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Using RESTCONF with LMAP Measurement Agents
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Abstract

This document describes how RESTCONF can be used with a YANG data model for Large-Scale Measurement Platforms (LMAP).

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1. Introduction

The Framework for Large-Scale Measurement of Broadband Performance (LMAP) [RFC7594] describes an overall framework for large-scale broadband performance measurement systems. The standardization work in the IETF is restricted to the interaction between Measurement Agents and their Controllers and between Measurement Agents and result Collectors (see Figure 1 in [RFC7594]).

The protocol selection process within the LMAP working group of the IETF gave preference to a solution that reuses existing IETF protocols rather than inventing new ones. In addition, there was a preference to use a protocol that is layered on top of HTTP since this allows to reuse implementations already widely available.

This document discusses how the RESTCONF protocol [RFC8040] can be used to facilitate the communication between components implementing the LMAP framework. In particular, this document discusses how RESTCONF can be used as a Control Protocol to deliver Instruction(s) from a Controller to a Measurement Agent, and as a Report Protocol delivering Report(s) from a Measurement Agent to a Collector.

Measurement Agents may be deployed as separate hardware devices or as functions embedded in consumer electronic devices and home routers or as pure software solutions that can be installed on off-the-shelf computing equipment. Measurement Agents receive instructions from a Controller about when and how to conduct measurements (the Measurement Schedule) and how and when to report measurement results to a data Collector (the Report Schedule). Further information about the interaction between Measurement Agents and Controllers and Collectors can be found in [RFC7594].

The LMAP information model [I-D.ietf-lmap-information-model] defines in a conceptual and protocol-independent way the information exchanged between a Controller and a Measurement Agent as well as the information exchanged between a Measurement Agent and a Collector. A concrete YANG [RFC7950] data model derived from the conceptual information model is defined in [I-D.ietf-lmap-yang].

This document uses the LMAP terminology defined in [RFC7594].

2. Overview of RESTCONF

The RESTCONF protocol [RFC8040] provides an HTTP-based protocol for accessing data defined in YANG [RFC7950]. The basic idea behind RESTCONF is to expose YANG-defined data as a collection of Web resources that can be accessed and manipulated using standard HTTP [RFC7230] GET, DELETE, PATCH, POST, and PUT methods. The resource hierarchy is derived from the nesting structure of the YANG schema tree, leading to a so-called data-model-driven application programming interface (API).

RESTCONF is essentially a convention how to use HTTP over TLS to access a resources representing YANG-defined data. The resources are represented using either XML encoding (according to [RFC7950]) or JSON encoding (according to [RFC7951]). The examples shown in this document use the JSON encoding.

The normal mode of operation is that the RESTCONF client initiates a secure transport to the RESTCONF server. For devices located behind a middlebox (e.g., a network address translator or a firewall), a so called Call Home mechanism has been defined [RFC8071]. The Call Home mechanism allows the RESTCONF server to initiate a secure transport to a RESTCONF client. Note that Call Home only changes the TCP connection establishment, the TLS and HTTP client/server roles do not change. The policy used to control the Call Home mechanism can be configured through a configuration data model [I-D.ietf-netconf-restconf-client-server]. This model provides a mechanism to configure a list of redundant endpoints and it provides control over Call Home parameters (e.g, frequency of Call Home attempts, idle-timers, keep-alive timers).

3. RESTCONF as LMAP Control Protocol

The LMAP Control Protocol delivers Instruction(s) from a Controller to a Measurement Agent. The LMAP Control Protocol is realized by running a RESTCONF server on the Measurement Agent and a RESTCONF client on the Controller. Figure 1 depicts how the connection and the secure transport is established when the Measurement Agent is directly reachable from the Controller, i.e., the Measurement Agent

has a well-known name or address and is directly reachable from the Controller.

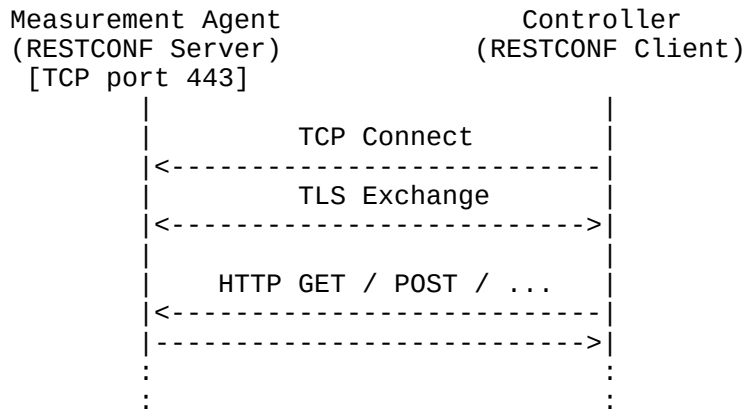

Figure 1: RESTCONF as Control protocol (without Call Home)

In several deployment scenarios, it will not be possible for the Controller to initiate a connection to the Measurement Agent due to the presence of middleboxes such as network address translators and firewalls. In such a situation, the Measurement Agent running a RESTCONF server will Call Home to the Controller running a RESTCONF client as shown in Figure 2.

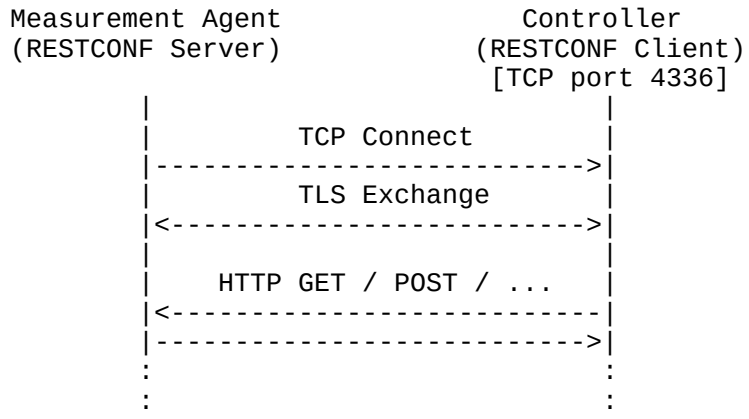

Figure 2: RESTCONF as Control Protocol (with Call Home)

Note that the Call Home mechanism only 'reverses' the way the underlying TCP connection is established. The subsequent TLS

exchange has the TLS server role on the RESTCONF server side and the TLS client role on the RESTCONF client side.

The YANG data model [I-D.ietf-lmap-yang], derived from the underlying information model [I-D.ietf-lmap-information-model], translates into a collection of RESTCONF resources that can be accessed and manipulated at various levels of granularity using HTTP GET, DELETE, PATCH, POST, and PUT methods.

An example exchange showing how a schedule object is installed on a Measurement Agent is shown in Appendix A.

[[CREF1: Move the example inline, update it to be aligned to the final YANG model and use JSON encoding.]]

4. RESTCONF as LMAP Report Protocol

The LMAP Report Protocol delivers Report(s) from a Measurement Agent to a Collector. The LMAP Report Protocol is realized by running a RESTCONF server on the Collector and a RESTCONF client on the Measurement Agent. Figure 3 depicts how the connection and the secure transport is established and how reports are delivered to the Controller. Note that it is generally assumed that the Controller is directly reachable from the Measurement Agent. (In situations where this may not be true, RESTCONF Call Home can be used as well but this is not shown here.)

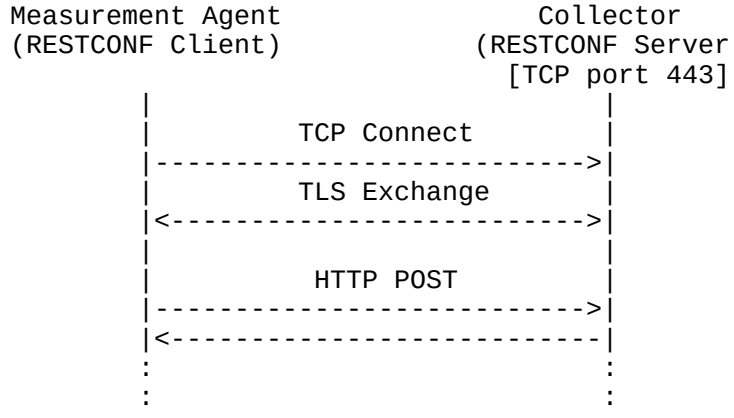

Figure 3: RESTCONF as Report Protocol

Note that the Measurement Agent pushes results to the Collector by invoking an operation on the Controller. This maps to an HTTP POST

in RESTCONF. Hence, pushing results can effectively be done by posting a the result to a specific RESTCONF resource.

An example exchange showing how results are reported to a Controller is shown in Appendix B.

[[CREF2: Move the example inline, update it to be aligned to the final YANG model and use JSON encoding.]]

5. RESTCONF Configuration for LMAP

[[CREF3: This section could explain how an LMAP implementation needs to be configured to make use of the Call Home mechanism and how report tasks refer to the configuration (if any standardized) needed to obtain the necessary credentials to report results. Is this necessary are can we simply refer to the I-Ds that have the details? Note that these I-Ds are not stable yet.]]

6. Security Considerations

Security and privacy aspects of the LMAP framework are discussed in Sections 7 and 8 of [RFC7594]. Section 12 of [RFC8040] and Section 5 of [RFC8071] discuss the security aspects of RESTCONF and the RESTCONF Call Home mechanism.

The security considerations specific to the LMAP information model and the YANG data model can be found in Section 6 of [I-D.ietf-lmap-information-model] and Section 5 of [I-D.ietf-lmap-yang].

7. IANA Considerations

This document has no requests for IANA.

8. Acknowledgements

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9. References

9.1. Normative References

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Burbridge, T., Eardley, P., Bagnulo, M., and J. Schoenwaelder, "Information Model for Large-Scale Measurement Platforms (LMAP)", draft-ietf-lmap-information-model-16 (work in progress), January 2017.

[I-D.ietf-lmap-yang]
Schoenwaelder, J. and V. Bajpai, "A YANG Data Model for LMAP Measurement Agents", draft-ietf-lmap-yang-10 (work in progress), January 2017.

[RFC7594] Eardley, P., Morton, A., Bagnulo, M., Burbridge, T., Aitken, P., and A. Akhter, "A Framework for Large-Scale Measurement of Broadband Performance (LMAP)", RFC 7594, DOI 10.17487/RFC7594, September 2015, <http://www.rfc-editor.org/info/rfc7594>.

[RFC8040] Bierman, A., Bjorklund, M., and K. Watsen, "RESTCONF Protocol", RFC 8040, DOI 10.17487/RFC8040, January 2017, <http://www.rfc-editor.org/info/rfc8040>.

[RFC8071] Watsen, K., "NETCONF Call Home and RESTCONF Call Home", RFC 8071, DOI 10.17487/RFC8071, February 2017, <http://www.rfc-editor.org/info/rfc8071>.

9.2. Informative References

[I-D.ietf-netconf-restconf-client-server]
Watsen, K. and J. Schoenwaelder, "RESTCONF Client and Server Models", draft-ietf-netconf-restconf-client-server-01 (work in progress), November 2016.

[RFC7230] Fielding, R., Ed. and J. Reschke, Ed., "Hypertext Transfer Protocol (HTTP/1.1): Message Syntax and Routing", RFC 7230, DOI 10.17487/RFC7230, June 2014, <http://www.rfc-editor.org/info/rfc7230>.

[RFC7950] Bjorklund, M., Ed., "The YANG 1.1 Data Modeling Language", RFC 7950, DOI 10.17487/RFC7950, August 2016, <http://www.rfc-editor.org/info/rfc7950>.

[RFC7951] Lhotka, L., "JSON Encoding of Data Modeled with YANG", RFC 7951, DOI 10.17487/RFC7951, August 2016, <http://www.rfc-editor.org/info/rfc7951>.

Appendix A. Example RESTCONF Control Protocol Exchange

Below is a YANG tree diagram of a part of the data model covering schedules. This is taken from [I-D.ietf-lmap-yang].

```
module: ietf-lmap-control
   +--rw lmap
      +--rw schedules
         +--rw schedule* [name]
            +--rw name      lmap:identifier
            +--rw event     event-ref
            +--rw execution-mode   enumeration
            +--rw action* [name]
               +--rw name           string
               +--rw task           task-ref
               +--rw option* [name]
               |  +--rw id          lmap:identifier
               |  +--rw name?       string
               |  +--rw value?      string
               +--rw destination*  leafref
```

Below is an XML representation of instance data conforming to the YANG data model is shown below. Note that some of the strings are references to other portions of the instance data not show here. This is again taken from [I-D.ietf-lmap-yang].

```
<lmap xmlns="urn:ietf:params:xml:ns:yang:ietf-lmap">
  <schedules>
    <schedule>
      <name>hourly-schedule</name>
      <event>hourly</event>
      <execution-mode>sequential</execution-mode>
      <action>
        <name>icmp-latency-hourly</name>
        <task>icmp-latency-measurement</task>
        <destination>daily</destination>
      </action>
    </schedule>
  </schedules>
</lmap>
```

Below is an example showing how RESTCONF can be used to create the above schedule. The prefix C: indicates the Controller, the prefix M: indicates the Measurement Agent. This example uses a JSON encoding (and note that much of the white-space can be removed, this is only there to help with readability).

```
C: POST /restconf/data/ietf-lmap-control:lmap/schedules HTTP/1.1
C: Host: example.com
C: Content-Type: application/yang.data+json
C:
C:   {
C:     "ietf-lmap-control:schedule": {
C:       "name": "hourly-schedule",
C:       "event": "hourly",
C:       "execution-mode": "sequential",
C:       "action": [
C:         {
C:           "name": "icmp-latency-hourly",
C:           "task": "icmp-latency-measurement",
C:           "destination": "daily",
C:         }
C:       ]
C:     }
C:   }

M: HTTP/1.1 201 Created
M: Date: Mon, 26 Mar 2015 17:01:00 GMT
M: Server: example-server
M: Location: https://example.com/restconf/data
M:           /ietf-lmap-control:lmap/schedules/schedule=hourly-schedule
M: Last-Modified: Mon, 26 Mar 2015 17:01:00 GMT
M: ETag: b3a3e673be2
```

Appendix B. Example RESTCONF Report Protocol Exchange

Below is an example showing how a Measurement Agent can submit results to a Collector running an RESTCONF server. The prefix C: indicates the Collector, the prefix M: indicates the Measurement Agent.

```
  M: POST /restconf/operations/ietf-lmap-report:report HTTP/1.1
  M: Host: example.com
  M: Content-Type: application/yang.operation+xml
  M:
  M: <input xmlns="urn:ietf:params:xml:ns:yang:ietf-lmap-report">
  M:   <date>2015-10-28T13:27:42+02:00</date>
  M:   <agent-id>550e8400-e29b-41d4-a716-446655440000</agent-id>
  M:   <group-id>wireless measurement at the north-pole</group-id>
  M:   <result>
  M:     <schedule-name>pinger</schedule-name>
  M:     <action-name>fping</action-name>
  M:     <task-name>fping</task-name>
  M:     <option>
```

```
M:       <id>display-address</id>
M:       <name>-A</name>
M:     </option>
M:     <option>
M:       <id>display-DNS-lookup</id>
M:       <name>-d</name>
M:     </option>
M:     <option>
M:       <id>number-of-packets</id>
M:       <name>-C</name>
M:       <value>5</value>
M:     </option>
M:     <option>
M:       <id>quiet</id>
M:       <name>-q</name>
M:     </option>
M:     <option>
M:       <id>www.example.org</id>
M:       <name>www.example.org</name>
M:     </option>
M:     <option>
M:       <id>mail.example.com</id>
M:       <name>mail.example.com</name>
M:     </option>
M:     <start>2016-03-21T10:48:55+01:00</start>
M:     <end>2016-03-21T10:48:57+01:00</end>
M:     <status>0</status>
M:     <table>
M:       <column>target</column>
M:       <column>ip</column>
M:       <column>rtt-1</column>
M:       <column>rtt-2</column>
M:       <column>rtt-3</column>
M:       <column>rtt-4</column>
M:       <column>rtt-5</column>
M:       <row>
M:         <value>www.example.org</value>
M:         <value>2001:db8::1</value>
M:         <value>14.15</value>
M:         <value>14.14</value>
M:         <value>14.09</value>
M:         <value>14.17</value>
M:         <value>14.51</value>
M:       </row>
M:       <row>
M:         <value>mail.example.org</value>
M:         <value>2001:db8::2</value>
M:         <value>12.24</value>
```

```
     M:         <value>11.99</value>
     M:         <value>12.49</value>
     M:         <value>11.87</value>
     M:         <value>12.45</value>
     M:       </row>
     M:     </table>
     M:   </result>
     M: </input>

     C: HTTP/1.1 200 OK
```

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