction of the stateful resource component of the WS-Resource effectively destroys the WS-Resource.

```
…
  <wsrl:DestroyResponse />
…
```

The receipt of the DestroyResponse message serves as a confirmation of the destruction of the WS-Resource. Once it has sent a DestroyResponse message, any further message exchanges directed at the subject WS-Resource MUST respond with a fault. In the absence of any other fault conditions that may take precedence this MUST be the "ResourceUnknown" fault message.

If the WS-Resource does not respond to the Destroy request message with the DestroyResponse message, then it MUST send one of the following fault messages:

- ResourceUnknownFault

  - The stateful resource identified in the message (which follows the implied resource pattern) is not known to the Web service.
- ResourceNotDestroyedFault
  - The WS-Resource could not be destroyed for some reason.
- Others tbd.

4.1 Example SOAP Encoding of the Destroy Message Exchange

The following is a non-normative example of a Destroy request message using SOAP 1.2 [SOAP 1.2]:

```
<s12:Envelope
    xmlns:s12="http://www.w3.org/2003/05/soap-envelope"
    xmlns:wsa="http://schemas.xmlsoap.org/ws/2003/03/addressing"
    xmlns:wsrl=
  "http://www.ibm.com/xmlns/stdwip/web-services/WS-ResourceLifetime"
    xmlns:ex="http://example.com/exampleNS">
  <s12:Header>
    <wsa:Action>
        http://www.ibm.com/xmlns/stdwip/web-services/WS-
ResourceLifetime/Destroy
    </wsa:Action>
    <wsa:To s12:mustUnderstand="1">
        http://www.provider.org/ProviderEndpoint
    </wsa:To>
    <ex:ResourceId>
         uuid:84decd55-7d3f-65ad-ac44-675d9fce5d22
    </ex:ResourceId>
  </s12:Header>
  <s12:Body>
    <wsrl:Destroy/>
  </s12:Body>
</s12:Envelope>
```

The following is an example DestroyResponse message using SOAP 1.2 [SOAP 1.2]:

```
<s12:Envelope
    xmlns:s12="http://www.w3.org/2003/05/soap-envelope"
    xmlns:wsa="http://schemas.xmlsoap.org/ws/2003/03/addressing"
    xmlns:wsrl=
  "http://www.ibm.com/xmlns/stdwip/web-services/WS-ResourceLifetime"
    xmlns:resp="http://www.other.org/otherNS">
  <s12:Header>
    <wsa:Action>
        http://www.ibm.com/xmlns/stdwip/web-services/WS-
ResourceLifetime/DestroyResponse
    </wsa:Action>
    <wsa:To s12:mustUnderstand="1">
        http://www.requestor.org/someEndpoint
    </wsa:To>
    <resp:SomeResourceId>
        uuid:9fef5fec-6dc3-44a2-ba32-8680cace43f9
    </resp:SomeResourceId>
  </s12:Header>
  <s12:Body>
    <wsrl:DestroyResponse />
  </s12:Body>
</s12:Envelope>
```

5 Scheduled Destruction

A time-based approach MAY be used for managing the destruction of a WS-Resource. In this case, the WS-Resource has an associated termination time that defines the time after which the WS-Resource is expected to be destroyed and thus before which the WS-Resource can reasonably be expected to be available. As defined in the following subsections, a WS-Resource's termination time may be inspected through the TerminationTime resource property, and may be changed using the SetTerminationTime request message.

Typical use of scheduled destruction is to allow a service requestor to keep a WS-Resource active by adjusting the WS-Resource's termination time to some appropriate point in time using the SetTerminationTime request message.

Note that termination time is not required to monotonically increase, nor is a service required to accept a requested termination time. An implementation MAY refuse a request to adjust termination time for various reasons, including, for example, to enforce a policy that allows termination time to only change monotonically.

If a WS-Resource wishes to provide support for scheduled WS-Resource destruction, it MUST support all of the message exchanges and resource properties specified in this section.

5.1 Regarding Time

This specification assumes that services and clients use the UTC global time standard, expressed as type dateTime from XML Schema. Note that xsd:dateTime includes an optional designation of a time zone. The use of the time zone designation is RECOMMENDED. In the absence of the time zone designation, the xsd:dateTime value MUST be interpreted as universal time (UTC) time.

The approach allows operations and resource properties to refer unambiguously to absolute times. However, assuming the GMT time standard to represent time does *not* imply any particular level of clock synchronization between clients and services. No specific accuracy of synchronization is specified or expected by this specification, as this is a service-quality issue.

The scheduled destruction operations and resource properties have been designed to allow for tolerance of lack of clock synchronization between clients and services. The CurrentTime resource property may be used by a client to determine the clock skew between the client and the service, within a margin of error determined by the round-trip latency of the message exchange to retrieve that value. This clock skew and margin of error can then be factored into in subsequent decisions of when to send subsequent requests to change the termination time, and what termination times to request. The skew can also be monitored and adjusted with each SetTerminationTime message exchange, based on the CurrentTime that is returned from this request. This approach can also be used, to a limited extent, to accommodate clocks that "jump" either forward or backward in time.

5.2 Querying Current Time

In order to assist the service requestor in inspecting and setting a WS-Resource's termination time without requiring a specific accuracy of clock synchronization between the service requestor and the service provider, the WS-Resource MUST provide a resource property element that provides the current time as it is known by the WS-Resource. The form of this resource property element is:

```
…
  <xsd:element name="CurrentTime" type="xsd:dateTime"/>
…
```

The resource properties definition of the WS-Resource MUST contain exactly one element of QName wsrl:CurrentTime. The constraints on this element are as follows:

/wsrl:CurrentTime

> A WS-Resource MUST NOT allow the CurrentTime resource property to be modified by a SetResourceProperties request message as defined in [WS-ResourceProperties].
>
> If the element does not include the time zone designation, the value of the element MUST be interpreted as universal time (UTC) time.

5.3 Determining Current Termination Time

In order to allow the service requestor to determine the current termination time of a WS-Resource, the WS-Resource MUST provide a resource property element that indicates the current termination time of the WS-Resource. The form of this resource property element is:

```
…
  <xsd:element name="TerminationTime" nillable="true"
               type="xsd:dateTime" />
…
```

The resource properties definition of the WS-Resource MUST contain exactly one element of QName wsrl:TerminationTime. The constraints on this element are as follows:

/wsrl:TerminationTime

> The time, relative to the time source used by the WS-Resource, after which the WS-Resource MAY be destroyed.
>
> If the value of this resource property element contains the xsi:nil attribute with value "true" then the lifetime of the WS-Resource is considered to be *indefinite*; that is, there is no scheduled destruction time.
>
> A WS-Resource MUST NOT allow the TerminationTime resource property to be modified by a SetResourceProperties request message as defined in [WS-ResourceProperties].
>
> If the element does not include the time zone designation, the value of the element MUST be interpreted as universal time (UTC) time.

5.4 Requesting Change to Termination Time

The SetTerminationTime request message MUST be implemented by a WS-Resource supporting scheduled destruction in order to allow a requestor to change its scheduled termination time. The form of the SetTerminationTime request message is:

```
  <wsrl:SetTerminationTime>
    <wsrl:RequestedTerminationTime>
       xsd:dateTime
    </wsrl:RequestedTerminationTime>
  </wsrl:SetTerminationTime>
```

The SetTerminationTime request message MUST follow the implied resource pattern, as defined in Section 2.

Further constraints on the processing of the SetTerminationTime request message are as follows:

/wsrl:SetTerminationTime/wsrl:RequestedTerminationTime

> This is the new WS-Resource termination time that is being requested by the client. This value is interpreted relative to the time source known to the WS-Resource. If the element does not include the time zone designation, the value of the element MUST be interpreted as universal time (UTC) time.
>
> If the value is "in the past" relative to the current time as known by the WS-Resource, then the WS-Resource MAY be destroyed immediately. This facility provides the ability to support an asynchronous form of immediate destruction.
>
> If the value is xsi:nil, then the intent of the service requestor is to specify there is no scheduled termination time for the WS-Resource. In such situations it is RECOMMENDED that the WS-Resource support the immediate WS-Resource destruction operations described in section 4.

A WS-Resource that receives this message MAY reject the request to change the WS-Resource's termination time for any reason (e.g. policy). In this case, a fault message MUST be returned to the service requestor.

If a WS-Resource accepts the request to set the WS-Resource's termination time, it MUST update the TerminationTime resource property of the WS-Resource to the value specified in the message or to a value "in the future" relative to the requested time. If the SetTerminationTime request is accepted, the WS-Resource MUST respond with the following message:

```
<wsrl:SetTerminationTimeResponse>
  <wsrl:NewTerminationTime>
     xsd:dateTime
  </wsrl:NewTerminationTime>
  <wsrl:CurrentTime>
     xsd:dateTime
  </wsrl:CurrentTime>
<wsrl:SetTerminationTimeResponse>
```

Further constraints on the SetTerminationTimeResponse message are as follows:

/wsrl:SetTerminationTimeResponse/wsrl:NewTerminationTime

> This value MAY be "in the future" relative to the xsd:dateTime requested by the service requestor in the SetTerminationTime request message.
>
> This value reflects the new date and time at which the WS-Resource is scheduled to be destroyed.
>
> This value MUST also be reflected through the value of the TerminationTime resource property.

/wsrl:SetTerminationTimeResponse/wsrl:CurrentTime

> This value MUST be the time, as it is known by the WS-Resource, at which the WS-Resource processed this SetTerminationTime request.

If the WS-Resource does not respond to the SetTerminationTime request message with the SetTerminationTimeResponse message, then it MUST send one of the following fault messages:

- ResourceUnknownFault

  - The stateful resource identified in the message (which follows the implied resource pattern) is not known to the Web service.
- UnableToSetTerminationTimeFault
  - The request for termination time could not be changed for some reason.
- TerminationTimeChangeRejectedFault
  - In the case where a WS-Resource is willing to update its termination time, but only with a value “in the past” relative to the requested termination time, then the WS-Resource MAY include a “hint” in the TerminationTimeUnchangedFault message indicating the time to which it is willing to extend TermationTime.

5.5 Example SOAP Encoding of the SetTerminationTime Message Exchange

The following is a non-normative example of a SetTerminationTime request message using SOAP 1.2 [SOAP 1.2]:

```
<s12:Envelope
    xmlns:s12="http://www.w3.org/2003/05/soap-envelope"
    xmlns:wsa="http://schemas.xmlsoap.org/ws/2003/03/addressing"
    xmlns:wsrl=
  "http://www.ibm.com/xmlns/stdwip/web-services/WS-ResourceLifetime"
    xmlns:ex="http://example.com/exampleNS">
  <s12:Header>
    <wsa:Action>
        http://www.ibm.com/xmlns/stdwip/web-services/WS-
ResourceLifetime/SetTerminationTime
    </wsa:Action>
    <wsa:To s12:mustUnderstand="1">
        http://www.provider.org/ProviderEndpoint
    </wsa:To>
    <ex:ResourceId>
         uuid:84decd55-7d3f-65ad-ac44-675d9fce5d22
    </ex:ResourceId>
  </s12:Header>
  <s12:Body>
    <wsrl:SetTerminationTime>
      <wsrl:RequestedTerminationTime>
         2001-12-31T12:00:00
      </wsrl:RequestedTerminationTime>
    </wsrl:SetTerminationTime>
  </s12:Body>
</s12:Envelope>
```

The following is an example SetTerminationTimeResponse message using SOAP 1.2 [SOAP 1.2]:

```
<s12:Envelope
    xmlns:s12="http://www.w3.org/2003/05/soap-envelope"
    xmlns:wsa="http://schemas.xmlsoap.org/ws/2003/03/addressing"
    xmlns:wsrl=
  "http://www.ibm.com/xmlns/stdwip/web-services/WS-ResourceLifetime"
    xmlns:resp="http://www.other.org/otherNS">
  <s12:Header>
    <wsa:Action>
        http://www.ibm.com/xmlns/stdwip/web-services/WS-
ResourceLifetime/SetTerminationTimeResponse
```

```
    </wsa:Action>
    <wsa:To s12:mustUnderstand="1">
        http://www.requestor.org/someEndpoint
    </wsa:To>
    <resp:SomeResourceId>
        uuid:9fef5fec-6dc3-44a2-ba32-8680cace43f9
    </resp:SomeResourceId>
  </s12:Header>
  <s12:Body>
    <wsrl:SetTerminationTimeResponse>
      <wsrl:NewTerminationTime>
         2001-12-31T12:00:00
      </wsrl:NewTerminationTime>
      <wsrl:CurrentTime>
         2001-12-31T11:00:00
      </wsrl:CurrentTime>
    </wsrl:SetTerminationTimeResponse>
  </s12:Body>
</s12:Envelope>
```

5.6 Termination Time Expiration

If the service requestor fails to successfully update the termination time of a WS-Resource before the termination time expires, the WS-Resource MAY be destroyed and therefore no longer be accessible. Termination time has expired when the termination time of the WS-Resource (as reflected by the value of the WS-Resource’s TerminationTime resource property element) is “in the past” relative to the current time as expressed in the value of the WS-Resource’s CurrentTime resource property element.

The specific mechanisms employed to destroy the WS-Resource after termination time has expired is implementation dependent. An implementation MAY delay destruction of the WS-Resource at its own discretion. The requestor MUST not depend on the destruction of the WS-Resource occurring at termination time expiration but SHOULD assume that the WS-Resource is no longer accessible after termination time has expired.

6 Notification of Resource Destruction

A WS-Resource MAY choose to support the pattern of notifying interested parties when it is destroyed. If a WS-Resource chooses to support this pattern and if the WS-Resource uses WS-Notification [WS-Notification] to implement this pattern, then it MUST follow the approach described in this section. An implementation MAY choose to not support this pattern, or it MAY choose to do so using some means other than WS-Notification; in such circumstances, the implementation MAY ignore the approach described in this section.

If the WS-Resource is also a NotificationProducer, according to the WS-BaseNotification specification [WS-BaseNotification], then it SHOULD provide a topic [WS-Topics] to allow requestors to subscribe for notification of its destruction. The notification applies to both immediate and scheduled destruction. The form of the topic is:

```
<wstop:TopicSpace name="ResourceLifetime"
   targetNamespace=
    "http://www.ibm.com/xmlns/stdwip/web-services/WS-ResourceLifetime"
… >
```

```
   <wstop:Topic name="ResourceTermination" …>
      <wstop:MessagePattern>
         <wsrp:QueryExpression
           dialect=”http://www.w3.org/TR/1999/REC-xpath-19991116” >
             boolean(/*/TerminationNotification)
         </wsrp:QueryExpression>
      </wstop:MessagePattern>
…
```

The value of /wstop:Topic/@MessageTypes is implementation dependent; this specification does not define the exact content of the notification messages produced on this topic. However, the notification message associated with this topic MUST contain the following element:

```
<wsrl:TerminationNotification>
  <wsrl:TerminationTime>xsd:dateTime</wsrl:TerminationTime>
  <wsrl:TerminationReason>xsd:any</wsrl:TerminationReason>?
</wsrl:TerminationNotification>
```

This constraint is specified in the /wstop:Topic/wstop:MessagePattern element. The TerminationNotification element is further constrained as follows:

/wsrl:TerminationTime

> This element contains the date and time when the WS-Resource was destroyed.

/wsrl:TerminationReason

> This OPTIONAL element contains an explanation of the situation surrounding the destruction of the WS-Resource. This element is specific to the type of the WS-Resource that was destroyed.

A requestor would send a subscribe request message, following the WS-Notification specification, specifying the “ResourceTermination” topic and referencing a chosen WS-Resource using a WS-Resource qualified endpoint reference [State Paper].

7 Security Considerations

This specification defines the message exchanges used to request the destruction of a WS-Resource, or to obtain information about the termination time of the WS-Resource. In this context, there are two categories of security aspects that need to be considered: (a) securing the message exchanges and (b) securing the operations that inform the WS-Resource destruction.

7.1 Securing the Message Exchanges

When messages are exchanged between a requestor and a WS-Resource in order to access or act upon the resource properties, it is strongly RECOMMENDED that the communication between them be secured using the mechanisms described in WS-Security. In order to properly secure messages, the body and all relevant headers need to be included in the digital signature so as to prove the integrity of the message. In addition the reference properties within an Endpoint Reference may be encrypted to ensure their privacy. In the event that a requestor communicates with a WS-Resource to access its resource properties, either directly through a query or indirectly through a notification of resource property state change, it is RECOMMENDED that a security context be established using the mechanisms described in WS-Trust [WS-Trust] and WS-SecureConversation [WS-SecureConversation].

It is common for communication between requestors and WS-Resources to exchange multiple messages. As a result, the usage profile is such that it is susceptible to key attacks. For this reason it is strongly RECOMMENDED that the keys used to secure the channel be changed frequently. This "re-keying" can be effected a number of ways. The following list outlines four common techniques:

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

It should be noted that the mechanisms listed above are independent of the security context token (SCT) and secret returned when subscribed the first time. That is, the keys used to secure the channel during notifications may be independent of the key used to prove the right to subscribe with a NotificationSource.

The security context MAY be re-established using the mechanisms described in WS-Trust and WS-SecureConversation. Similarly, secrets can be exchanged using the mechanisms described in WS-Trust. Note, however, that the current shared secret SHOULD NOT be used to encrypt the new shared secret. Derived keys, the preferred solution from this list, can be specified using the mechanisms described in WS-SecureConversation.

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

- **Message alteration** – Alteration is prevented by including signatures of the message information using WS-Security.
- **Message disclosure** – Confidentiality is preserved by encrypting sensitive data using WS-Security.
- **Key integrity** – Key integrity is maintained by using the strongest algorithms possible (by comparing secured policies – see WS-Policy and WS-SecurityPolicy).
- **Authentication** – Authentication is established using the mechanisms described in WS-Security and WS-Trust. Each message is authenticated using the mechanisms described in WS-Security.
- **Accountability** – Accountability is a function of the type of and string of the key and algorithms being used. In many cases, a strong symmetric key provides sufficient accountability. However, in some environments, strong PKI signatures are required.
- **Availability** – Many services are subject to a variety of availability attacks. Replay is a common attack and it is RECOMMENDED that this be addressed as described in the next bullet. Other attacks, such as network-level denial of service attacks are harder to avoid and are outside the scope of this specification. That said, care should be taken to ensure that minimal processing be performed prior to any authenticating sequences.
- **Replay** – Messages may be replayed for a variety of reasons. To detect and eliminate this attack, mechanisms should be used to identify replayed messages

such as the timestamp/nonce outlined in WS-Security and the sequences outlined in WS-ReliableMessaging.

7.2 Securing Resource Destruction

Given WS-ResourceLifetime defines a mechanism to destroy WS-Resources, security policies should be established that ensure that only authorized requesters can destroy a WS-Resource. Authorization policies should be defined so that the implications of destroying a WS-Resource either through immediate requests or by setting termination time, are considered. The two approaches for destruction may be considered equivalent for authorization reasons. In other words, an authorization policy that describes the ability to perform Destroy operation on a WS-Resource, confirming to ImmediateResourceTermination portType, may need to be applied when the SetTerminationTime operation is performed on the same resource.

It should be noted that this specification does not allow modifications to (a) CurrentTime, (b) TerminationTime, resource properties through SetResourceProperty request message of WS-ResourceProperties. Therefore, there should be no authorization enforcement performed when these properties are accessed using the Set request message but leave it to the runtime to enforce the requirement as specified. Given a requestor can subscribe for notification of the destruction of the resource using, "ResourceLifetime" topic, the security considerations specified in WS-Notification specification are applicable to this topic.

8 Acknowledgements

Special thanks to the Global Grid Forum's Open Grid Services Infrastructure working group, which defined the OGSI v1.0 [OGSI] specification which was a large inspiration for the ideas expressed in this specification.

This specification has been developed as a result of joint work with many individuals and teams. The authors wish to acknowledge the contributions from many people, including: Dave Booz, Glen Daniels Rob High, Diane Jordan, Jim Knutson, David Martin, Bryan Murray, Peter Niblett, Ian Robinson, and Jay Unger.

9 References

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[WS-Trust]

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[XML-Infoset]

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[XML]

http://www.w3.org/TR/REC-xml

[XPATH]

http://www.w3.org/TR/xpath

Appendix I – XML Schema

The XML types and elements used in this specification are defined in the following XML Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<!--
   Legal Disclaimer

   Copyright Notice

   (c) Copyright Computer Associates International, Inc.,
       Fujitsu Limited, Hewlett-Packard Development Company,
       International Business Machines Corporation and
       The University of Chicago 2003, 2004. All Rights Reserved.
-->

<xsd:schema
  xmlns="http://www.w3.org/2001/XMLSchema"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:wsrl=
  "http://www.ibm.com/xmlns/stdwip/web-services/WS-ResourceLifetime"
  targetNamespace=
  "http://www.ibm.com/xmlns/stdwip/web-services/WS-ResourceLifetime">

<!-- =============== Resource Property Related  =================== -->
<!-- ==== Resource Properties for ScheduledResourceTermination ==== -->

  <xsd:element name="CurrentTime" type="xsd:dateTime"/>

  <xsd:element name="TerminationTime" nillable="true"
```

```
               type="xsd:dateTime" />

<!-- ============= Notification Message Related  ================== -->
  <xsd:element name="TerminationNotification">
    <xsd:complexType>
      <xsd:sequence>
        <xsd:element name="TerminationTime" type="xsd:dateTime"
                     minOccurs="1" maxOccurs="1" />
        <xsd:element name="TerminationReason" type="xsd:anyType"
                     minOccurs="0" maxOccurs="1" />
      </xsd:sequence>
    </xsd:complexType>
  </xsd:element>

</xsd:schema>
```

Appendix II – WSDL 1.1

The following illustrates the WSDL 1.1 for the Web service methods described in this specification:

```
<?xml version="1.0" encoding="utf-8"?>
<!--
  Legal Disclaimer

  Copyright Notice

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       Fujitsu Limited, Hewlett-Packard Development Company,
       International Business Machines Corporation and
       The University of Chicago 2003, 2004. All Rights Reserved.
-->

<wsdl:definitions name="WS-ResourceLifetime"
  xmlns="http://schemas.xmlsoap.org/wsdl/"
  xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
  xmlns:wsa="http://schemas.xmlsoap.org/ws/2003/03/addressing"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:wsrp=
 "http://www.ibm.com/xmlns/stdwip/web-services/WS-ResourceProperties"
  xmlns:wsrl=
    "http://www.ibm.com/xmlns/stdwip/web-services/WS-ResourceLifetime"
  targetNamespace=
    "http://www.ibm.com/xmlns/stdwip/web-services/WS-ResourceLifetime">

<!-- ===================== Types Definitions ====================== -->
  <wsdl:types>
    <xsd:schema
      xmlns="http://www.w3.org/2001/XMLSchema"
      targetNamespace=
    "http://www.ibm.com/xmlns/stdwip/web-services/WS-ResourceLifetime">

      <xsd:include
         schemaLocation=
"http://www-106.ibm.com/developerworks/library/ws-resource/WS-
ResourceLifetime.xsd"
```

```
      />

      <xsd:import
            namespace=
            "http://schemas.xmlsoap.org/ws/2003/03/addressing"
            schemaLocation=
            "http://schemas.xmlsoap.org/ws/2003/03/addressing"
      />


<!-- ==== Common fault information to carry in all fault messages ====
-->
       <complexType name="BaseFaultType">
          <sequence>
             <element name="Timestamp" type="xsd:dateTime"
                      minOccurs="1" maxOccurs="1"/>
             <element name="Originator"
type="wsa:EndpointReferenceType"
                      minOccurs="0" maxOccurs="1"/>
             <element name="ErrorCode"
                      minOccurs="0" maxOccurs="1">
                <complexType>
                   <complexContent mixed="true">
                      <extension base="xsd:anyType">
                         <attribute name="dialect" type="xsd:anyURI"
                                    use="required"/>
                      </extension>
                   </complexContent>
                </complexType>
             </element>
             <element name="Description" type="xsd:string"
                      minOccurs="0" maxOccurs="unbounded"/>
             <element name="FaultCause" type="wsrl:BaseFaultType"
                      minOccurs="0" maxOccurs="unbounded"/>
          </sequence>
       </complexType>

<!-- ==== Resource Properties for ScheduledResourceTermination ==== -->
       <xsd:element name="ScheduledResourceTerminationRP" >
          <xsd:complexType>
             <xsd:sequence>
                <xsd:element ref="wsrl:CurrentTime"
                             minOccurs="1" maxOccurs="1" />
                <xsd:element ref="wsrl:TerminationTime"
                             minOccurs="1" maxOccurs="1" />
               </xsd:sequence>
            </xsd:complexType>
         </xsd:element>

<!-- ====== Message Types for ImmediateResourceTermination  ======= -->

      <xsd:element name="Destroy">
         <xsd:complexType />
      </xsd:element>

      <xsd:element name="DestroyResponse" >
         <xsd:complexType />
      </xsd:element>

      <xsd:complexType name="ResourceUnknownFaultType">
         <xsd:complexContent>
            <xsd:extension base="wsrl:BaseFaultType"/>
         </xsd:complexContent>
      </xsd:complexType>
      <xsd:element name="ResourceUnknownFault"
                   type="wsrl:ResourceUnknownFaultType"/>

      <xsd:complexType name="ResourceNotDestroyedFaultType">
         <xsd:complexContent>
            <xsd:extension base="wsrl:BaseFaultType"/>
         </xsd:complexContent>
      </xsd:complexType>
      <xsd:element name="ResourceNotDestroyedFault"
                   type="wsrl:ResourceNotDestroyedFaultType"/>

<!-- ====== Message Types for ScheduledResourceTermination  ======= -->

      <xsd:element name="SetTerminationTime">
         <xsd:complexType>
            <xsd:sequence>
               <xsd:element name="RequestedTerminationTime"
                            nillable="true"
                            type="xsd:dateTime" />
            </xsd:sequence>
         </xsd:complexType>
      </xsd:element>

      <xsd:element name="SetTerminationTimeResponse">
         <xsd:complexType>
            <xsd:sequence>
               <xsd:element name="NewTerminationTime"
                            nillable="true"
                            type="xsd:dateTime" />
               <xsd:element name="CurrentTime"
                            type="xsd:dateTime" />
            </xsd:sequence>
         </xsd:complexType>
      </xsd:element>

      <xsd:complexType name="UnableToSetTerminationTimeFaultType">
         <xsd:complexContent>
            <xsd:extension base="wsrl:BaseFaultType"/>
         </xsd:complexContent>
      </xsd:complexType>
      <xsd:element name="UnableToSetTerminationTimeFault"
                   type="wsrl:UnableToSetTerminationTimeFaultType"/>

      <xsd:complexType name="TerminationTimeChangeRejectedFaultType">
         <xsd:complexContent>
            <xsd:extension base="wsrl:BaseFaultType"/>
         </xsd:complexContent>
      </xsd:complexType>
      <xsd:element name="TerminationTimeChangeRejectedFault"
                   type="wsrl:TerminationTimeChangeRejectedFaultType"/>
```

```
    </xsd:schema>
  </wsdl:types>

<!-- ============= Message Definitions for Destroy ====================
  Destroy()
  returns: empty
-->
  <wsdl:message name="DestroyRequest">
     <part name="DestroyRequest"
           element="wsrl:Destroy" />
  </wsdl:message>

  <wsdl:message name="DestroyResponse">
     <part name="DestroyResponse"
           element="wsrl:DestroyResponse" />
  </wsdl:message>

  <wsdl:message name="ResourceUnknownFault">
     <part name="ResourceUnknownFault"
           element="wsrl:ResourceUnknownFault" />
  </wsdl:message>

  <wsdl:message name="ResourceNotDestroyedFault">
     <part name="ResourceNotDestroyedFault"
           element="wsrl:ResourceNotDestroyedFault" />
  </wsdl:message>

<!-- ===================== SetTerminationTime ====================
  SetTerminationTime(xsd:dateTime)
  returns: xsd:dateTime
-->

  <message name="SetTerminationTimeRequest">
     <part name="SetTerminationTimeRequest"
           element="wsrl:SetTerminationTime" />
  </message>

  <message name="SetTerminationTimeResponse">
     <part name="SetTerminationTimeResponse"
           element="wsrl:SetTerminationTimeResponse" />
  </message>

  <wsdl:message name="UnableToSetTerminationTimeFault">
     <part name="UnableToSetTerminationTimeFault"
           element="wsrl:UnableToSetTerminationTimeFault" />
  </wsdl:message>

  <wsdl:message name="TerminationTimeChangeRejectedFault">
     <part name="TerminationTimeChangeRejectedFault"
           element="wsrl:TerminationTimeChangeRejectedFault" />
  </wsdl:message>

<!-- =================== PortType Definitions ===================== -->
  <wsdl:portType name="ImmediateResourceTermination">
    <wsdl:operation name="Destroy">
```

```
      <wsdl:input message="wsrl:DestroyRequest" />
      <wsdl:output message="wsrl:DestroyResponse" />
      <wsdl:fault name="ResourceUnknownFault"
                  message="wsrl:ResourceUnknownFault" />
      <wsdl:fault name="ResourceNotDestroyedFault"
                  message="wsrl:ResourceNotDestroyedFault" />
    </wsdl:operation>
  </wsdl:portType>

  <wsdl:portType name="ScheduledResourceTermination"
     wsrp:ResourceProperties ="wsrl:ScheduledResourceTerminationRP">
    <wsdl:operation name="SetTerminationTime">
      <wsdl:input message="wsrl:SetTerminationTimeRequest" />
      <wsdl:output message="wsrl:SetTerminationTimeResponse" />
      <wsdl:fault name="ResourceUnknownFault"
                  message="wsrl:ResourceUnknownFault" />
      <wsdl:fault name="UnableToSetTerminationTimeFault"
                  message="wsrl:UnableToSetTerminationTimeFault" />
      <wsdl:fault name="TerminationTimeChangeRejectedFault"
                  message="wsrl:TerminationTimeChangeRejectedFault" />
    </wsdl:operation>
  </wsdl:portType>

</wsdl:definitions>
```