Dynamic Resource Linking for Constrained RESTful Environments
draft-groves-core-dynlink-00

Abstract

   For CoAP [RFC7252] Dynamic linking of state updates between
   resources, either on an endpoint or between endpoints, is defined
   with the concept of Link Bindings. This document defines conditional
   observation attributes that work with Link Bindings or with simple
   CoAP Observe [RFC7641].

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   provisions of BCP 78 and BCP 79.

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1. Introduction

IETF Standards for machine to machine communication in constrained environments describe a REST protocol and a set of related information standards that may be used to represent machine data and machine metadata in REST interfaces. CoRE Link-format is a standard for doing Web Linking [RFC5988] in constrained environments.

This document introduces the concept of a Link Binding, which defines a new link relation type to create a dynamic link between resources over which to exchange state updates. Specifically, a Link Binding is a link for binding the state of 2 resources together such that updates to one are sent over the link to the other. CoRE Link Format representations are used to configure, inspect, and maintain Link Bindings. This document additionally defines a set of conditional Observe Attributes for use with Link Bindings and with the standalone CoRE Observe [RFC7641] method.

Editor's note: This initial version is based on the text of I.D.ietf-core-interfaces-04. Further work is needed around link bindings and extending the obeserve attributes with another use case that requires 3 new optional attributes.

2. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
"SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this
document are to be interpreted as described in [RFC2119].

This specification requires readers to be familiar with all the terms
and concepts that are discussed in [RFC5988] and [RFC6690]. This
specification makes use of the following additional terminology:

Link Binding: A unidirectional logical link between a source
   resource and a destination resource, over which state information
   is synchronized.

3. Link Bindings and Observe Attributes

In a M2M RESTful environment, endpoints may directly exchange the
content of their resources to operate the distributed system. For
example, a light switch may supply on-off control information that
may be sent directly to a light resource for on-off control.
Beforehand, a configuration phase is necessary to determine how the
resources of the different endpoints are related to each other. This
can be done either automatically using discovery mechanisms or by
means of human intervention and a so-called commissioning tool. In
this document the abstract relationship between two resources is
called a link Binding. The configuration phase necessitates the
exchange of binding information so a format recognized by all CoRE
endpoints is essential. This document defines a format based on the
CoRE Link-Format to represent binding information along with the
rules to define a binding method which is a specialized relationship
between two resources. The purpose of a binding is to synchronize
the content between a source resource and a destination resource.
The destination resource MAY be a group resource if the authority
component of the destination URI contains a group address (either a
multicast address or a name that resolves to a multicast address).
Since a binding is unidirectional, the binding entry defining a
relationship is present only on one endpoint. The binding entry may
be located either on the source or the destination endpoint depending
on the binding method. The following table gives a summary of the
binding methods described in more detail in Section 3.2.

Name	Identifier	Location	Method
Polling	poll	Destination	GET
Observe	obs	Destination	GET + Observe
Push	push	Source	PUT

3.1. Format

   Since Binding involves the creation of a link between two resources,
   Web Linking and the CoRE Link-Format are a natural way to represent
   binding information. This involves the creation of a new relation
   type, purposely named "boundto". In a Web link with this relation
   type, the target URI contains the location of the source resource and
   the context URI points to the destination resource. The Web link
   attributes allow a fine-grained control of the type of
   synchronization exchange along with the conditions that trigger an
   update. This specification defines the attributes below:

```
        +--------------------+----------+------------------+
        | Attribute          | Parameter | Value           |
        +--------------------+----------+------------------+
        | Binding method     | bind     | xsd:string       |
        | Minimum Period (s) | pmin     | xsd:integer (>0) |
        | Maximum Period (s) | pmax     | xsd:integer (>0) |
        | Change Step        | st       | xsd:decimal (>0) |
        | Greater Than       | gt       | xsd:decimal      |
        | Less Than          | lt       | xsd:decimal      |
        +--------------------+----------+------------------+
```

   Bind Method: This is the identifier of a binding method which
      defines the rules to synchronize the destination resource. This
      attribute is mandatory.

   Minimum Period: When present, the minimum period indicates the
      minimum time to wait (in seconds) before sending a new
      synchronization message (even if it has changed). In the absence
      of this parameter, the minimum period is up to the notifier.

   Maximum Period: When present, the maximum period indicates the
      maximum time in seconds between two consecutive state
      synchronization messages (regardless if it has changed). In the
      absence of this parameter, the maximum period is up to the
      notifier. The maximum period MUST be greater than the minimum
      period parameter (if present).

   Change Step: When present, the change step indicates how much the
      value of a resource SHOULD change before sending a new
      notification (compared to the value of the last notification).
      This parameter has lower priority than the period parameters, thus
      even if the change step has been fulfilled, the time since the
      last notification SHOULD be between pmin and pmax.

   Greater Than: When present, Greater Than indicates the upper limit
      value the resource value SHOULD cross before sending a new

notification. This parameter has lower priority than the period
parameters, thus even if the Greater Than limit has been crossed,
the time since the last notification SHOULD be between pmin and
pmax.

Less Than: When present, Less Than indicates the lower limit value
the resource value SHOULD cross before sending a new notification.
This parameter has lower priority than the period parameters, thus
even if the Less Than limit has been crossed, the time since the
last notification SHOULD be between pmin and pmax.

3.2. Binding methods

A binding method defines the rules to generate the web-transfer
exchanges that will effectively send content from the source resource
to the destination resource. The description of a binding method
must define the following aspects:

Identifier: This is value of the "bind" attribute used to identify
the method.

Location: This information indicates whether the binding entry is
stored on the source or on the destination endpoint.

REST Method: This is the REST method used in the Request/Response
exchanges.

Conditions: A binding method definition must state how the condition
attributes of the abstract binding definition are actually used in
this specialized binding.

This specification supports 3 binding methods described below.

Polling: The Polling method consists of sending periodic GET
requests from the destination endpoint to the source resource and
copying the content to the destination resource. The binding
entry for this method MUST be stored on the destination endpoint.
The destination endpoint MUST ensure that the polling frequency
does not exceed the limits defined by the pmin and pmax attributes
of the binding entry. The copying process MAY filter out content
from the GET requests using value-based conditions (e.g Change
Step, Less Than, Greater Than).

Observe: The Observe method creates an observation relationship
between the destination endpoint and the source resource. On each
notification the content from the source resource is copied to the
destination resource. The creation of the observation
relationship requires the CoAP Observation mechanism [RFC7641]

hence this method is only permitted when the resources are made available over CoAP. The binding entry for this method MUST be stored on the destination endpoint. The binding conditions are mapped as query string parameters (see Section 3.4).

Push: When the Push method is assigned to a binding, the source endpoint sends PUT requests to the destination resource when the binding condition attributes are satisfied for the source resource. The source endpoint MUST only send a notification request if the binding conditions are met. The binding entry for this method MUST be stored on the source endpoint.

3.3. Binding table

The binding table is a special resource that gives access to the bindings on a endpoint. A binding table resource MUST support the Binding interface defined in Section 4.1. A profile SHOULD allow only one resource table per endpoint.

3.4. Resource Observation Attributes

When resource interfaces following this specification are made available over CoAP, the CoAP Observation mechanism [RFC7641] MAY be used to observe any changes in a resource, and receive asynchronous notifications as a result. In addition, a set of query string parameters are defined here to allow a client to control how often a client is interested in receiving notifications and how much a resource value should change for the new representation to be interesting. These query parameters are described in the following table. A resource using an interface description defined in this specification and marked as Observable in its link description SHOULD support these observation parameters. The Change Step parameter can only be supported on resources with an atomic numeric value.

These query parameters MUST be treated as resources that are read using GET and updated using PUT, and MUST NOT be included in the Observe request. Multiple parameters MAY be updated at the same time by including the values in the query string of a PUT. Before being updated, these parameters have no default value.

```
+----------------+-----------------+-----------------+
| Resource       | Parameter       | Data Format     |
+----------------+-----------------+-----------------+
| Minimum Period | /{resource}?pmin | xsd:integer (>0) |
| Maximum Period | /{resource}?pmax | xsd:integer (>0) |
| Change Step    | /{resource}?st   | xsd:decimal (>0) |
| Less Than      | /{resource}?lt   | xsd:decimal      |
| Greater Than   | /{resource}?gt   | xsd:decimal      |
+----------------+-----------------+-----------------+
```

Minimum Period: When present, the minimum period indicates the
   minimum time to wait (in seconds) before sending a new
   synchronization message (even if it has changed). In the absence
   of this parameter, the minimum period is up to the notifier.

Maximum Period: When present, the maximum period indicates the
   maximum time in seconds between two consecutive state
   synchronization messages (regardless if it has changed). In the
   absence of this parameter, the maximum period is up to the
   notifier. The maximum period MUST be greater than the minimum
   period parameter (if present).

Change Step: When present, the change step indicates how much the
   value of a resource SHOULD change before sending a new
   notification (compared to the value of the last notification).
   This parameter has lower priority than the period parameters, thus
   even if the change step has been fulfilled, the time since the
   last notification SHOULD be between pmin and pmax.

Greater Than: When present, Greater Than indicates the upper limit
   value the resource value SHOULD cross before sending a new
   notification. This parameter has lower priority than the period
   parameters, thus even if the Greater Than limit has been crossed,
   the time since the last notification SHOULD be between pmin and
   pmax.

Less Than: When present, Less Than indicates the lower limit value
   the resource value SHOULD cross before sending a new notification.
   This parameter has lower priority than the period parameters, thus
   even if the Less Than limit has been crossed, the time since the
   last notification SHOULD be between pmin and pmax.

4. Interface Descriptions

This section defines REST interfaces for Binding table resources.
The interface supports the link-format type.

The if= column defines the Interface Description (if=) attribute
value to be used in the CoRE Link Format for a resource conforming to
that interface. When this value appears in the if= attribute of a
link, the resource MUST support the corresponding REST interface
described in this section. The resource MAY support additional
functionality, which is out of scope for this specification.
Although this interface descriptions is intended to be used with the
CoRE Link Format, it is applicable for use in any REST interface
definition.

The Methods column defines the methods supported by that interface,
which are described in more detail below.

```
+-----------+----------+-------------------+----------------+
| Interface | if=      | Methods           | Content-Formats |
+-----------+----------+-------------------+----------------+
|   Binding | core.bnd | GET, POST, DELETE | link-format    |
+-----------+----------+-------------------+----------------+
```

4.1. Binding

The Binding interface is used to manipulate a binding table. A
request with a POST method and a content format of application/link-
format simply appends new bindings to the table. All links in the
payload MUST have a relation type "boundTo". A GET request simply
returns the current state of a binding table whereas a DELETE request
empties the table.

The following example shows requests for adding, retrieving and
deleting bindings in a binding table.


```
Req: POST /bnd/ (Content-Format: application/link-format)
<coap://sensor.example.com/s/light>;
  rel="boundto";anchor="/a/light";bind="obs";pmin="10";pmax="60"
Res: 2.04 Changed

Req: GET /bnd/
Res: 2.05 Content (application/link-format)
<coap://sensor.example.com/s/light>;
  rel="boundto";anchor="/a/light";bind="obs";pmin="10";pmax="60"

Req: DELETE /bnd/
Res: 2.04 Changed
```

5. Security Considerations

An implementation of a client needs to be prepared to deal with
responses to a request that differ from what is specified in this
document. A server implementing what the client thinks is a resource
with one of these interface descriptions could return malformed
representations and response codes either by accident or maliciously.
A server sending maliciously malformed responses could attempt to
take advantage of a poorly implemented client for example to crash
the node or perform denial of service.

6. IANA Considerations

The "binding" interface description types requires registration.

The new link relations type "boundto" requires registration.

7. Acknowledgments

Acknowledgement is given to colleagues from the SENSEI project who
were critical in the initial development of the well-known REST
interface concept, to members of the IPSO Alliance where further
requirements for interface types have been discussed, and to Szymon
Sasin, Cedric Chauvenet, Daniel Gavelle and Carsten Bormann who have
provided useful discussion and input to the concepts in this
document.

8. Changelog

Initial Version 00

o This initial version is based on the text regarding the dynamic
   linking functionality in I.D.ietf-core-interfaces-05.

o The WADL description has been dropped in favour of a thorough
   textual description of the REST API.

9. References

9.1. Normative References

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9.2. Informative References

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   [RFC7641]   Hartke, K., "Observing Resources in the Constrained
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