Time-series application design through OneEdge

Application Note

80654NT11932A Rev. 0 – 2021-09-30

APPLICABILITY TABLE

PRODUCTS	Platform Version ID
ME910C1-AU ME910C1-E1 ME910C1-E2 ME910C1-NA ME910C1-NV ME910C1-WW ML865C1-EA ML865C1-NA	30
ME910G1-W1 ME910G1-WW ME310G1-W1 ME310G1-WW ME310G1-W2 ML865G1-WW	37
LE910C1-EUX LE910C1-SAX LE910C1-SVX	25

CONTENTS

1. INTRODUCTION

1.1. Scope

This document describes the management of time-series data in OneEdge implementation.

The time-series data is a logical concept to represent a set of information during the time.

1.2. Audience

This document is intended for Telit OneEdge customers.

1.3. Contact Information, Support

For general contact, technical support services, technical questions and report of documentation errors contact Telit Technical Support at:

- *TS-EMEA@telit.com*
- *TS-AMERICAS@telit.com*
- *TS-APAC@telit.com*
- *TS-SRD@telit.com*
- *TS-ONEEDGE@telit.com*

Alternatively, use:

https://www.telit.com/contact-us/

For detailed information about where you can buy the Telit modules or for recommendations on accessories and components visit:

https://www.telit.com

Our aim is to make this guide as helpful as possible. Keep us informed of your comments and suggestions for improvements.

Telit appreciates the user feedback on our information.

1.4. Symbol Conventions

	**Danger:** This information MUST be followed or catastrophic equipment failure or personal injury may occur.
	**Warning:** Alerts the user on important steps about the module integration.
	**Note/Tip:** Provides advice and suggestions that may be useful when integrating the module.
	**Electro-static Discharge:** Notifies the user to take proper grounding precautions before handling the product.

Table 1: Symbol Conventions

All dates are in ISO 8601 format, that is YYYY-MM-DD.

1.5. Related Documents

- MExxxC1 HW User Guide: 1VV0301351
- MExxxC1 AT Command Reference Guide: 80529ST10815A
- MExxxC1 LwM2M AT commands User Reference Guide: 80529ST10974A
- MExxxG1 HW Design Guide: 1VV0301593
- MExxxG1 AT Command Reference Guide: 80617ST10991A
- MExxxG1 LwM2M AT commands Reference Guide: 80617ST11022A
- OMA Lightweight M2M Specification: OMA-TS-LightweightM2M-V1_0_2-20180209-A

2. OVERVIEW

This document describes the development of a OneEdge application according to the "time-series" use case.

It's highly recommended that the "OneEdge Getting started" guide is read and understood as precondition of this application note.

3. HIGH-LEVEL ARCHITECTURE

The main actors include in the OneEdge application are described in the fig.2

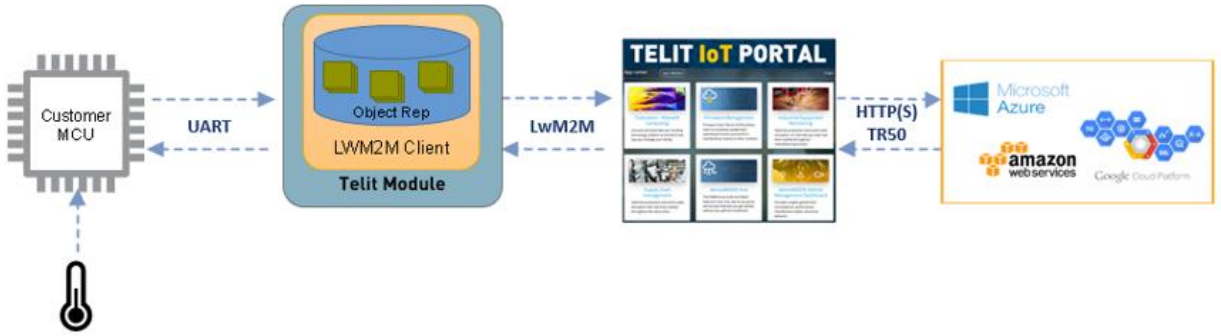

Figure 1: "hosted" high-level architecture

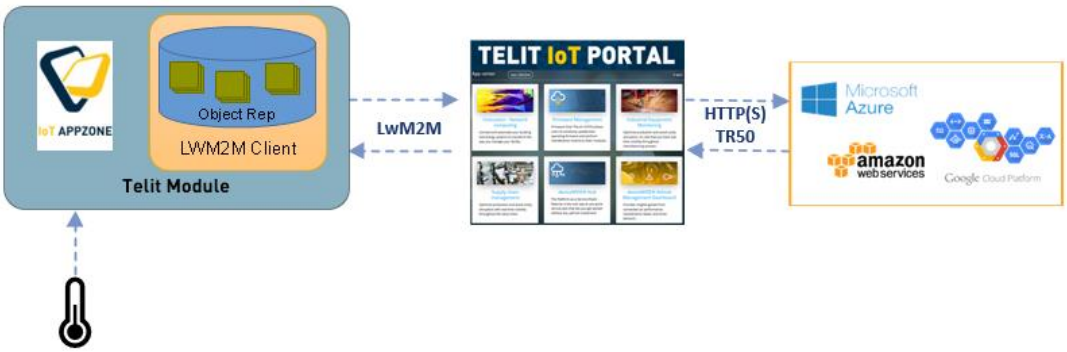

Figure 2: "hostless" high-level architecture

3.1. Customer MCU or AppZone

The "Customer MCU" is the microprocessor that manages the logic of the customer application, described in Figure 1.

Figure 2 shows an alternative architecture, in which the "Customer MCU" is replaced by an AppZone application running into the Telit Module, which performs the same actions and logics of the "Customer MCU".

Please refer to ts-emea@telit.com for more details about AppZone, which it is not a scope of this application note.

In both cases, the application logics is in charge to the customer, based on the real application scenario.

3.2. Telit module

The Telit module is a cellular modem with a LwM2M client built-in in the software.

The LwM2M client is responsible to communicate with the LwM2M server through the LwM2M protocol.

When customer application is running on external MCU, it communicates with the Telit modem through AT command on the serial port.

On the other hand, when the AppZone is utilized, the customer application runs inside the Telit module and normally uses internal APIs to communicate with the main modem firmware.

3.3. Telit OneEdge IoT portal

The Telit OneEdge IoT portal is a web-based portal with "Device Management" capabilities and with a LwM2M server integrated.

Across the OneEdge service, the Telit OneEdge IoT portal is responsible to provide a high-level representation of the devices and to show their data in a human-oriented view.

Furthermore, the Telit OneEdge IoT portal can interact with external Third-party services like Microsoft Azure, Amazon AWS, Google Cloud Platform and generic HTTP/HTTPS services through easy connectors and TR50 interface.

3.4. External Third-party services

The Telit OneEdge IoT portal integrates some functionalities to push data to external clouds, for example Microsoft Azure or Amazon AWS.

Furthermore, TR50 interface on the Telit OneEdge IoT portal can be used to pull data or execute generic actions on the portal.

4. TIME-SERIES DEFINITION

Since historical data is relevant only if sampling data sets are linked to specific timestamps, the sampling date information must be added to the sample set values.

A sampling set contains multiple sensor data, collected at the same timestamp.

To represent multiple sampling data sets all together, a custom binary protocol can be defined, appending the sample sets information to an opaque buffer to be managed by the host application.

The precondition for this "fixed length" binary protocol is that the size of every sensor content has to be defined at the beginning of the application design and cannot change during the life of the application.

Below is an example of a sampling set related to N generic sensors:

Timestamp (4B)=0xAAAAAAAA

Sensor1 (size1)=0xBB…BB

Sensor2 (size2)=0xCC…CC

…

SensorN (sizeN)=0xDD…DD

Please note that size1, size2, sizeN can be different.

According to this constrain, the generic sample set has a fixed length, which is the sum of the sizes of all the sensors and the timestamp (fixed to 4 bytes):

$$Sample\_set\_size = 4B + size1 + size2 + \ldots + sizeN$$

The representation of a sample set is below:

AAAAAAAABB…BBCC…CC…DD…DD

The buffer could be a memory zone allocated by the host application and filled with multiple sample sets according to periodic sampling frequency: every time a new sample set is available on host application, it has to be appended to the buffer by the host application.

At specific times, for example at the end of the day, the host application must send the content of the buffer to OneEdge IoT portal.

5. TIME-SERIES IN ONEEDGE

Following the previous description, the best approach with OneEdge for time-series is the opaque resource.

The "Uplink" opaque resource of custom "Telit Application Data" object, available as default into the LwM2M client, can be used to contain the opaque buffer.

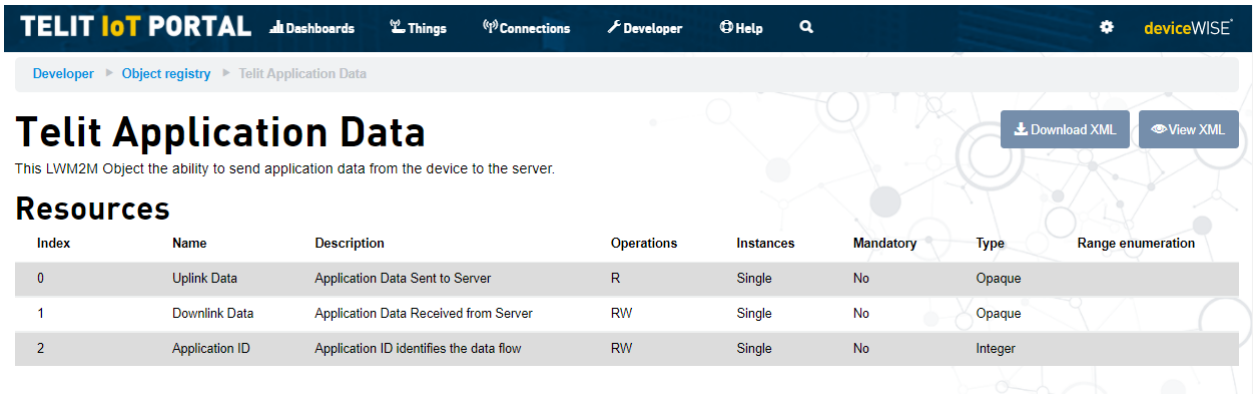

Figure 3: Telit proprietary "Telit Application Data" object

Since the opaque resources in Telit LwM2M client are limited to 1024 bytes, only a limited number of sample sets can fit an opaque resource.

Considering Y as the size of a single sample set, the example below shows M sample sets into an opaque resource:

1 ... Y	Y+1 ... 2Y	2Y+1 ... 3Y				1024
Sample set1	Sample set2	Sample set3	...	...	...	Sample setM

Table 2: multiple sample sets into an opaque resource

Through an observation configured on "Uplink" resource of custom "Telit Application Data" object, every time the host application writes a new content on the resource, the LwM2M client sends a notify message to the LwM2M server (OneEdge IoT portal) with the new value.

If the buffer content exceeds the maximum resource size (1024 bytes), the host application has to split the buffer in multiple parts to be sent separately on the same LwM2M resource.

For example, the diagram below shows the flow to send a long buffer content splitting it in multiple opaque resource sendings.

Buffer longer than opaque resource size (1024 bytes)

1 ... 1024	1025 ... 2048	2049 ... 3072	...
Part1	Part2	Part3	...

Table 3: long buffer split into more parts of 1024 bytes

High level actions:

Send Part1

Wait for ACK of Part1 sending:

Send Part2:

Wait for ACK of Part2 sending:

Send Part3:

Wait for ACK of Part3 sending:

...

Send PartX:

Wait for ACK of PartX sending:

Note that the last part could be partially filled (less than 1024 bytes).

6. TIME-SERIES USE CASE EXAMPLE: METERING DEVICE

In this chapter a metering device use case will be exposed.

The meter design application will be described and finally also the step-by-step procedure will be provided to evaluate the application behavior.

6.1. Data flow diagram

The image below shows the flow of AT commands, LwM2M messages and events across the actors involved in the metering use case.

The vertical arrows indicate the time, starting from the top to the bottom.

All the four features are represented: the registration phase which is a one-time action, the time-series data sending from the device to the OneEdge IoT portal, the data gathering from an external application and the on-demand remote setting from the OneEdge IoT portal to the device.

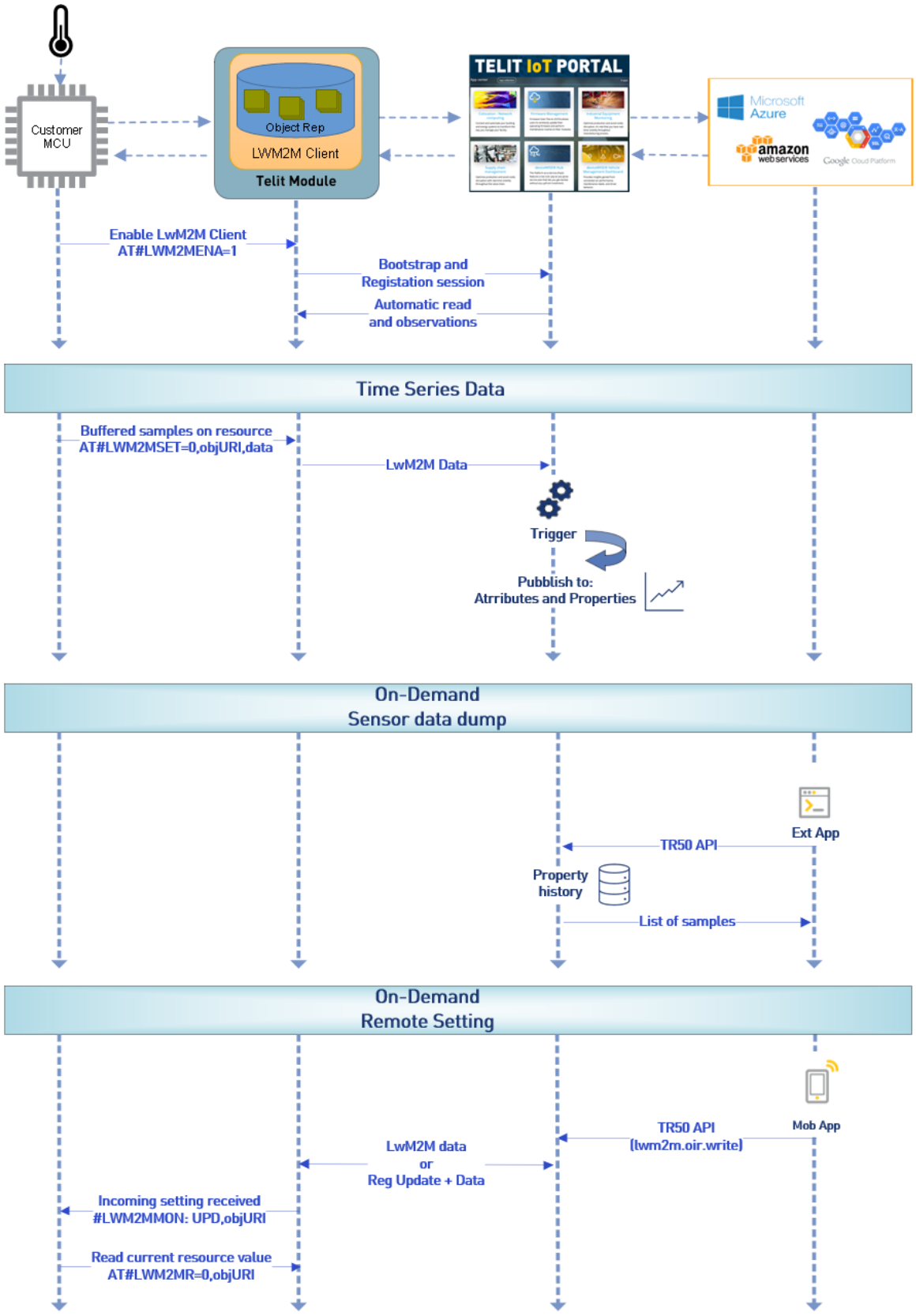

Figure 4: data flow diagram

6.2. Meter data requirements

A metering device is typically a system with several sensors connected to the main CPU. The general logic reads the sensors data and send it to a server at specific frequency.

Below are some typical requirements and features:

a) [REQ #1] The device is main powered;

Device to Portal direction:

a) [REQ #2] The device exports the following information to the OneEdge IoT portal;
    a. Meter Serial Number (String), i.e. "AB123CD";
    b. Meter FW version (String), i.e. "1.2";

b) [REQ #3] The device exports the following sensor values to the OneEdge IoT portal;
    a. Temperature (float): the temperature value as °Celsius;
    b. Humidity (integer), i.e. the humidity value as %RH;
    c. Pressure (integer), i.e. the value of the air pressure as mbar;
    d. Engine rotations (integer);
    e. Event Counter (integer);

b) [REQ #4] The sampling of all the sensors is performed on host application at specific frequency that can be remotely configured and the sample values are stored into the host application; default sampling rate is 1 hour;

c) [REQ #5] The device sends the historical collection of all stored sensor samples with timestamps to the OneEdge IoT portal at specific times that can be remotely configured; default sending rate is 1 day;

Portal to device direction:

d) [REQ #6] On-demand, the User configures remotely following parameters of the host application:
    a. Sampling rate (integer), the number of seconds between the samplings;
    b. Sending rate (integer), the number of seconds between the sendings;

Portal view:

e) [REQ #7] "static" information are reported to the OneEdge IoT portal on attributes;

f) [REQ #8] the values of the samples are plotted on charts on the OneEdge IoT portal;

Portal to Third party:

g) [REQ #9] On-demand, an external application (i.e., a scheduled script on AWS, mobile app) retrieves a set of sensors samples from the OneEdge IoT portal related to a specific time window;

Device management:

h) [REQ #10] device and connectivity parameters related to Telit module are reported on OneEdge IoT portal every 12 hours;

6.2.1. Mapping of the requirements on OneEdge environment

Table 4 reports the mapping of the customer requirements of the OneEdge features:

Req	Brief description	Section of data model involved	Paragraph
[REQ #1]	Main powered	Device profile, lifetime	6.4.2
[REQ #2]	Device to portal: static info	LwM2M custom object	6.3.1, 6.4.2
[REQ #3]	Device to portal: sensor values	LwM2M custom object	6.3.3
[REQ #4]	Sampling at specific frequency	LwM2M custom object	6.3.3
[REQ #5]	Sending of historical data at specific times	LwM2M custom object	6.3.3
[REQ #6]	Portal to device: configuration parameters	LwM2M custom object	6.3.2
[REQ #7]	Portal view: attributes	Thing definition, binding on Device profile	6.4.1
[REQ #8]	Portal view: charts/properties	Thing definition, trigger	6.4.1, 6.4.3
[REQ #9]	Portal third party: retrieving historical data	TR50 interface	6.4.4
[REQ #10]	Device Management	Device profile	6.3.4

Table 4: mapping of the requirements on the OneEdge features

6.3. Meter LwM2M data model

The Figure 5 shows the LwM2M objects involved in the proposed data model. All the 3 objects are described in next paragraphs.

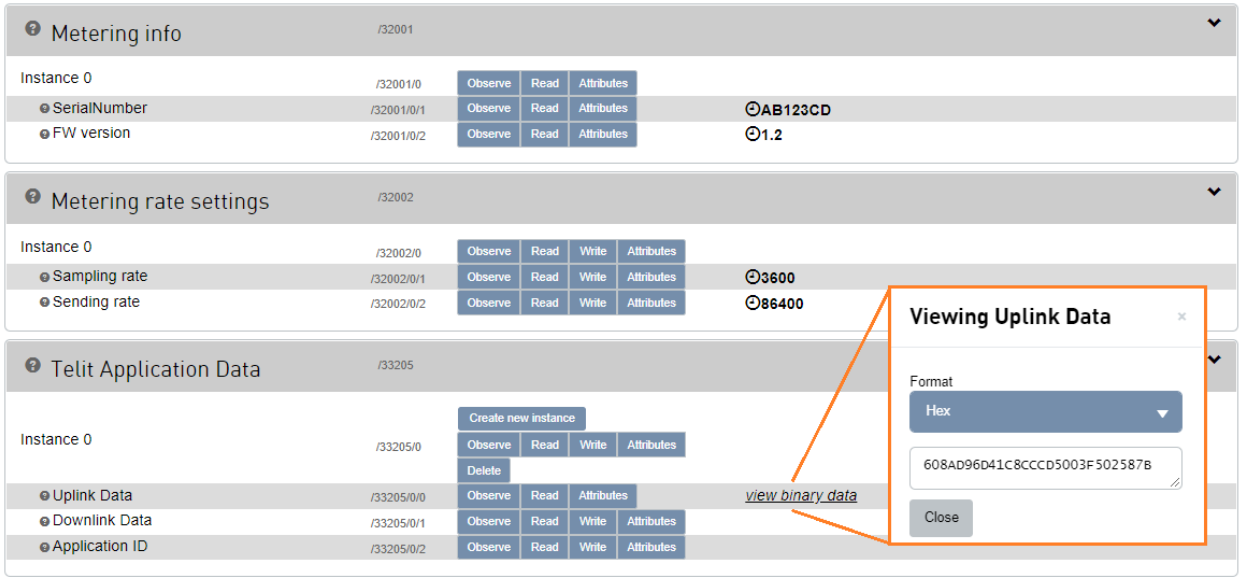

Figure 5: view of all objects involved in this data model

6.3.1. Custom "Metering info" object

According to requirement [REQ #2], the static information related to the metering device to be sent from the remote device to the OneEdge IoT portal are mapped into the custom LwM2M "Metering info" object.

The structure of this object is showed in Figure 6:

Metering info

This LWM2M custom object manages the basic info a metering application

Download XML | View XML | Unregister

Resources

Index	Name	Description	Operations	Instances	Mandatory	Type	Range enumeration
1	Meter SerialNumber	the Serial Number of the meter; i.e. 'AB123CD'	R	Single	Yes	String	
2	Meter FW version	the FW version of the meter; i.e. '1.2'	R	Single	Yes	String	

Figure 6: custom "Metering info" object structure as showed on OneEdge IoT portal – object registry section

6.3.2. Custom "Metering rate settings" object

According to requirement [REQ #6], the information to be sent from the OneEdge IoT portal to the metering device are mapped into the custom LwM2M "Metering rate settings" object.

Figure 7 shows the structure of this object:

Metering rate settings

This LWM2M custom object manages the configuration of typical rates of a metering application

Download XML | View XML | Unregister

Resources

Index	Name	Description	Operations	Instances	Mandatory	Type	Range enumeration
1	Sampling rate	Sampling rate in seconds; i.e., if set to 3600, samples are retrieved every 3600 seconds (1 hour)	RW	Single	Yes	Integer	
2	Sending rate	Sending rate in seconds; i.e., if set to 86400, samples are retrieved every 86400 seconds (1 day)	RW	Single	Yes	Integer	

Figure 7: custom "Metering rate settings" object as showed on object registry section of OneEdge IoT portal

6.3.3. Proprietary "Telit Application data" object

According to requirements [REQ #3] and [REQ #5] and the concepts described in "Time-series in OneEdge" (chapter 5), the sensor values are managed as a binary content into a buffer on host application.

The sensors of the "meter data" example application can be managed in the following way:

a) The timestamp in Unix Epoch time (number of seconds from year 1970) can be addressed by 4 bytes;

b) float value of temperature can be addressed through 4 bytes as floating-point format;

c) humidity range is a percentage so the range 0-100 can be addressed within 1 byte;

d) pressure as integer value can be addressed by 2 bytes;

e) the number of engine revolutions per minute can fit into 2 bytes, assuming max value as 65535.

f) The Event counter can be addressed by 1 byte, assuming maximum value as 255.

The current timestamp in Unix Epoch format can be retrieved reading the value of resource 3/0/13.

Below is an example of sampling set with dummy values:

Timestamp (4B)=2021/04/29 16:06:05 UTC=1619712365=0x608AD96D

Temperature (4B)=25.1 °C=0x41C8CCCD

Humidity (1B)=80% RH=0x50

Pressure (2B)=1013 mbar=0x03F5

Engine rotations (2B)=600=0x0258

Event counter (1B)=123=0x7B

The opaque buffer to send the sampling set with the dummy values is:

608AD96D41C8CCCD5003F502587B

The amount of data for a sampling set of the 5 sensors including the timestamp is 4 + 4 + 1 + 2 + 2 + 1 = 14 Bytes, so, since an opaque LwM2M resource contains up to 1024 bytes, the opaque buffer can contain up to 72 sampling sets.

Representation of 72 sample sets inside the same opaque resource at maximum capacity:

<time1>xx…xxxxxxxxxxxxxx<time2>xx…xxxxxxxxxxxxxx……<time72>xx…xxxxxxxxxxxxxx…

The opaque buffer can be managed by the "Uplink" resource of custom "Telit Application Data" object, available as default into the LwM2M client:

Figure 8: proprietary "Telit Application Data" object

According to requirement [REQ #4], the host application has to retrieve and append the sample sets into the buffer on host application once per hour; every 24 hours (requirement [REQ #5]) the host sends the data to the OneEdge IoT portal writing the buffer content on the Uplink resource. If the size of the buffer exceeds the maximum size of the opaque resource which is 1024 bytes, the host application has to split the buffer in multiple sendings.

6.3.4. Device Management feature

Furthermore, referring to requirement [REQ #10], modem and connectivity information are available into standard "Device" and "Connectivity Monitoring" objects. These objects can be read by the OneEdge IoT portal at registration and registration update events.

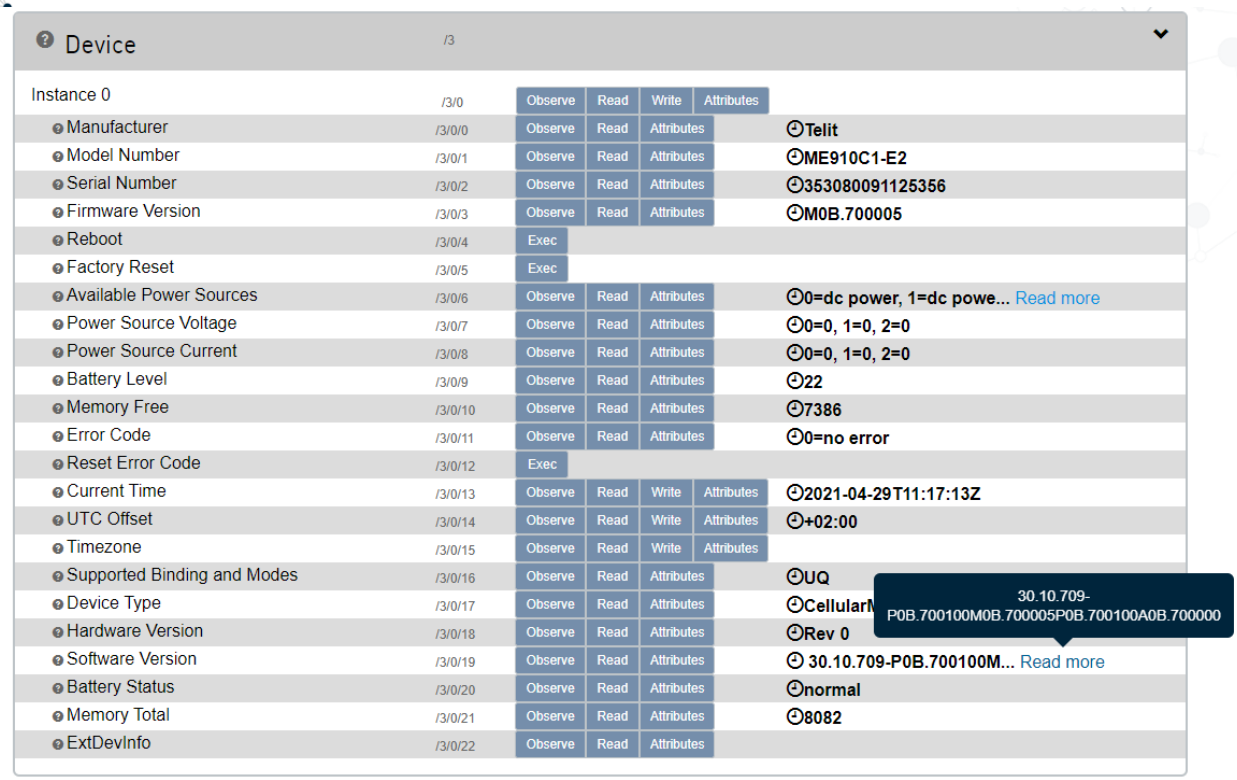

Figure 9: standard "Device" object with values as reported internally by the LwM2M client

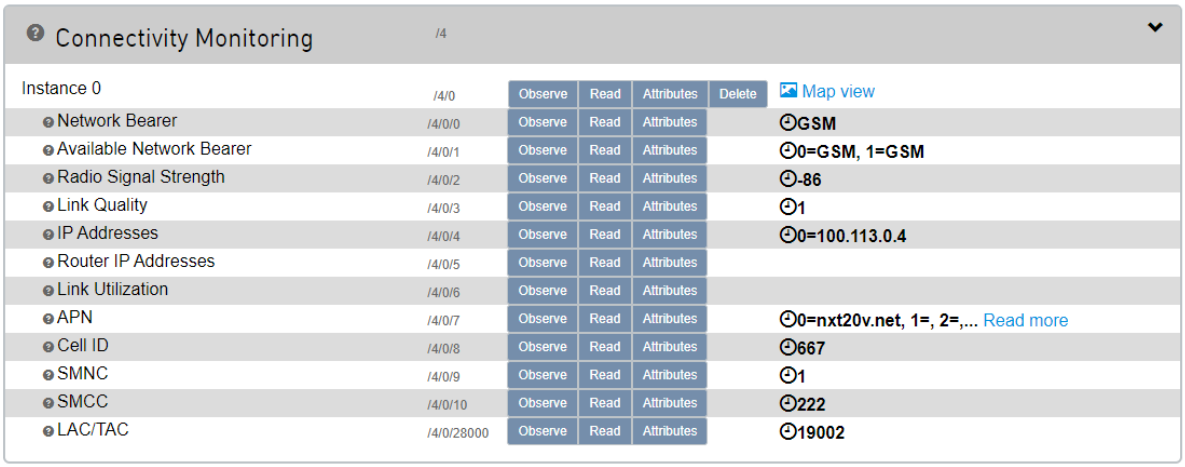

Figure 10: view of the standard "Connectivity Monitoring" object with some example values

6.4. OneEdge IoT portal configuration

6.4.1. Thing definition

According to requirement [REQ #7], attributes are created to contain the resources of "Metering info" object and some information related to the metering device.

According to requirement [REQ #8], a property for every sensor is created on the thing definition of the OneEdge IoT portal.

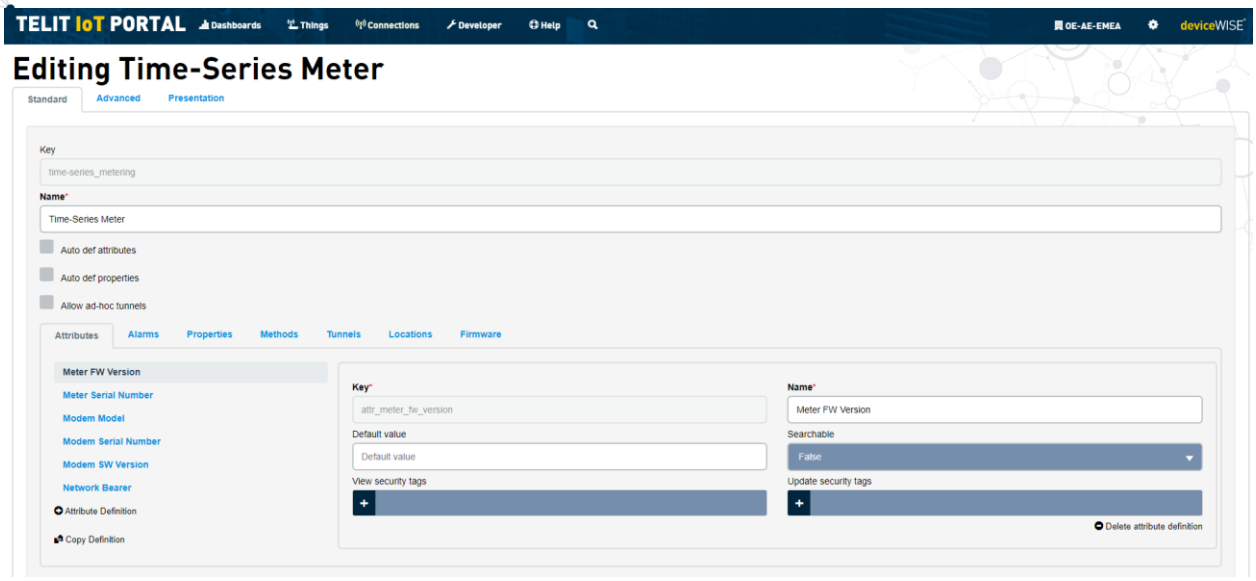

Figure 11: attribute list on "Time-Series Meter" thing definition

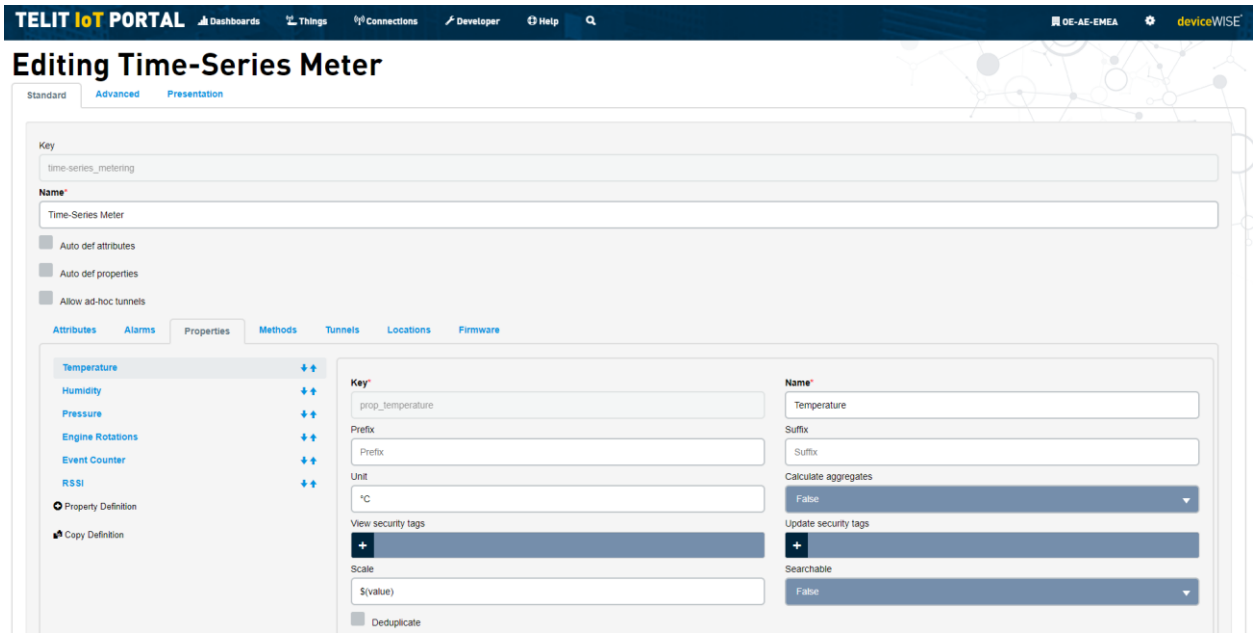

Figure 12: property list on "Time-Series Meter" thing definition

6.4.2. LwM2M device profile

According to the requirement [REQ #1], since the device is main powered, it can be kept supplied 24/24h and 7/7day: in this condition, the LwM2M client is enabled once the device is powered ON and left enabled as long as the device is running. This means that the LwM2M client performs just one full LwM2M registration in the life (and anytime the LwM2M client is enabled again).

The LwM2M lifetime can be used to configure periodic actions between LwM2M client and server, for example, according to Device Management feature (requirement [REQ #10),

the portal is configured to read "Connectivity Monitoring" object every 12 hours setting lifetime as 43200 seconds.

The LwM2M device profile is customized as below:

a) Lifetime = 43200 seconds (12 hours)

b) READ "Connectivity Monitoring" object at every registration update;

Furthermore, according to requirement [REQ #2], the static information of the device are reported to the OneEdge IoT portal (once for every LwM2M registration) configuring the device profile with following settings:

a) READ "Metering info" object at full LwM2M registration;

According to requirement [REQ #5], the LwM2M profile has to be configured to perform the following actions:

a) OBSERVE on "Uplink" resource of "Telit Application Data" object: in this way, every time the values changes on the LwM2M client, the values are automatically sent to the portal;

The metering info are published on attributes through bindings on LwM2M device profile.

The image below shows the summary of all the device profile configurations such that the LwM2M server performs automatic actions and the OneEdge IoT portal links some LwM2M resource values to some attributes and properties.

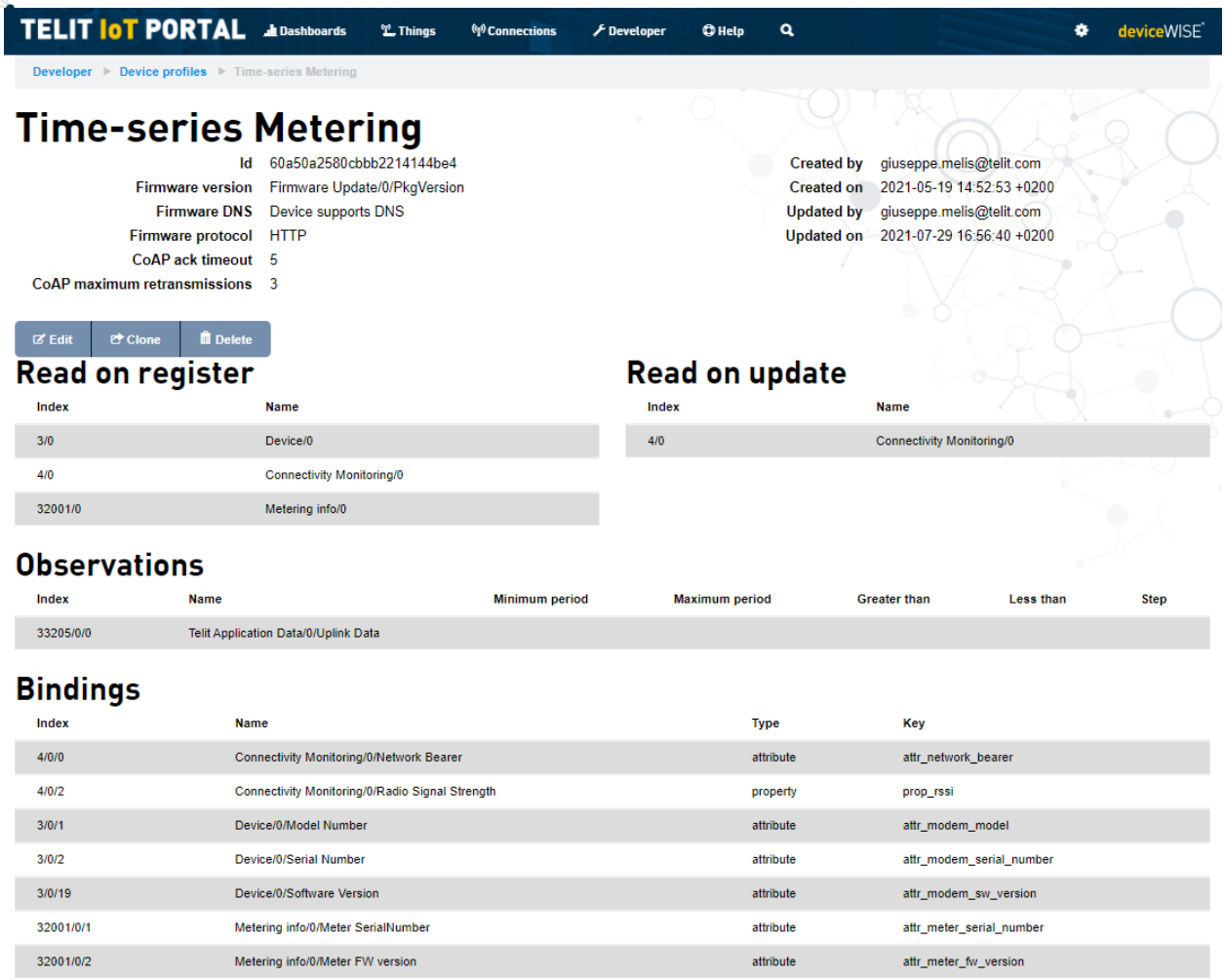

Figure 13: summary of "Time-series Metering" device profile configuration

6.4.3. Triggers

According to requirement [REQ #8], the opaque buffer into the "Uplink" resource of "Telit Application Data" object is consumed by the trigger "Time-series sensors from opaque buffer to properties" on the OneEdge IoT Portal to extract the single sampling values and publish them to property charts.

The image below shows the flow of the trigger.

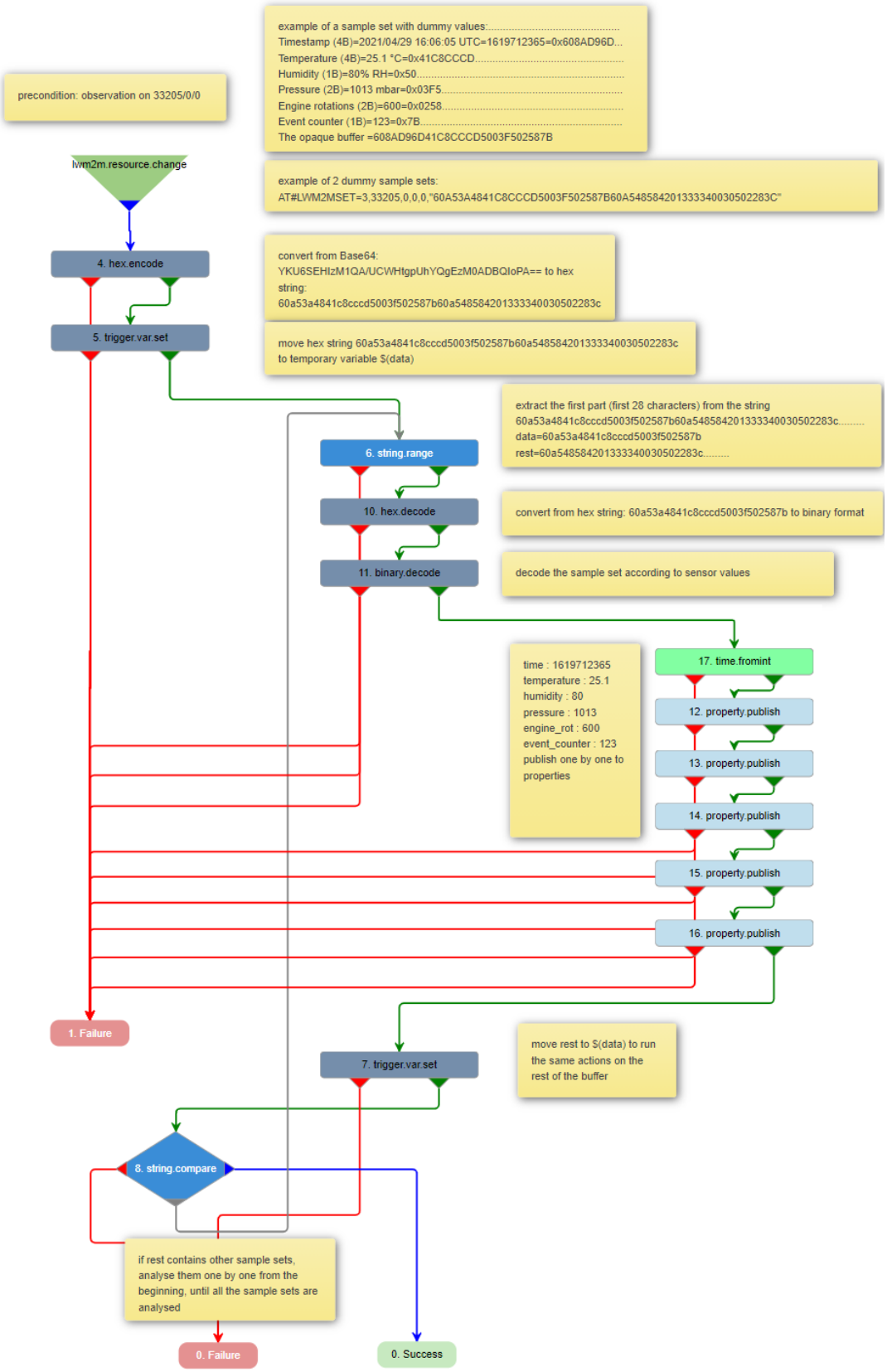

Figure 14: trigger flow to extract sensor values from the opaque buffer and publish them on the properties

6.4.4. TR50 interface for external applications

According to requirement [REQ #6], *lwm2m.device.oir.write* API is available at OneEdge IoT portal side to let the User application to send the remote settings to the remote device.

Below is an example to write the value 1800 to "sampling rate" resource (resource ID is 1) of "Metering rate settings" object (object ID is 32002) from an external application:

```
{
    "1": {
        "command": "lwm2m.device.oir.write",
        "params": {
            "thingId": "604f7ac680cbbb4c0cf34467",
            "objId": 32002,
            "instId": 0,
            "resId": "1",
            "encoding": 11542,
            "data": "1800"
        }
    }
}
```

According to requirement [REQ #9], the property.history and export.collection.dump APIs can be called by an external application to retrieve the sample values into a specific time window.

References:

https://docs.devicewise.com/Content/Products/IoT_Portal_API_Reference_Guide/APIs/Property/property.history.htm

https://docs.devicewise.com/Content/Products/IoT_Portal_API_Reference_Guide/APIs/Export/export.collection.dump.htm

Example to retrieve the list of the temperature values of last day from an external application:

```
Request
{
    "1": {
        "command": "property.history",
```

```
        "params": {
            "thingKey": "ep_353080091125356",
            "key": "prop_temperature",
            "start": "2021-05-21T00:00:00Z",
            "end": "2021-05-21T23:59:59Z"
        }
    }
}
Response
{
    "1": {
        "success": true,
        "params": {
            "values": [
                {"value": 32.299999, "ts": "2021-05-21T14:06:30Z"},
                {"value": 25.100000, "ts": "2021-05-21T14:08:30Z"},
                {"value": 39.599998, "ts": "2021-05-21T14:10:30Z"},
                {"value": 42.299999, "ts": "2021-05-21T14:12:30Z"}
            ]
        }
    }
}
```


6.5. Step by step simulation setup

In following paragraphs, all steps to simulate the time-series use case are described in both cases of hosted and hostless architecture.

6.5.1. Pre-requisites and one-time configuration:

The following 6 steps are needed as precondition for both the architectures.

a) Materials (device, cables, SIM card, etc) and procedures according to OneEdge Getting started document;

b) download the 3 files from the following link:

https://github.com/telit/oneedge-projects-resources/tree/feature/initial-time-series/use-cases/time-series/OE_Portal_configuration;

c) "Time-series Metering" device profile: import the file "time-series_dev_profile.json" on section "Developer → Device profiles" of OneEdge IoT portal;

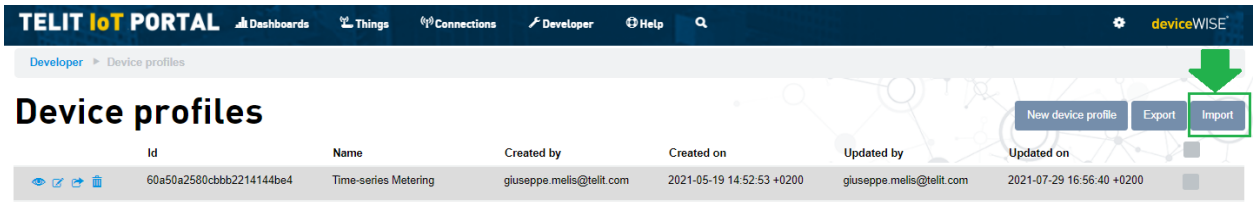

Figure 15: "Device profiles" section with "Import" button in detail

d) "Time-series Meter" thing definition: import the file "time-series_thing_def.json" on section "Developer → Thing definitions" profiles of OneEdge IoT portal;

Figure 16: "Thing definitions" section with "Import" button in detail

e) On "Things" section of the OneEdge IoT portal:

- identify your device through the IMEI code
- configure "Time-series Meter" thing definition (Figure 17)
- configure "Time-series Metering" device profile (Figure 18)

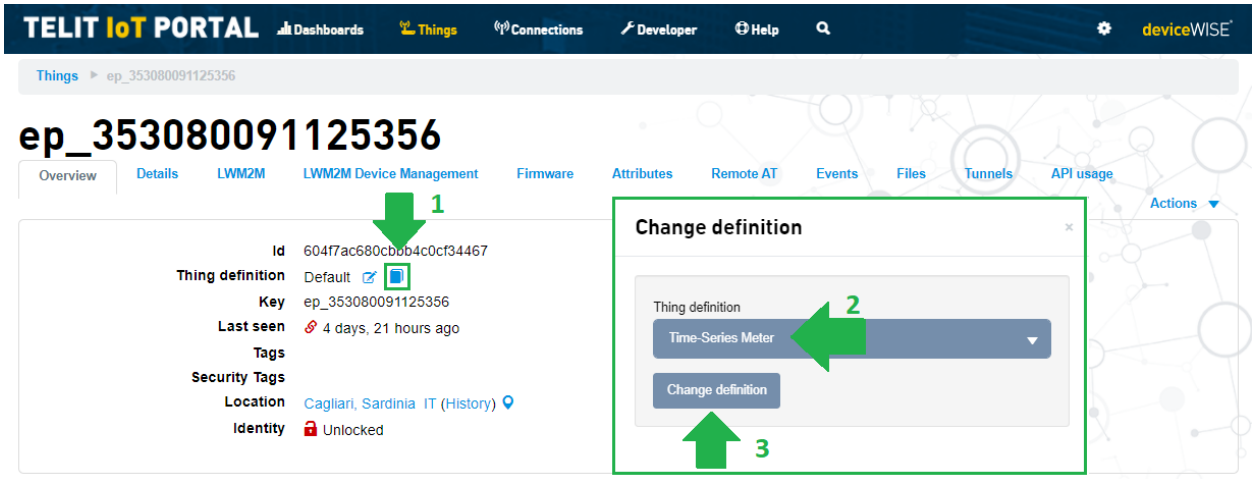

Figure 17: "Change definition" button on thing "Overview" tab

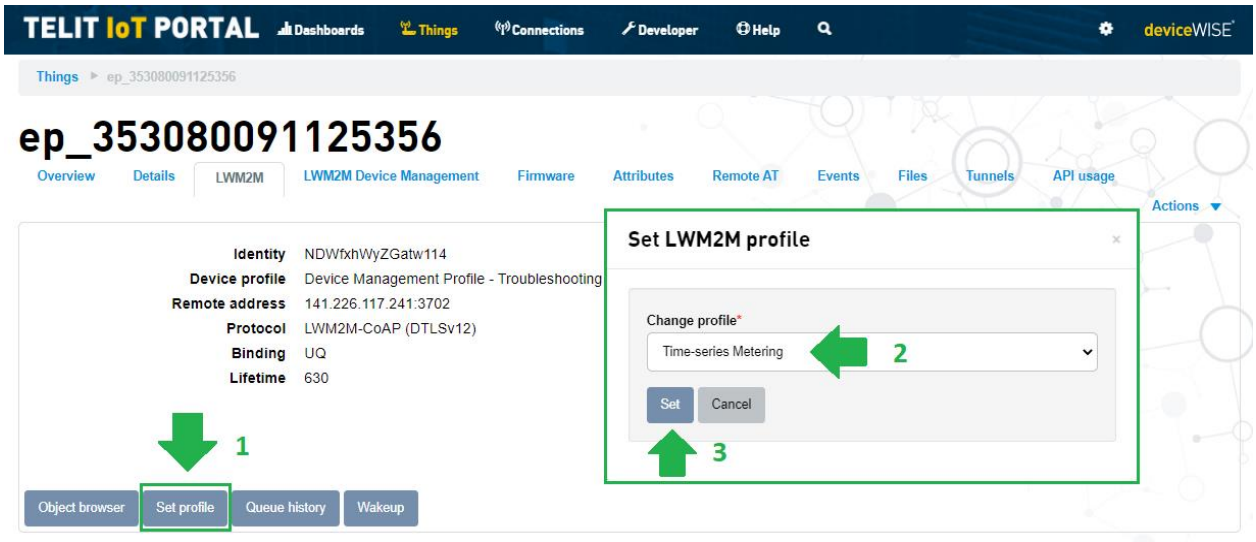

Figure 18:"Set profile" button on thing "LwM2M" tab

f) Custom object files: add the files "object_32001.xml" and "object_32002.xml" on section "Developer → Object registry" of OneEdge IoT portal;

For each XML file, the following 2 steps must be performed:

- Press "New object" button to open the edit box popup
- Copy the content of the XML file and paste it on the edit popup

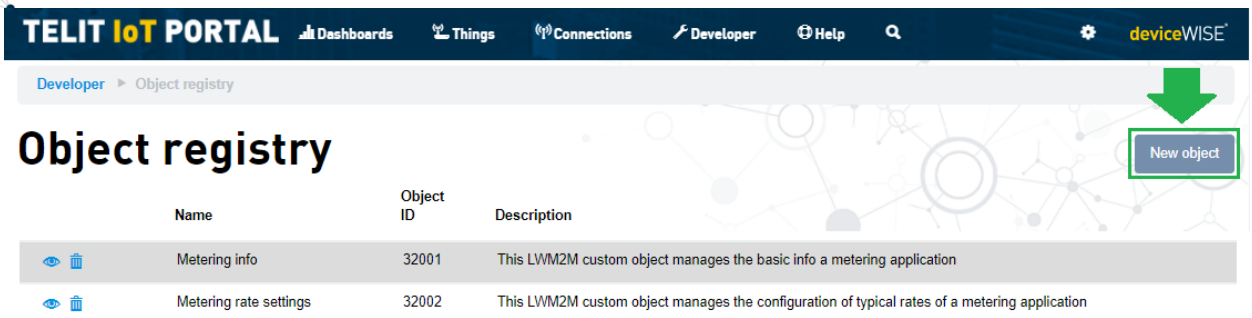

Figure 17: "Object registry" section with "Import" button in detail

g) "Time-series sensors from opaque buffer to properties" trigger: import the file "time-series_trigger.json" on section "Developer → Triggers" of OneEdge IoT portal (action 1 in the Figure 20); then it has to be started (action 2 in the Figure 20);

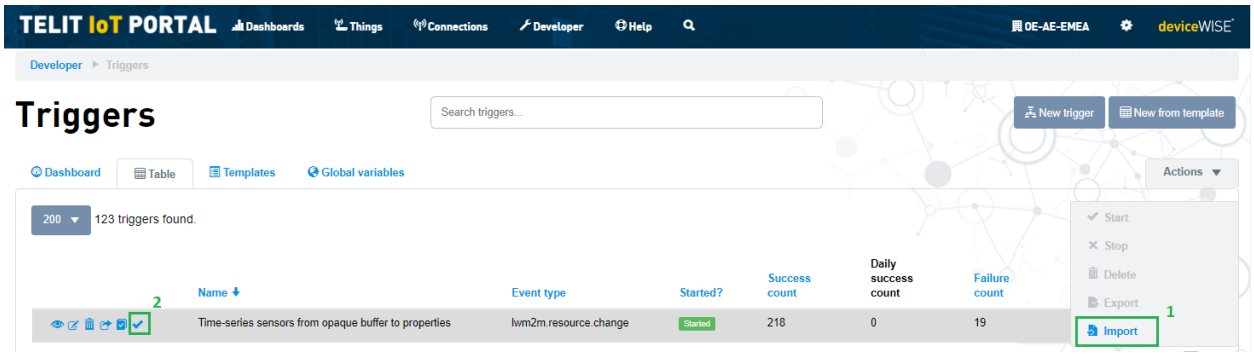

Figure 20: "Triggers" section with "Import" and "Start" butons in detail

6.5.2. Hosted architecture: AT commands simulation

This paragraph describes the specific steps involved in a hosted architecture: the host application is responsible to send the AT commands and manage URC received on the serial port.

6.5.2.1. Setup of the "Time-series metering" application

This section is to setup the LwM2M client with all the preconditions.

The following 7 steps are not needed if the device has already been configured and at next power up the procedure could be skipped to paragraph 6.5.2.2.

1) On IoT portal, configure the thing under test with the "Time-series Metering" device profile and the "Time-series Meter" thing definition;
2) Load XML files into the device:

```
AT#M2MWRITE="/XML/object_32001.xml",2272
```

```
>>>
OK
AT#M2MWRITE="/XML/object_32002.xml",2365
>>>
OK
```

3) Reset the LwM2M client and reboot the device

```
AT#LWM2MSTS=0,999,"coaps://bs.telit.io",1
OK
AT#REBOOT
OK
```

4) Enable the LwM2M client and wait for registration to the IoT portal

```
AT#LWM2MW=0,33211,0,0,1,1
OK
AT#LWM2MENA=1
OK
LWM2M-TLT:"BOOTSTRAPPING",SSID=0,"coaps://bs.telit.io"
LWM2M-TLT:"BOOTSTRAPPED",SSID=0,"coaps://bs.telit.io"
LWM2M-TLT:"REGISTERING",SSID=99,"coaps://api-dev.devicewise.com"
LWM2M-TLT:"REGISTERED",SSID=99,"coaps://api-dev.devicewise.com"

AT#LWM2MW=0,33211,0,0,1,1
OK
```

5) Create the instances of the custom objects

```
AT#LWM2MNEWINST=0,32001,0
OK
AT#LWM2MNEWINST=0,32002,0
OK
```

6) At host application, configure Meter on object “Metering info”

```
AT#LWM2MSET=2,32001,0,1,0,"AB123CD"
OK
AT#LWM2MSET=2,32001,0,2,0,"1.2"
OK
```

7) Restart the LwM2M client to allow the observation to be correctly set

```
AT#LWM2MENA=0
OK
LWM2M-TLT:"DEREGISTERING",SSID=99,"coaps://api-dev.devicewise.com"
LWM2M-TLT:"DEREGISTERED",SSID=99,"coaps://api-dev.devicewise.com"
LWM2M-TLT:"CLIENT_DISABLED"
```

6.5.2.2. Startup of the metering host application

8) Start the LwM2M client

```
AT#LWM2MENA=1
OK
LWM2M-TLT:"REGISTERING",SSID=99,"coaps://api-dev.devicewise.com"
LWM2M-TLT:"REGISTERED",SSID=99,"coaps://api-dev.devicewise.com"
```

9) After the registration, some automatic actions are performed according to the “Time-series Metering” device profile (section 6.4.2): READ “Metering info” object and OBSERVE “Uplink” resource of “Telit Application Data” object. The “Metering

info" are showed as attributes on the specific thing space on the portal (Thing → Table → IMEI → view)

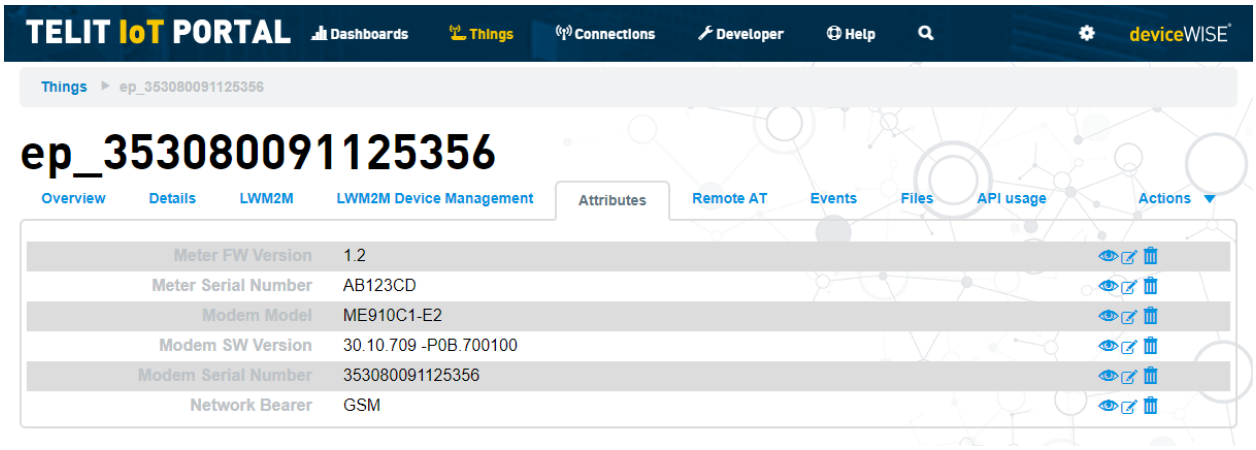

Figure 21: attribute view on thing space

10) Configure ACK Notify service on the LwM2M client to receive URC on host application when the notifies are received on the OneEdge IoT portal

```
AT#LWM2MNFYACKURI=0,1,33205,0,0
OK
AT#LWM2MNFYACKENA=0,1
OK
```

11) Configure monitoring service on the LwM2M client to receive URC on host application when a remote setting is received on the LwM2M client

```
AT#LWM2MMON=1,32002
OK
```

6.5.2.3. Sampling loop

12) At host application side, assign a dummy value for each sensor to simulate a sampling set; currentTime resource (3/0/13) can be used as sample timestamp (Epoch Unix).

```
AT#LWM2MR=0,3,0,13,0
#LWM2MR: 1619712365
OK

Timestamp=1619712365
Temperature=25.1
Humidity=80
Pressure=1013
Engine_rotations=600
Event_counter=123
```

13) Convert the values at step12 into hexadecimal format according to the size of the customer binary protocol and append them to a buffer on the host application.

Integer values must be converted as hexadecimal format according to the size defined in the fixed-length binary protocol in section 6.3.3.

Float values must be represented as floating-point format as 4 bytes in hexadecimal format.

```
Timestamp=608AD96D
Temperature=41C8CCCD
Humidity=50
Pressure=03F5
Engine_rotations=0258
Event_counter=7B
Host application buffer=608AD96D41C8CCCD5003F502587B
```

14) According to current sampling rate (1 hour as default), the host application repeats steps 12 and 13, appending a sample set as hexadecimal format on the host application buffer at every cycle

```
Host application buffer= <sample_set_N> + <sample_set_N+1> + ...
```

6.5.2.4. Sending loop

15) According to current sending rate (24 hour as default), the host writes current buffer content into "Uplink" resource of "Telit Application Data" object. Since the device profile configured an observation on the "Uplink" resource, the LwM2M client sends a LwM2M notify message to the OneEdge IoT portal.

```
AT#LWM2MSET=3,33205,0,0,0,"608AD96D41C8CCCD5003F502587B<other_sample_sets>"
OK
```

The "#LWM2MNFYACK" URC message is sent to the serial port to inform the host application that the LwM2M notify message has been correctly received by the OneEdge IoT portal.

```
#LWM2MNFYACK: 0,99,"/33205/0/0","ACK"
```

16) The OneEdge IoT portal receives the buffer content, so the "Time-series sensors from opaque buffer to properties" trigger decodes the sensor values and publish them on properties.

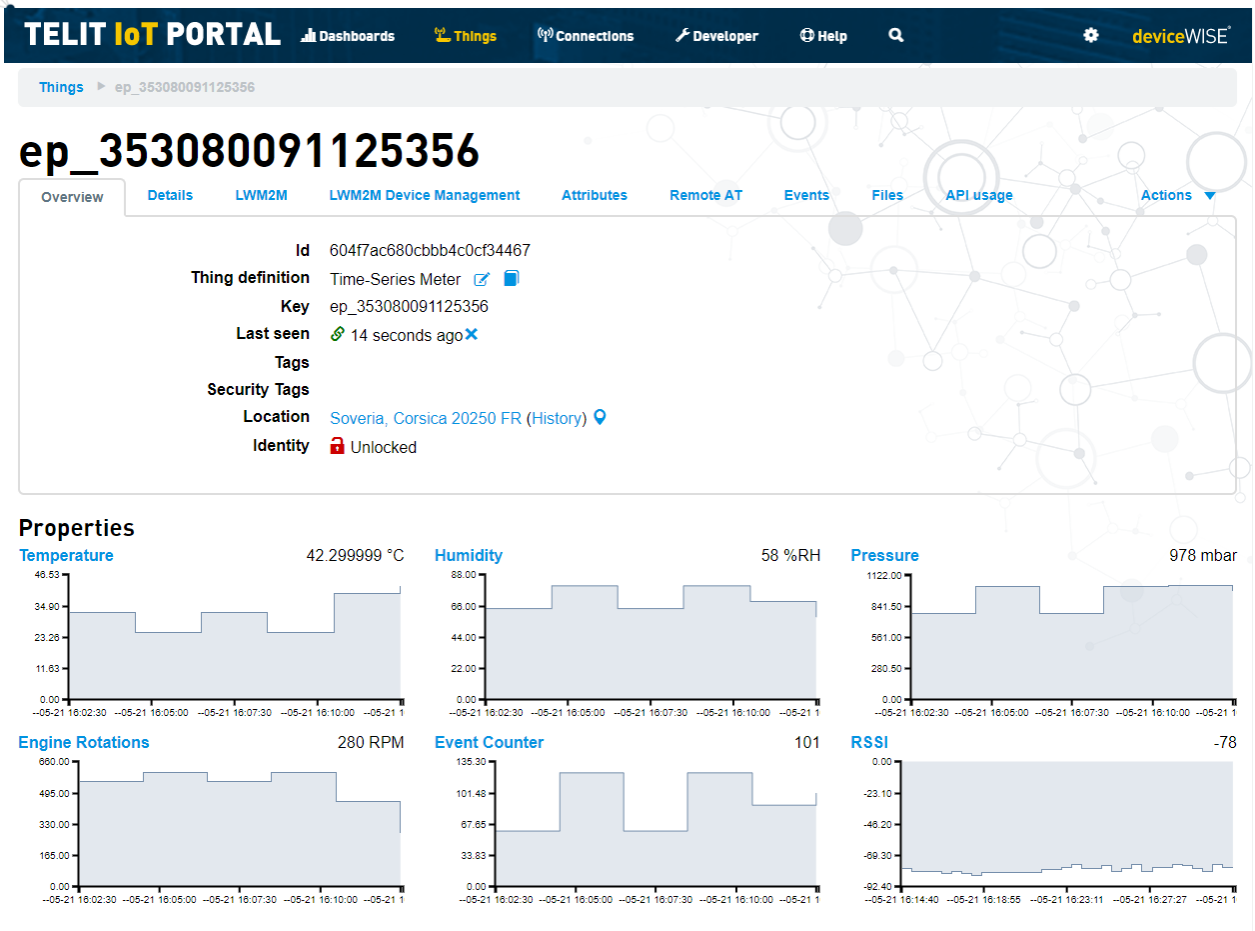

Figure 22: property view on thing space

6.5.2.5. Remote settings:

17) The User can modify the value of "sampling rate" resource of "Metering rate settings" object through the "object browser" on OneEdge portal side or through TR50 *lwm2m.device.oir.write* command, as explained on section 6.4.4.

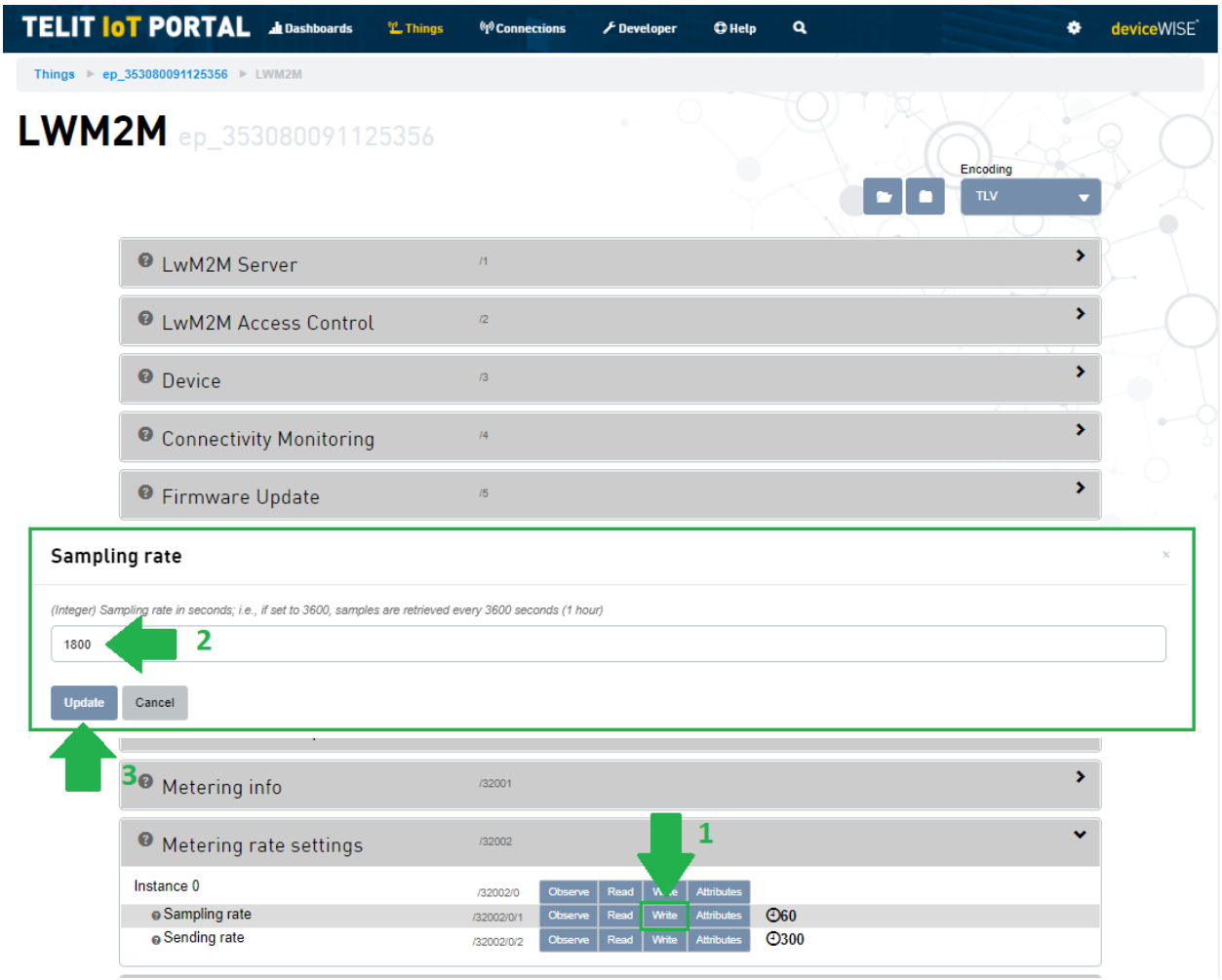

Figure 23: steps to change the value to "Sampling rate" resource on object browser

When the LwM2M client receives the new value for the modified resource, the host application receives a monitoring URCs on the serial port and this event is used by the host application to read the set value

```
#LWM2MMON: UPD,"/32002/0/1/0"

AT#LWM2MR=0,32002,0,1,0
#LWM2MR: 1800
OK
```

18) The same logic of step 17 is applied to "Sending rate" resource.

```
#LWM2MMON: UPD,"/32002/0/2/0"

AT#LWM2MR=0,32002,0,2,0
#LWM2MR: 21600
OK
```

Tip: The resources of an object can be set together in one-shot action both on object browser and on TR50 *lwm2m.device.oir.write* command.

6.5.3. Hostless architecture: AppZone application simulation

An AppZone application is also available to simulate a host routine which collects sensor data periodically and send the buffer content to OneEdge IoT portal.

As default, the sending rate is 60 seconds and the sending rate is 300 seconds.

If a new rate value is sent from the OneEdge IoT portal, for example changing the sending rate to 30 seconds or sending rate to 10 minutes, the host application considers the new values for the next sampling and sending rates.

The values of the sensors are increased or decreased by some rules hard-coded on the host application to show some ramps on the property charts.

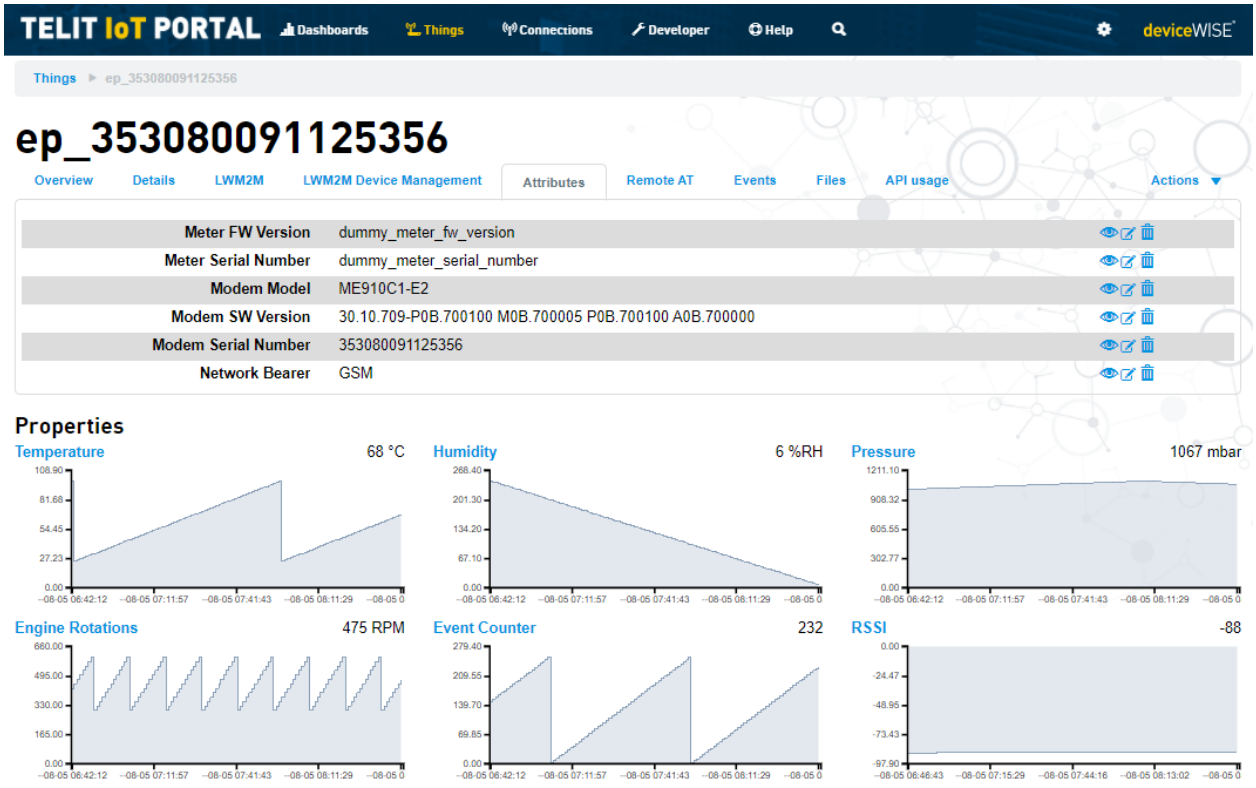

Figure 24: view of the attributes and properties as simulated by the AppZone application

However, if the AppZone application is installed on a "Bravo" board, the sensor values represent the real environmental values (real temperature, humidity and pressure values).

The AppZone application binary file for Bravo boards is available at following link:

https://github.com/telit/IoT-AppZone-BravoSamples/releases

where the asset built for the same FW version running on the device can be downloaded.

Inside of the zip file "bravo_sample_apps_xxx.zip" there are all the available sample apps, inject the "m2mapz.bin" file contained in the "BRAVO_Time_Series_Demo" folder.

Refer to following link

https://github.com/telit/IoT-AppZone-BravoSamples/tree/master/Samples/README.md

for deployment instructions.

If a generic Telit device (not Bravo board) or the source code needs to be rebuilt without the Bosch libraries dependencies, the source code is available here

https://github.com/telit/IoT-AppZone-BravoSamples/tree/master/Samples/BRAVO_Time_Series_Demo/.

The "README.rd" inside the project provides details on this build options.

After pre-requisites and one-time configuration (paragraph 6.5.1) and the basic setup through AT commands (paragraph 6.5.2.1), the AppZone application can be run and the sensor values will be reported on the property charts of OneEdge IoT portal.

6.6. OneEdge messages and APIs count

OneEdge applications could have limits related to the usage of the features and data exchange.

Basically, there are two types of counters: LwM2M messages, between device and OneEdge IoT portal

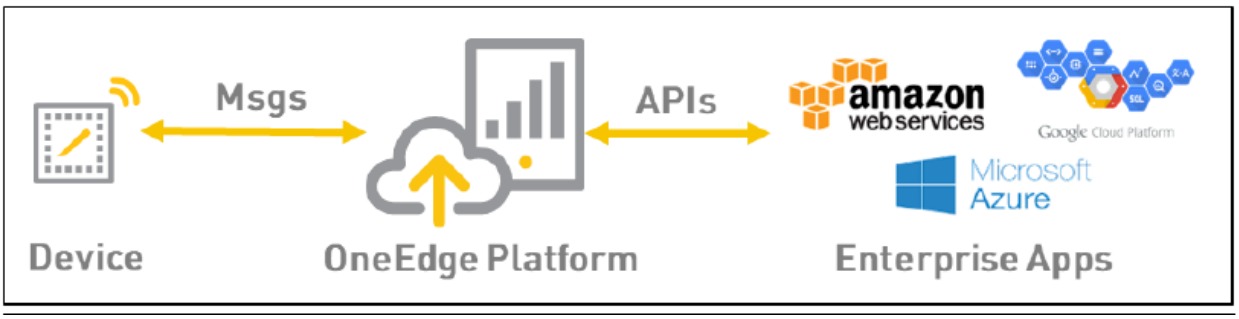

Figure 25: LwM2M messages and APIs

Please refer to Telit sales team for more details about limits and commercial aspects.

The tables below are related to the amount of LwM2M messages (between client and server) and APIs (between cloud to cloud) consumed by the various actions).

Some actions are performed only once in the life of the device or few times according to some events, and some others are related to periodic actions.

Registration (once the LwM2M client is started) :

Action	Messages and APIs amount
Registration	1 message
READ "Metering info" object	1 message
READ "Device" object	1 message
OBSERVE on "Uplink" resource	1 message

Time series data (periodic):

Action	Messages and APIs amount
Sending opaque buffer	1 message

Server to server (periodic):

Action	Messages and APIs amount
Pull historical data	1 API

On-demand remote setting (only when needed):

Action	Messages and APIs amount
Sending remote parameter from User to device	1 API + 2 messages

Device Management feature (periodic):

Action	Messages and APIs amount
Registration update	1 message

READ “Connectivity Monitoring” object,	1 message

The spreadsheet file available at the following link can be used to simulate the monthly amount of messages and APIs of the metering device application described on chapter 6. Some parameters can be customized to simulate the amount in case of different sample set dimensions and frequencies.

https://github.com/telit/oneedge-projects-resources/tree/feature/initial-time-series/use-cases/time-series/Utilities

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- it can interfere with other electronic devices, particularly in environments such as hospitals, airports, aircrafts, etc.
- there is a risk of explosion such as gasoline stations, oil refineries, etc. It is the responsibility of the user to enforce the country regulation and the specific environment regulation.

Do not disassemble the product; any mark of tampering will compromise the warranty validity. We recommend following the instructions of the hardware user guides for correct wiring of the product. The product has to be supplied with a stabilized voltage source and the wiring has to be conformed to the security and fire prevention regulations. The product has to be handled with care, avoiding any contact with the pins because electrostatic discharges may damage the product itself. Same cautions have to be taken for the SIM, checking carefully the instruction for its use. Do not insert or remove the SIM when the product is in power saving mode.

The system integrator is responsible for the functioning of the final product. Therefore, the external components of the module, as well as any project or installation issue, have to be handled with care. Any interference may cause the risk of disturbing the GSM network or external devices or having an impact on the security system. Should there be any doubt, please refer to the technical documentation and the regulations in force. Every module has to be equipped with a proper antenna with specific characteristics. The antenna has to be installed carefully in order to avoid any interference with other electronic devices and has to guarantee a minimum distance from the body (20 cm). In case this requirement cannot be satisfied, the system integrator has to assess the final product against the SAR regulation.

The equipment is intended to be installed in a restricted area location.

The equipment must be supplied by an external specific limited power source in compliance with the standard EN 62368-1:2014.

The European Community provides some Directives for the electronic equipment introduced on the market. All of the relevant information is available on the European Community website:

https://ec.europa.eu/growth/sectors/electrical-engineering_en

8. GLOSSARY

ADC	Analog – Digital Converter
CA	Connection Agent
CLK	Clock
CMOS	Complementary Metal – Oxide Semiconductor
CS	Chip Select
DAC	Digital – Analog Converter
DTE	Data Terminal Equipment
ESR	Equivalent Series Resistance
EVB	Evaluation Board
EVK	Evaluation Kit
GPIO	General Purpose Input Output
HS	High Speed
HSDPA	High Speed Downlink Packet Access
HSIC	High Speed Inter Chip
HSUPA	High Speed Uplink Packet Access
I2C	Inter Integrated Circuit
I/O	Input Output
MCU	MicroController Unit
MISO	Master Input – Slave Output
MOSI	Master Output – Slave Input
MRDY	Master Ready
OMA	Open Mobile Alliance
PCB	Printed Circuit Board
PDP	Packet Data Protocol
RSSI	Radio Signal Strength Information
RTC	Real Time Clock
SIM	Subscriber Identification Module
SPI	Serial Peripheral Interface
SRDY	Slave Ready
TATC	Telit AT Controller

TTSC	Telit Technical Support Centre
UART	Universal Asynchronous Receiver Transmitter
UMTS	Universal Mobile Telecommunication System
URI	Universal Resource Identifier
URC	Unsolicited Result Code
USB	Universal Serial Bus

9. DOCUMENT HISTORY

Revision	Date	Changes
0	2021-09-30	First issue

From Mod.0809 rev.3

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