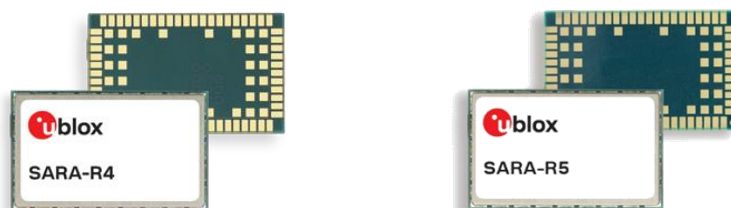




# SARA-R4 / SARA-R5 series

## LwM2M objects and commands

### Application note



### Abstract

u-blox cellular modules offer LwM2M options to achieve a few mandatory objects, extensible object, and Firmware Over The Air update (uFOTA). This application note covers details on the mandatory objects, an example about extensible object and available com

# Document information

|                               |                                 |             |
|-------------------------------|---------------------------------|-------------|
| <b>Title</b>                  | <b>SARA-R4 / SARA-R5 series</b> |             |
| <b>Subtitle</b>               | LwM2M objects and commands      |             |
| <b>Document type</b>          | Application note                |             |
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| <b>Disclosure restriction</b> | C1-Public                       |             |

This document applies to the following products:

| Product name   |                                          |
|----------------|------------------------------------------|
| SARA-R410M     | except for "01B", "52B" product versions |
| SARA-R412M     |                                          |
| SARA-R422      |                                          |
| SARA-R422M8S   |                                          |
| SARA-R422S     |                                          |
| SARA-R422M10S  |                                          |
| SARA-R5 series |                                          |

 SARA-R410M-02B-00, SARA-R410M-02B-01, SARA R410M-02B-02, SARA-R412M-02B-00, SARA-R412M-02B-01, and SARA-R412M-02B-02 support the LwM2M feature only for the uFOTA service. For more details, see the SARA-R4 series firmware update with uFOTA, FOAT and EasyFlash application note [\[10\]](#).

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# 1 LwM2M overview and architecture

Lightweight machine-to-machine (LwM2M) is a secure, efficient, and deployable client-server protocol for managing resource constrained devices on a variety of networks. The module implements the LwM2M client and sits in between the server and the host application. The u-blox client implementation is compliant with LwM2M OMA TS version 1.0 [7].

## 1.1 LwM2M interfaces

The Open Mobile Alliance (OMA) defines the application layer communication between an LwM2M server and an LwM2M client.

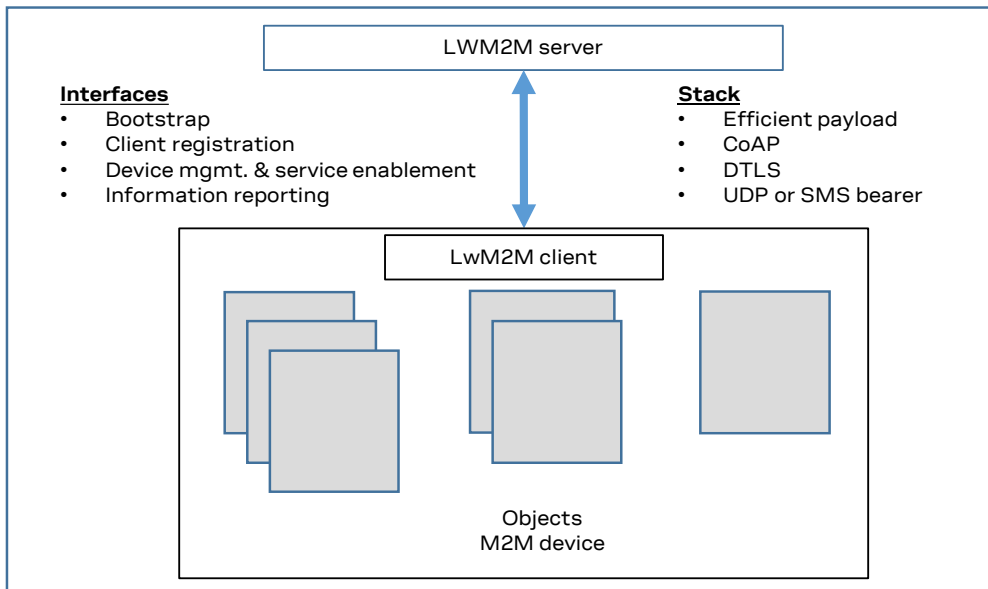


**Figure 1: Interfaces between the server and client**

- Bootstrap interface: to configure servers' info, credentials & ACLs
- Client registration interface: to inform server about "existence" and supported functionality (e.g., objects, transport bindings)
- Device management and service enablement interface: to access object instances and resources
- Information reporting interface: to publish/subscribe interaction to monitor changes in resources

The LwM2M client connects to the server using the CoAP protocol. For secure connections it uses DTLS with the Pre-Shared Key (PSK).

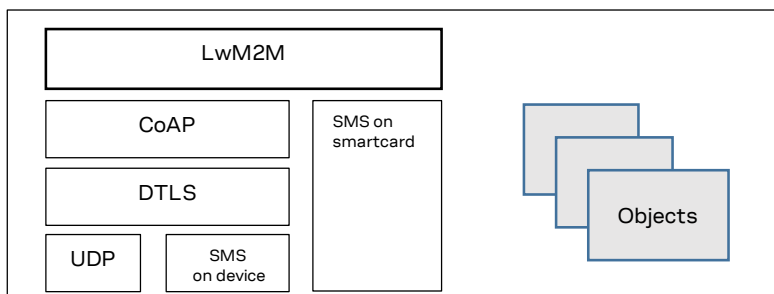


**Figure 2: Protocols used in LwM2M**



The SMS on device/smart card is not implemented in SARA-R4 series.

## 1.2 High level LwM2M client architecture

The LwM2M architecture on the module consists of the modem, LwM2M client, Lua interpreter and the Lua objects.

An external host or LwM2M server with permission can access the object instances and resources provided by the LwM2M client. A “Write” operation changes the value of a resource, the values of an array of resources instances, or the values of multiple resources of an object instance. A “Read” operation accesses the value of a resource, an array of resource instances, an object instance or all the object instances of an object.

LwM2M objects are implemented as Lua scripts. The scripts can be modified to perform custom actions in response to LwM2M operations. For example, an "Execute" operation from an LwM2M server could be used to send a URC to the external host to trigger a specific action.

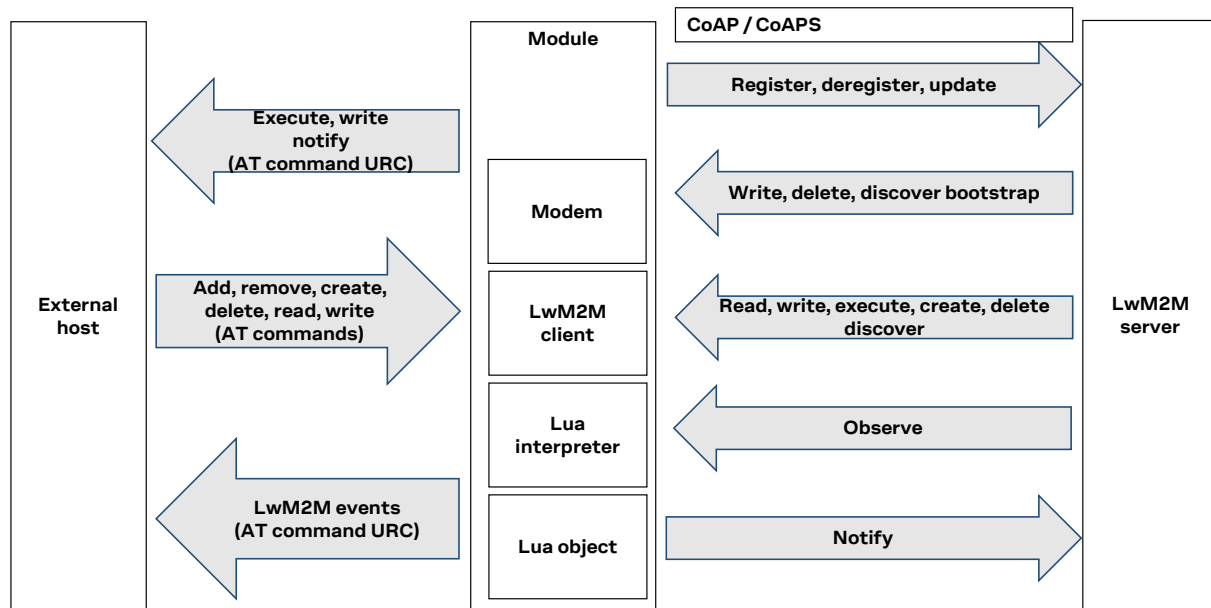


Figure 3: High level architecture

## 1.3 Objects and resources

LwM2M uses a simple flat data model consisting of object instances and their constituent resources that can be addressed using consistent URI scheme across clients.

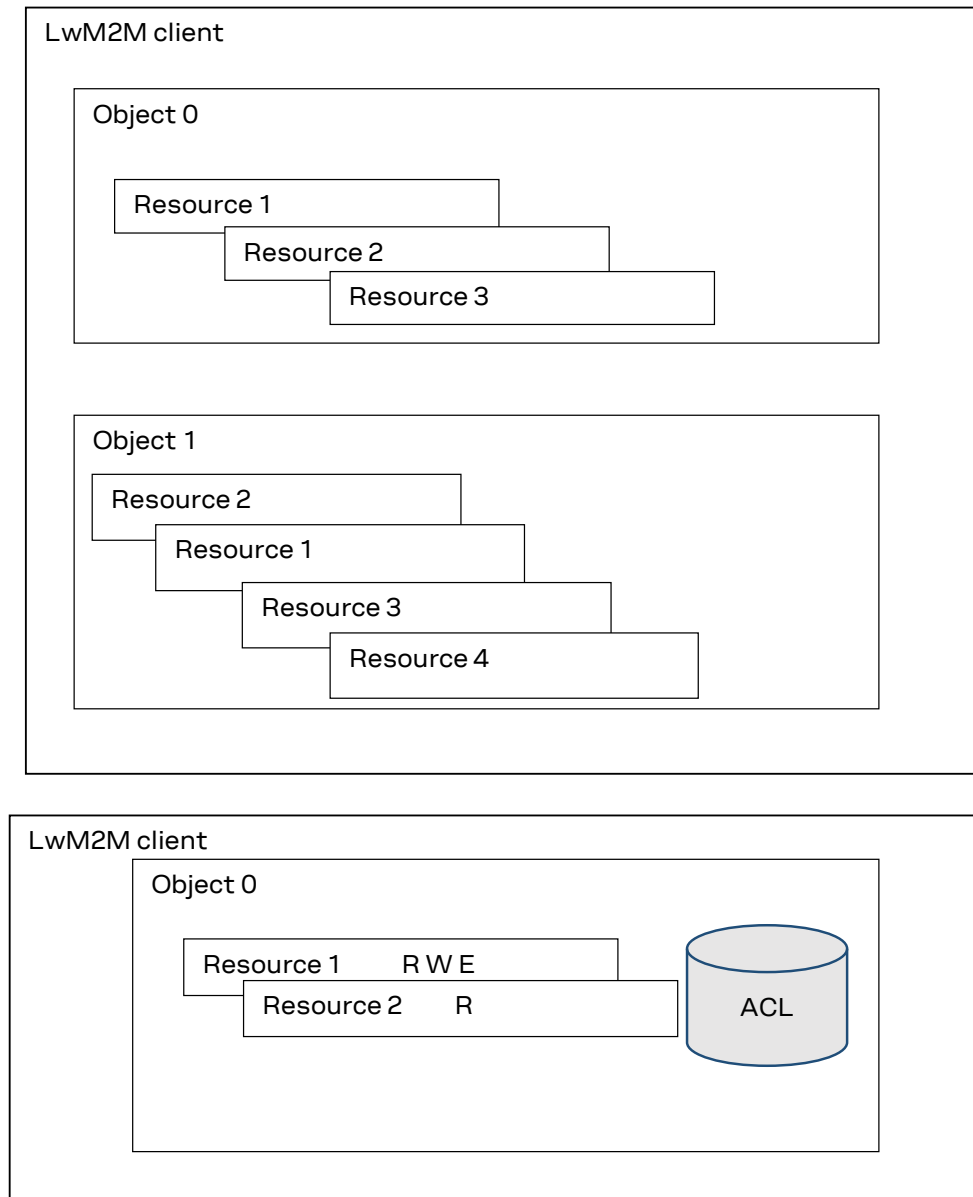


**Figure 4: Objects, instances, and resources**

- An object can have multiple instances and is a collection of resources.
- A resource is an atomic piece of information that can be read, written, or executed.
- Access control lists (ACLs) define which operations on a given object instance are allowed for which LwM2M server(s).
- A resource can be of the type: string, integer (8 – 64 bit), float, boolean, time, ObjLnk, none
- Objects/Resources are accessed with simple URI like `/[ObjectID]/[ObjectInstance]/[ResourceID]`  
Ex: `/3/0/1` = 3 – Device Object, 0 – Instance of Object, 1 –Manufacturer

## 2 Objects and categories

For more details on LwM2M and categories, see

<http://www.openmobilealliance.org/wp/OMNA/LwM2M/LwM2MRegistry.html>.

| Category  | URN                              | Object ID                                       | Description                                                                                                                                                                                |
|-----------|----------------------------------|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| oma-label | urn:oma:lwm2m:oma:<id>:<version> | 0 - 1023                                        | Objects produced by OMA. Only OMA can use this range                                                                                                                                       |
| ext-label | urn:oma:lwm2m:ext:<id>:<version> | 2048 - 10240                                    | Objects registered by 3rd party standards organizations or alliances                                                                                                                       |
| x-label   | urn:oma:lwm2m:x:<id>:<version>   | 10241 - 26240<br>26241 - 32768<br>32769 - 42768 | Objects registered by companies or individuals.<br>Objects Produced by Vendors to re-use<br>Block of objects reserved by vendors (Max 50).<br>Private range, Objects will not be published |

## 2.1 Supported objects

LwM2M objects are implemented as Lua scripts which act as the container for the objects, object instances, and resources. The Lua objects are generated using the XML provided by OMA and customized for the module. For more details, see section [4.1.1](#).

Find here below the objects and resources supported by SARA-R4 / SARA-R5 series modules.

| Object ID | Name                         | Resources supported by SARA-R410M-02B / SARA-R412M-02B                                                | Notes                                                                          |
|-----------|------------------------------|-------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| 0         | Security                     | 0, 1, 2, 3, 5, 9, 10, 11, 30000**                                                                     | ** = Only supported in Verizon configuration                                   |
| 1         | Server                       | 0, 1, 2, 3, 4, 5, 7, 8, 16, 17, 18, 30000**                                                           | ** = Only supported in Verizon configuration                                   |
| 2         | Access Control               | 0, 1, 2, 3                                                                                            |                                                                                |
| 3         | Device                       | 0, 1, 2, 3, 4, 5, 6*, 7*, 8*, 9*, 10, 11*, 12*, 13*, 14*, 15*, 16, 17, 18*, 19, 20*, 21, 22*, 30000** | * = Data written by end device<br>** = Only supported in Verizon configuration |
| 4         | Connectivity Monitoring      | 0, 1, 2, 3, 4, 5, 7*, 8, 9, 10, 30000**                                                               | * = Data written by end device<br>** = Only supported in Verizon configuration |
| 5         | FW Update                    | 1, 2, 3, 5, 7, 8, 9                                                                                   | Only via uFOTA / Verizon server                                                |
| 6         | Location                     | 0, 1, 2, 3, 4, 5, 6                                                                                   | Data written by end device                                                     |
| 7         | Connectivity Statistics      | 0, 1, 2, 3, 4, 5, 6, 7, 8                                                                             |                                                                                |
| 10        | Cellular Connectivity        | 4, 5, 9                                                                                               |                                                                                |
| 11        | APN Connection Profile       | 0, 1, 3, 9, 10, 11, 12, 24, 25                                                                        |                                                                                |
| 14        | Software Component           | 0, 2, 5                                                                                               |                                                                                |
| 15        | Device Capability Management | 0, 1, 2, 3, 4, 5, 6, 7                                                                                | Data written by end device                                                     |
| 16        | Portfolio                    | 0                                                                                                     | Data written by end device                                                     |
| 3300      | Generic Sensor               | 5601, 5603, 5604, 5605, 5607, 5700, 5701, 5750, 5751                                                  | Data written by end device                                                     |
| 10241     | Host Device Information      | 5905, 5906, 5907, 5908                                                                                | Data written by end device                                                     |
| 10262     | Interval Data Delivery       | 0, 1, 2, 3                                                                                            | Data written by end device                                                     |
| 10299**   | Host Device                  | 0, 1, 2*, 3, 4, 5*, 6                                                                                 | * = Data written by end device                                                 |
| 10308     | AT&T Extended Connectivity   | 1, 2, 3, 7, 8                                                                                         | Only supported in AT&T configuration                                           |

**Table 1: LwM2M objects, SARA-R4 "02B" product versions**

| Object ID | Name                         | Resources supported by SARA-R410M-63B-00 / SARA-R410M-73B-00 / SARA-R410M-83B-00 | Resources supported by SARA-R410M-63B-01 / SARA-R410M-73B-01 / SARA-R410M-83B-01             | Notes                          |
|-----------|------------------------------|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|--------------------------------|
| 0         | Security                     | 0, 1, 2, 3, 5,                                                                   | 0, 1, 2, 3, 5, 10, 11                                                                        |                                |
| 1         | Server                       | 0, 1, 7, 8                                                                       | 0, 1, 2, 3, 4, 5, 7, 8                                                                       |                                |
| 2         | Access Control               | 0, 1, 2, 3                                                                       | 0, 1, 2, 3                                                                                   |                                |
| 3         | Device                       | 0, 1, 2, 3, 4, 6*, 7*, 8*, 9*, 11*, 16, 17                                       | 0, 1, 2, 3, 4, 5, 6*, 7*, 8*, 9*, 10, 11*, 12*, 13*, 14*, 15*, 16, 17, 18*, 19, 20*, 21, 22* | * = Data written by end device |
| 4         | Connectivity Monitoring      | 0, 1, 2, 3, 4, 5, 7, 8                                                           | 0, 1, 2, 3, 4, 5, 7*, 8, 9, 10                                                               | * = Data written by end device |
| 5         | FW Update                    | 1, 2, 3, 5, 9                                                                    | 1, 2, 3, 5, 7, 8, 9                                                                          | Only via uFOTA server          |
| 6         | Location                     | 0, 1, 2, 3, 4, 5, 6                                                              | 0, 1, 2, 3, 4, 5, 6                                                                          | Data written by end device     |
| 7         | Connectivity Statistics      | 2, 3, 6, 7, 8                                                                    | 2, 3, 4, 5, 6, 7, 8                                                                          |                                |
| 14        | Software Component           | -                                                                                | 0, 2, 5                                                                                      |                                |
| 15        | Device Capability Management | -                                                                                | 0, 1, 2, 3, 4, 5, 6, 7                                                                       | Data written by end device     |
| 16        | Portfolio                    | -                                                                                | 0                                                                                            | Data written by end device     |
| 3300      | Generic Sensor               | 0                                                                                | 0, 5601, 5603, 5604, 5605, 5607, 5700, 5701, 5750, 5751                                      | Data written by end device     |
| 10241     | Host Device Information      | -                                                                                | 5905, 5906, 5907, 5908                                                                       | Data written by end device     |
| 10262     | Interval Data Delivery       | -                                                                                | 0, 1, 2, 3                                                                                   | Data written by end device     |

**Table 2: LwM2M objects, SARA-R4 "63B", "73B", "83B" product versions**

| Object ID | Name           | Resources supported by SARA-R422 / SARA-R422S / SARA-R422M8S / SARA-R422M10S                         | Notes                                                                                                                             |
|-----------|----------------|------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| 0         | Security       | 0, 1, 2, 3, 5, 9, 10, 11, 30000**                                                                    | ** = Only supported in Verizon configuration by SARA-R422-01B, SARA-R422S-01B and SARA-R422M10S                                   |
| 1         | Server         | 0, 1, 2, 3, 4, 5, 7, 8, 16, 17, 18, 30000**                                                          | ** = Only supported in Verizon configuration by SARA-R422-01B, SARA-R422S-01B and SARA-R422M10S                                   |
| 2         | Access Control | 0, 1, 2, 3                                                                                           |                                                                                                                                   |
| 3         | Device         | 0, 1, 2, 3, 4, 5, 6*, 7*, 8*, 9*, 10, 11*, 12*, 13*, 14*, 15*, 16, 17, 18, 19, 20*, 21, 22*, 30000** | * = Data written by end device<br>** = Only supported in Verizon configuration by SARA-R422-01B, SARA-R422S-01B and SARA-R422M10S |

| Object ID | Name                         | Resources supported by SARA-R422 / SARA-R422S / SARA-R422M8S / SARA-R422M10S | Notes                                                                                           |
|-----------|------------------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| 4         | Connectivity Monitoring      | 0, 1, 2, 3, 4, 5, 7, 8, 9, 10, 30000**                                       | ** = Only supported in Verizon configuration by SARA-R422-01B, SARA-R422S-01B and SARA-R422M10S |
| 5         | FW Update                    | 1, 2, 3, 5, 8, 9                                                             | Only via uFOTA server                                                                           |
| 6         | Location                     | 0, 1, 2, 3, 4, 5, 6                                                          | Data written by end device                                                                      |
| 7         | Connectivity Statistics      | 0, 1, 2, 3, 4, 5, 6, 7, 8                                                    |                                                                                                 |
| 10        | Cellular Connectivity        | 4, 5, 9                                                                      |                                                                                                 |
| 11        | APN Connection Profile       | 0, 1, 3, 9, 10, 11, 12, 24, 25                                               |                                                                                                 |
| 14        | Software Component           | 0, 2, 5                                                                      |                                                                                                 |
| 15        | Device Capability Management | 0, 1, 2, 3, 4, 5, 6, 7                                                       | Data written by end device                                                                      |
| 16        | Portfolio                    | 0                                                                            | Data written by end device                                                                      |
| 3300      | Generic Sensor               | 5601, 5603, 5604, 5605, 5607, 5700, 5701, 5750, 5751                         | Data written by end device                                                                      |
| 10241     | Host Device Information      | 5905, 5906, 5907, 5908                                                       | Data written by end device                                                                      |
| 10262     | Interval Data Delivery       | 0, 1, 2, 3                                                                   | Data written by end device                                                                      |
| 10308     | AT&T extended connectivity   | 1, 2, 3, 7, 8                                                                | Only supported in AT&T configuration by SARA-R422-01B, SARA-R422S-01B and SARA-R422M10S         |

**Table 3: LwM2M objects, SARA-R422 / SARA-R422S / SARA-R422M8S / SARA-R422M10S**

| Object ID | Name                    | Resources supported                                                                                 | Notes                                                                          |
|-----------|-------------------------|-----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| 0         | Security                | 0, 1, 2, 3, 5, 9, 10, 11, 30000**                                                                   | ** = Only supported in Verizon configuration                                   |
| 1         | Server                  | 0, 1, 2, 3, 4, 5, 7, 8, 10, 16, 17, 18, 30000**                                                     | ** = Only supported in Verizon configuration                                   |
| 2         | Access Control          | 0, 1, 2, 3                                                                                          |                                                                                |
| 3         | Device                  | 0, 1, 2, 3, 4, 5, 6*, 7*, 8*, 9*, 10, 11*, 12, 13, 14*, 15*, 16, 17, 18, 19, 20*, 21*, 22*, 30000** | * = Data written by end device<br>** = Only supported in Verizon configuration |
| 4         | Connectivity Monitoring | 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 30000**                                                           | ** = Only supported in Verizon configuration                                   |
| 5         | FW Update               | 1, 2, 3, 5, 6, 7, 8, 9, 10**                                                                        | ** = Only supported in Verizon configuration                                   |
| 7         | Connectivity Statistics | 0, 1, 2, 3, 4, 5, 6, 7, 8                                                                           |                                                                                |
| 11        | APN Connection Profile  | 0, 1, 3, 24                                                                                         | Not supported in Verizon configuration                                         |
| 14        | Software Component      | 0, 2, 5                                                                                             |                                                                                |

| Object ID | Name                       | Resources supported | Notes                                                               |
|-----------|----------------------------|---------------------|---------------------------------------------------------------------|
| 16        | Portfolio                  | 0                   | Only supported in AT&T configuration;<br>Data written by end device |
| 10308     | AT&T extended connectivity | 1, 2, 3, 7, 8, 9    | Only supported in AT&T configuration                                |

**Table 4: LwM2M objects, SARA-R5 series modules**

-  The client recognizes these objects and provides access to some of the objects. It is up to the individual product on how these objects get populated. There are some object resources that cannot be populated by the host, even though these Lua object exists in the module's firmware, and therefore they cannot be used by an end device.
-  On SARA-R410M-02B / SARA-R412M-02B, in all the +UMNOPROF AT command configuration except for the Verizon configuration (+UMNOPROF: 3), the Object 11 "APN connection profile" is synchronized with APNs defined/displayed via the +CGDCONT AT command. In this way when creating/deleting an APN by the +CGDCONT AT command, the same will be created/deleted in a dedicated Object 11 resource.
-  On SARA-R5 series modules and on SARA-R422-01B / SARA-R422S-01B / SARA-R422M10S, only in AT&T configuration, the Object 11 "APN connection profile" is synchronized with APNs defined/displayed via the +CGDCONT AT command. In this way when creating/deleting an APN by the +CGDCONT AT command, the same will be created/deleted in a dedicated Object 11 resource. On SARA-R5 "00B" product versions, in all the +UMNOPROF AT command configuration except for the Verizon configuration (+UMNOPROF: 3), the Object 11 "APN connection profile" is synchronized with APNs defined/displayed via the +CGDCONT AT command.
-  On SARA-R5 series modules, on SARA-R410M-02B / SARA-R412M-02B and on SARA-R422-01B / SARA-R422S-01B / SARA-R422M10S, in AT&T configuration (+UMNOPROF: 2) the APN "attm2mgloba" must NOT be deleted from the +CGDCONT list, since the deletion of this APN will prevent LwM2M connectivity. This is compliant with AT&T requirement CDR-IOT-005 [11]. If an APN is disabled setting the Object 11 resource 3 to "false", then the APN activation will be locally rejected by the AT interface. If the disabled APN is used for attaching the module, it will be automatically replaced with "attm2mgloba". This complies with the AT&T requirement CDR-DVM-4559 [11]. On SARA-R510S-00B-00, SARA-R510M8S-00B-00, and SARA-R500S-00B-00 the automatic replacement is not available, so a disabled APN will result in the module not being able to attach.
-  On SARA-R5 series modules, time resource /3/0/13 is automatically updated and aligned to the module time.
-  On SARA-R4 series modules the time resource /3/0/13 shall be updated by the end device.
-  On SARA-R510M8S-00B-00, SARA-R510S-00B-00, SARA-R500S-00B-00 the object 14 "Software component" and resource /5/0/10 are not supported.

## 2.2 Custom or extensible LwM2M object

Customers might want to use an LwM2M object that can be used with their end product. The objects are based on Lua scripts <https://www.lua.org/>. The customer should follow these steps to generate an object and use it on the module:

1. The customer requests u-blox for assistance in creating custom/extensible objects<sup>1</sup>.
2. u-blox support will provide the **lwm2m\_object\_generator.lua** Lua script. Use this script to generate a Lua object that can run with the u-blox LwM2M client.
3. The customer downloads an OMA compliant XML file describing the LwM2M object. For example, the following link is for the generic sensor object: object ID 3300: Generic Sensor  
<http://www.openmobilealliance.org/tech/profiles/lwm2m/3300.xml>
4. The customer installs the Lua software to use the script provided. For details on how to install Lua on a Linux machine, see appendix B.
5. The customer can run the **lwm2m\_object\_generator.lua** Lua script providing the XML file as an argument as shown below. For example, the below command will generate the object file `object_generic_sensor.lua`.  

```
# lua lwm2m_object_generator.lua 3300.xml
```
6. Once the object is generated, the customer makes the necessary customizations (i.e. URC notification / generating a pulse) based on their requirements. See section 6 for details on available functions.
7. The object file can be copied to the module using the steps provided in section 5.3.2 that describes adding objects.
8. Once the object is added to the object table and the module is restarted, the LwM2M client can start using the new object.
9. If the LwM2M client is already registered, a registration update message is sent to the server(s) to indicate to the server(s) that the object now exists on the LwM2M client device.
10. The server can then perform operations on that object and its resources (read, write, create, execute, write attribute, delete, or discover). An instance of the object can be created, and resources can be populated.

 On SARA-R5 series the “Compiled Lua” or “Lua Bytecode” format is not supported. All Lua files must be in plain text, readable Lua code, as generated by the **lwm2m\_object\_generator.lua** Lua script.

<sup>1</sup> u-blox will also provide a service that requires a non-recurring expense (NRE) where the customer can request u-blox to create the customized or extensible object by providing their requirements and OMA compliant xml.

### 3 LwM2M impact on module functionality

LwM2M, as embedded application:

- Autonomously activates PDN and makes data traffic. MNO servers will use dedicated APN, while user-specific servers, like u-blox LwM2M server, will use user data.
- Affects PSM. If LwM2M is performing data traffic, the PSM will be inhibited, to allow for connectivity.
- Affects power consumption.

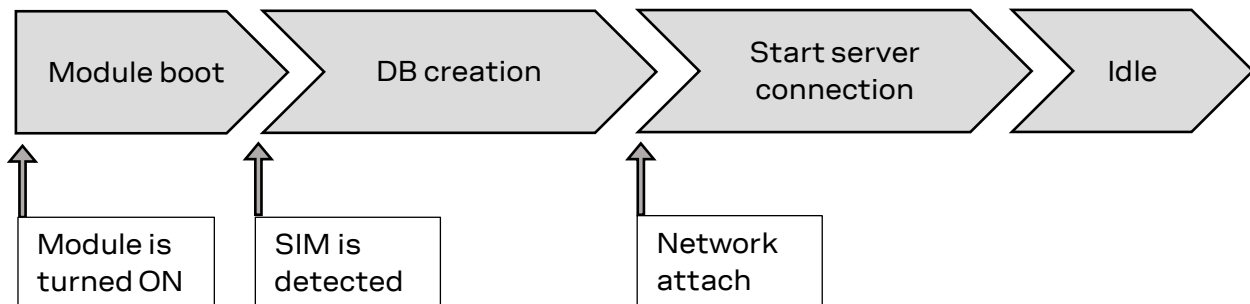
The following sections describe the main LwM2M procedures and their timings.

The undefined / regulatory profile (+UMNOPROF: 0) and the GCF-PTCRB profile (+UMNOPROF: 201) do not support LwM2M feature.

Section 3.2 refers to the factory-programmed configuration. It is possible for the LwM2M server/user to add/delete/modify the server's number and connectivity timings.

#### 3.1 LwM2M start sequence: DB creation

At the first boot after MNO change by the +UMNOPROF AT command, and if LwM2M is enabled by default, then the LwM2M client proceeds with the creation of the LwM2M database. This operation impacts module functionality and requires the host processor to not interfere with it.



- The module is already provisioned with LwM2M DB aligned to the default MNO profile configuration.
- The module deletes the DB file when swapping the +UMNOPROF profile from one to another. The suggested wait time for DB creation are:

○ **SARA-R5 series:**

| Target <MNO> | DB creation time (s) | Suggested wait time (s) |
|--------------|----------------------|-------------------------|
| 90           | 5                    | 10                      |
| 100          | 5                    | 10                      |
| 2            | 7                    | 10                      |
| 3            | 13                   | 20                      |

**Table 5: SARA-R5 series DB creation time**

The timings above consider time span from the module boot to the LwM2M initialization complete. The SIM must be inserted with PIN disabled.

URCs for initialization status information can be enabled, see section 4.1.1.

- **SARA-R4 series:** the suggested wait time for SARA-R4 series is 10 s for all supported MNO profiles.

- LwM2M client is not functional during the DB file creation, which is a one-time operation.
- It is highly recommended to not remove power or reboot the module during the DB file creation.
- The DB can be erased via the AT+ULWM2M=2 command. At the next reboot, the timings above are applied.

## 3.2 SARA-R5 series: LwM2M production mode

For environments with critical time constraints (e.g. module/device production phase), it is possible to skip LwM2M DB creation by activating the LwM2M production mode, in which the LwM2M client will not start and not initialize, so the DB creation is skipped.

The LwM2M production mode is tuned with two different settings in the +ULWM2MCONFIGEXT AT command:

- <production\_mode>: 0 - The production mode is disabled.
- <production\_mode>: 1 - The production mode is enabled if the inserted SIM matches the <production\_sim> parameter.
- <production\_sim>: string parameter of 5 or 6 digits which filters a special SIM used in production, e.g., if set to "00101" all the SIMs with IMSI starting by "00101" will not produce any LwM2M activity. An empty string "" means the feature is disabled.

Factory-programmed values are <production\_mode>=0 and <production\_sim>="" which means the feature is disabled (LwM2M always starts) in all the <mno> profiles apart from <mno>: 90 (Global) where it is enabled with <production\_sim>: "00101". This means that in Global default configuration, LwM2M will not start if a test SIM is inserted.

The changes apply to the current selected <mno> profile only. Reboot the module to apply the settings.

 LwM2M production mode shall be used for simulated and/or controlled environments, not in the field. If enabled, it will stop LwM2M functionality and prevent LwM2M-based services including FOTA. LwM2M is also a mandatory requirement for MNO certifications.

 On SARA-R510S-00B-00, SARA-R510M8S-00B-00 and SARA-R500S-00B-00 the LwM2M production mode feature and +ULWM2MCONFIGEXT parameters <production\_mode> and <production\_sim> are not supported.

## 3.3 Basic functionality

When active, the client attempts to perform a client-initiated bootstrap (only in Verizon Wireless (+UMNOPROF: 3), AT&T (+UMNOPROF: 2), AT&T FirstNet (+UMNOPROF: 206), AT&T 2-4-12 (+UMNOPROF: 198), NTT DoCoMo (+UMNOPROF: 20), T-Mobile (+UMNOPROF: 5) configurations). If the bootstrap was already successfully performed, the client would trigger registration to the available servers.

 In NTT Docomo (+UMNOPROF: 20) LwM2M is disabled by factory-programmed configuration. Issue the AT+ULWM2M=4 command to activate the LwM2M client.

The LwM2M client can connect to multiple servers and it does so with a frequency established by the life-time. This parameter depends on the operator and is set in the bootstrap process, which is performed only once, the first time the LwM2M client is activated.

Based on the supported operators, namely AT&T (Including Firstnet and 2-4-12 profiles), Verizon and NTT DoCoMo, the operator's bootstrap server configures one (AT&T, NTT DoCoMo) or more (Verizon) operating servers to which the LwM2M client then connects periodically before the respective life time expires (it does it a little more than life-time / 2).

In addition to the operator-configured servers, the u-blox server is always present. If the selected MNO profile is different from 2 (AT&T), 206 (AT&T FirstNet), 198 (AT&T 2-4-12), 3 (Verizon), 5 (T-Mobile), or 20 (NTT DoCoMo), then only the u-blox server is available by default. In this case no bootstrap is performed.

| <MNO>                                                                                                                                                                                                                                                                                                                           | Server            | SSID | Lifetime | CID/APN                     | Notes                  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|------|----------|-----------------------------|------------------------|
| 2 (AT&T),<br>198 (AT&T 2-4-12),<br>206 (AT&T FN)                                                                                                                                                                                                                                                                                | Device Management | 3    | 24 h     | attm2mglobal                | Connect at each reboot |
| 3 (Verizon)                                                                                                                                                                                                                                                                                                                     | Device Management | 102  | 30 d     | VZWADMIN                    | Connect at each reboot |
| 3 (Verizon)                                                                                                                                                                                                                                                                                                                     | Diagnostic        | 101  | 24 h     | VZWADMIN                    | Connect at each reboot |
| 3 (Verizon)                                                                                                                                                                                                                                                                                                                     | Repository        | 1000 | 24 h     | Internet (CID 1 by default) |                        |
| 5 (T-Mobile)                                                                                                                                                                                                                                                                                                                    | Device Management | 1    | 24 h     | lwm2m.iot.t-mobile.com:5684 |                        |
| 20 (NTT DoCoMo)                                                                                                                                                                                                                                                                                                                 | Device Management | 123  | 24 h     | dcmiot.net                  |                        |
| 4 (Telstra),<br>28 (Softbank)                                                                                                                                                                                                                                                                                                   | u-blox LwM2M      | 721  | 14 d     | Internet (CID 1 by default) |                        |
| 2 (AT&T),<br>3 (Verizon),<br>19 (Vodafone),<br>21 (Telus),<br>28 (SoftBank),<br>31 (Deutsche Telekom),<br>33 (VIVO),<br>39 (SKT),<br>43 (Rogers),<br>44 (Claro Brasil),<br>45 (TIM Brasil),<br>46 (Orange France),<br>90 (Global),<br>100/101 (Standard EU),<br>102 (Standard JP),<br>198 (AT&T 2-4-12),<br>206 (AT&T FirstNet) | u-blox LwM2M      | 721  | 24 h     | Internet (CID 1 by default) |                        |

**Table 6: servers present in LwM2M database after bootstrap, and their lifetime.**

 For the complete list of supported MNO profiles, see the +UMNOPROF AT command description in the SARA-R4 series AT commands manual [1] / SARA-R5 series AT commands manual [9].

### First-time bootstrap

The first time the LwM2M client is turned on, it will bootstrap and connect to the operational servers.

This procedure applies to any change of MNO profile, if the LwM2M client is active (+ULWM2M: 0) the selected configuration is different from undefined / regulatory (+UMNOPROF: 0) or GCF-PTCRB (+UMNOPROF: 201).

 The <MNO> change via the +UMNOPROF AT command must be done with the module in an offline state (+COPS: 2 or +CFUN: 0 or +CFUN: 4). If the module is not offline, the MNO switch may lead to inconsistent LwM2M configuration.

### Module already bootstrapped

After bootstrap, the LwM2M client connects to servers following the lifetime timing. The number of servers and the APN/CID used follows Table 6. This table also reports the MNO profiles where the connection to MNO servers is also triggered at each reboot, in compliance with MNO requirements.

### 3.4 LwM2M and power saving mode

If there are no active connections or FW upgrades in progress, the LwM2M client allows the module to enter power saving mode (PSM) without awaking the module at the end of the life-time of the servers to which it is registered. The first time the module wakes up for reasons independent of LwM2M, the LwM2M client will restart and will check the current time. If the life-time of one of the servers to which it is registered has expired, then it will connect to that server.

Therefore, if the life-times configured by the operator's bootstrap server are high, the LwM2M client is not invasive and does not prevent entry into PSM.

When the device exits the PSM, the LwM2M client will automatically perform registration update to Verizon (+UMNOPROF: 3), AT&T (+UMNOPROF: 2 or +UMNOPROF: 198), AT&T FirstNet (+UMNOPROF: 206) and NTT DoCoMo (+UMNOPROF: 20) servers. No activity will be performed in other +UMNOPROF configurations.

 On SARA-R5 series the <reg\_update\_boot> parameter of the +ULWM2MCONFIG AT command causes the device to connect to the servers at every power-on regardless of the life-time expiration. The <reg\_update\_boot> is set by default to 1 in AT&T and Verizon configuration. In +ULWM2MCONFIG the <reg\_upd\_at\_PSM\_exit> parameter applies to the PSM case but is not supported by SARA-R510S-00B-00, SARA-R510M8S-00B-00, or SARA-R500S-00B-00 where the device will obey the <reg\_update\_boot> when exiting from PSM.

### 3.5 Configuration of APNs and PDNs in LwM2M

#### 3.5.1 Operator-specific servers

When in AT&T (including FirstNet and AT&T 2-4-12), T-Mobile, Verizon, or NTT DoCoMo MNO configuration, LwM2M will by default connect to MNO-specific servers. Operators prescribe the usage of a dedicated APN for those, namely:

- **Verizon:** Class 2 APN “VZWADMIN” is activated and used for connection to Bootstrap, Device Management (DM) and Diagnostic server. This APN is hardcoded in the VZW APN table and it is not possible to delete or change it.
- **AT&T:** AT&T APN “attiotfirstnet.fn” when FirstNet MNO profile is selected (+UMNOPROF: 206), otherwise AT&T APN “attm2mglobal” is used. It is stored by default in LwM2M object /11/0. Even if this resource and its +CGDCONT entry can be deleted and changed by the user, removing this APN is generally prohibited. If the user or application processor re-defines or removes this APN, LwM2M functionality in AT&T will be disrupted, causing AT&T certification invalidation.
- **NTT DoCoMo:** DoCoMo APN “dmio.net” is used. It is configured to CID 2. The user or application processor is expected by carrier to configure CID 1 before use. User must define this PDN with FOTA APN information (APN name, IP type, authentication type, username, password) depending on the used NTT DoCoMo UICC. If the APN matches the value configured at CID 1 (Attach EPS bearer), the FOTA client will use CID 1 instead, to avoid multiple PDN activation with same APN.
- **Softbank:** no Softbank-specific server is contacted in Softbank configuration; FOTA relies on u-blox' LwM2M and FOTA servers. However, the MNO requires the module to use dedicated PDN settings to contact the u-blox server used for uFOTA.
  - On SARA-R4 series all LwM2M and FOTA communication for Softbank MNO profile is done with PDN context identifier 2. The user must define this PDN with FOTA APN information (APN name, IP type, authentication type, username, password) depending on the used Softbank UICC. If the APN matches the value configured at CID 1 (Attach EPS bearer), the FOTA client will use CID 1 instead to avoid multiple PDN activation with same APN.

- On SARA-R5 series the LwM2M and FOTA PDN must be configured (APN name, IP type, authentication type, username, password) by the user by the +ULWM2MFOTAAPN AT command. The user must also configure attach APN by editing the CID by the +CGDCONT AT command. These data are maintained across FOTA updates since the “APN sync” of the +ULWM2MCONFIGEXT configuration is set.
- **T-Mobile:** CID 1 is used for connection towards T-Mobile bootstrap and Device Management (DM) servers. This will use billable APN, customer shall check with the MNO if a dedicated APN is available upon UICC subscription, define a new PDP with the +CGDCONT AT command and configure accordingly the correct CID on the +ULWM2MCONFIG AT command.

 On SARA-R410M-63B-00 and SARA-R410M-63B-01 in Softbank or NTT DoCoMo configuration the CID 2 cannot be viewed or edited using the +CGDCONT AT command.

### 3.5.2 Custom servers

In all the MNO configurations, apart from undefined / regulatory (+UMNOPROF: 0), GCF-PTCRB (+UMNOPROF: 201) and NTT DoCoMo (+UMNOPROF: 20), the LwM2M client will attempt to connect to the u-blox LwM2M server. This connection will use the general-purpose data context, whose connection ID (CID) is 1.

#### SARA-R422-00B / SARA-R422S-00B / SARA-R422M8S

The LwM2M client always uses connection profile ID (CID) 1 (for more details, see the +CGDCONT AT command in the SARA-R4 series AT commands manual [1]) and this setting cannot be changed (the <cid> parameter of the +ULWM2MCONFIG AT command is not effective). In case a private APN is being provisioned, the user shall use the +CGDCONT AT command to:

- set the CID 1 to be used for general internet data APN so the LwM2M connectivity is granted,
- set any connection profile (CID) different from 1 to be used for private APN.

#### SARA-R5 series

It is possible for the user to set the general-purpose CID to be used for internet data, and even to configure a certain context identifier to be used by each server. The configuration is done by the +ULWM2MCONFIG and +ULWM2MCONFIGEXT AT commands:

| Command             | Response                                                                                                                                                                               | Description                                                                                                                                                                                                 |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                     |                                                                                                                                                                                        | The +ULWM2MCONFIG read command shows the CIDs being used by each server.                                                                                                                                    |
| AT+ULWM2MCONFIG?    | +ULWM2MCONFIG: 721,0,1,255,1,0,0,40,0,0,2<br>+ULWM2MCONFIG: 101,0,1,1,0,1,0,240,0,0,2<br>+ULWM2MCONFIG: 102,1,1,1,0,1,0,240,0,1,2<br>+ULWM2MCONFIG: 1000,0,1,255,0,0,0,240,0,0,2<br>OK | The 721 and 1000 servers are set to <cid>: 255, which means they will use the CID reported in the +ULWM2MCONFIGEXT read command.                                                                            |
| AT+ULWM2MCONFIGEXT? | +ULWM2MCONFIGEXT: 60,20,30,4,1,0,""<br>OK                                                                                                                                              | The CID is 1. This is the general data CID commonly used at attach, but a different CID can be inserted. It can be also possible to define a special CID for each server via the +ULWM2MCONFIG set command. |

 On SARA-R510S-00B-00, SARA-R510M8S-00B-00, and SARA-R500S-00B-00 <cid>=255 is not supported in the set command.

 Note that:

- Servers 101 and 102 do not use CID 1 since they are proprietary Verizon servers. Same applies to server 3 in AT&T. These will use dedicated APNs.
- If a certain CID is indicated for usage with a certain server, the CID must be at least defined in the +CGDCONT AT command entries.

### 3.5.2.1 Global configuration

In the global profile configuration (+UMNOPROF: 90) the default general purpose CID is 1, which matches the Attach EPS bearer.

 On SARA-R5 series it is possible to configure a CID to a value other than 1 via the +ULWM2MCONFIGEXT AT command with the <GeneralDataCid> parameter.

### 3.5.2.2 AT&T configuration

AT&T generally adopts the attach CID as a multipurpose APN. The default configuration is 1, which may be still changed as above. Configuration changes do not apply to AT&T-specific servers (SSIDs 0, 1, 3). This holds for AT&T FirstNet and AT&T 2-4-12.

### 3.5.2.3 Verizon configuration

Verizon IMS-less devices must consider the attach CID as internet data. It is still possible to point a certain server to a different CID, using configuration above. Configuration changes do not apply to VZW-specific servers (SSIDs 101,102).

## 3.5.3 SARA-R5 series and SARA-R422-01B / SARA-R422S-01B / SARA-R422M10S: server-based disable and roaming activity

It is possible to selectively disable a LwM2M server with the +ULWM2MCONFIG AT command, with the <server\_disabled> parameter. This allows server configuration such that no data may be sent to it in certain conditions:

- <server\_disabled>: 0 - the server is always enabled
- <server\_disabled>: 1 - the server is always disabled
- <server\_disabled>: 2 - the server is disabled only when the module is in roaming cell conditions

To avoid additional costs due to data traffic in roaming conditions, it is possible to configure LwM2M to allow server connections only when in Home network.

Factory-programmed configuration allows LwM2M connections to all the available servers, apart from Verizon Wireless (+UMNOPROF: 3) where the client will perform no activity (including FOTA) when in roaming.

 Disabling a server is not recommended as it will prevent LwM2M-based services including FOTA. LwM2M is also a mandatory requirement for MNO certifications.

 On SARA-R510S-00B-00, SARA-R510M8S-00B-00, and SARA-R500S-00B-00 <server\_disabled> parameter of the +ULWM2MCONFIG AT command is not supported.

## 3.6 Connection tear down timings

LwM2M client will tear down the CID being used for connection in 90 s after the latest successful sent message. This is a pre-defined value suggested for keeping client reachable from the server.

 On SARA-R5 series and in SARA-R422-01B / SARA-R422S-01B / SARA-R422M10S in Verizon network this timer value is 60 s.

### 3.7 Enabling LwM2M client and uFOTA

On certain product versions, for specific MNO profiles, the LwM2M client or uFOTA server is not enabled by default. Thus, after setting and activating the MNO profile, the LwM2M client may need to be enabled. Also, the uFOTA server may need to be enabled if the host device is to support uFOTA FW delta updates. To see if the LwM2M client and uFOTA is enabled by default for a specific MNO profile, see the “Mobile Network Operator profiles” section in the appendix in the SARA-R4 series AT commands manual [1] / SARA-R5 series AT commands manual [9].

After setting and then activating the desired MNO profile, the default LwM2M and uFOTA setting for the MNO profile can be checked to see if it is enabled or not.

| Command                  | Response                                          | Description                                                                                                                                     |
|--------------------------|---------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Stop LwM2M client</b> |                                                   |                                                                                                                                                 |
| AT+ULWM2M?               | +ULWM2M: 0<br>OK                                  | Upon boot, read +ULWM2M to check the <activation_mode> parameter of LwM2M client. In this example the response is 0, meaning enabled.           |
| AT+ULWM2MCONFIG?         | +ULWM2MCONFIG: 721,0,1,255,1,0,0,0,40,0,0,0<br>OK | Verify if uFOTA is enabled. In this example the parameters: <server_id>: 721 <server_disabled>:0 This indicates uFOTA server ID 721 is enabled. |

If MNO profile 2 (AT&T) or 206 (AT&T FirstNet) has LwM2M disabled, it can be enabled with the following steps, with the option to enable uFOTA too.

| Command                                                                                            | Response | Description                                                                                             |
|----------------------------------------------------------------------------------------------------|----------|---------------------------------------------------------------------------------------------------------|
| <b>Enabling LwM2M client on MNO profile 2 (AT&amp;T) or 206 (FN) and optionally enabling uFOTA</b> |          |                                                                                                         |
| AT+ULWM2M=0                                                                                        | OK       | Enable LwM2M client.                                                                                    |
| AT+CFUN=4                                                                                          | OK       | Set module to Airplane mode                                                                             |
| AT+CFUN=16                                                                                         | OK       | Reset the module.                                                                                       |
| AT+ULWM2MCONFIG= 0,0,1,2,0,0,0,0,0,0,0,0                                                           | OK       | Enable AT&T server setting: <server_id>: 0, <server_disabled>=0                                         |
| AT+ULWM2MCONFIG=721,0,1,1,1,0,0,0,0,0,0,0                                                          | OK       | Optional step: If uFOTA service is desired, enable uFOTA setting: <server_id>: 721, <server_disabled>=0 |
| AT+CFUN=16                                                                                         | OK       | Reset the module.                                                                                       |
| AT+CFUN=1                                                                                          | OK       | Exit Airplane by enabling online mode.                                                                  |

If an MNO profile has uFOTA disabled, it can be enabled with the following steps.

| Command                                               | Response | Description                                                 |
|-------------------------------------------------------|----------|-------------------------------------------------------------|
| <b>Enable uFOTA on MNO profile 3 (VZW) or 5 (TMO)</b> |          |                                                             |
| AT+ULWM2MCONFIG=721,0,1,3,1,0,0,0,0,0,0,0             | OK       | Enable uFOTA setting: <server_id>: 721, <server_disabled>=0 |
| AT+CFUN=16                                            | OK       | Reset the module                                            |
| <b>Enable uFOTA on all other MNO profiles</b>         |          |                                                             |
| AT+ULWM2M=0                                           | OK       | Enable LwM2M client.                                        |
| AT+CFUN=16                                            | OK       | Reset the module                                            |
| AT+ULWM2MCONFIG=721,0,1,1,1,0,0,0,0,0,0,0             | OK       | Enable uFOTA setting:                                       |

| Command    | Response | Description                              |
|------------|----------|------------------------------------------|
|            |          | <server_id>: 721,<br><server_disabled>=0 |
| AT+CFUN=16 | OK       | Reset the module                         |

For the above guidelines to enable LwM2M client and/or uFOTA server, note that all configurations are persistent except:

- For modules that support the Backup & Restore feature, in the event of a Restore, configurations change to the setting on the Backup copy:
  - To allow restore at desired configuration, configure Backup action after the LwM2M client has been set (see the +UBKUPDATA AT command). For more details, see corresponding SARA-R4 or SARA-R5 development application development guide [\[4\]](#), [\[5\]](#), [\[6\]](#).
- MNO profile change via the +UMNOPROF AT command, then the settings will reset the default MNO profile configuration. This is also valid for re-setting the same MNO profile already configured.
- In SARA-R422 the LwM2M client reset by means of AT+ULWM2M=2 will also reset the +ULWM2MCONFIG settings. So if any server was enabled and LwM2M client is reset, the changes must be re-submitted.
- FW update may reset settings to the target FW defaults.
  - Check target FW release notes for details and actions required.
  - If LwM2M client is disabled in the target FW, it is required to enable LwM2M client again via AT+ULWM2M=0 command. This will allow the FW update process (uFOTA) to conclude properly.

## 4 AT commands

For detailed AT command descriptions, see the SARA-R4 series AT commands manual [\[1\]](#) / SARA-R5 series AT commands manual [\[9\]](#).

### 4.1 Shut-down and start-up

The LwM2M client starts up along with the module.

On SARA-R410M and SARA-R412M, the +ULWM2M AT command shuts down and restore e the LwM2M client to factory-programmed settings. See example sequences in [Table 7](#).

| Command                     | Response | Description                                                                                                                |
|-----------------------------|----------|----------------------------------------------------------------------------------------------------------------------------|
| <b>Stop LwM2M client</b>    |          |                                                                                                                            |
| AT+ULWM2M=1                 | OK       | Stop the LwM2M client. Wait for the URC indicating the shut-down completion.                                               |
| AT+CFUN=15                  | OK       | Reset the module and restart the LwM2M client. Wait for the URC that indicates the process is up.                          |
| <b>Restore LwM2M client</b> |          |                                                                                                                            |
| AT+ULWM2M=2                 | OK       | Stop the LwM2M client and return to factory-programmed settings. Wait for the URC that indicates the shut-down completion. |
| AT+CFUN=15                  | OK       | Reset the module to restart the LwM2M client.                                                                              |

**Table 7: SARA-R410M and SARA-R412M stop and restore LwM2M client procedure**

 In the undefined (+UMNOPROF: 0) configuration, the LwM2M client does not start regardless of the +ULWM2M AT command configuration.

 On SARA-R410M-63B the +ULWM2M AT command supports two additional <activation\_mode> parameter values, <activation\_mode>=3 and <activation\_mode>=4, to disable and enable communication with the NTT DoCoMo LwM2M server when the NTT DoCoMo MNO profile is activated. These parameter settings are persistent across power cycles.

On SARA-R5 series and SARA-R422 / SARA-R422S / SARA-R422M8S / SARA-R422M10S, the AT+ULWM2M=0 and AT+ULWM2M=1 commands save the enabled flag in NVM, while the AT+ULWM2M=2 AT command performs a reset of the LwM2M client.

| Command                     | Response | Description                                                            |
|-----------------------------|----------|------------------------------------------------------------------------|
| <b>Disable LwM2M client</b> |          |                                                                        |
| AT+ULWM2M=1                 | OK       | Disables the LwM2M client. The setting will be effective after reboot. |
| AT+CFUN=16                  | OK       | Reboot the module.                                                     |
| <b>Enable LwM2M client</b>  |          |                                                                        |
| AT+ULWM2M=0                 | OK       | Enables the LwM2M client. The setting will be effective after reboot.  |
| AT+CFUN=16                  | OK       | Reboot the module to restart the LwM2M client.                         |
| <b>Restore LwM2M client</b> |          |                                                                        |
| AT+ULWM2M=2                 | OK       | Erases the persistent data of the LwM2M client. A reboot is needed.    |

| Command    | Response | Description                                    |
|------------|----------|------------------------------------------------|
| AT+CFUN=16 | OK       | Reboot the module to restart the LwM2M client. |

**Table 8: SARA-R5 and SARA-R422 / SARA-R422S / SARA-R422M8S / SARA-R422M10S stop and restore LwM2M client procedure**

-  In the regulatory (+UMNOPROF: 0) and the GCF-PTCRB (+UMNOPROF: 201) configurations, the LwM2M client does not start regardless of the +ULWM2M AT command configuration.
-  Changing the MNO profile (followed by a module reboot by the +CFUN AT command) back and forth also re-initializes the LwM2M client to the factory-programmed settings for the MNO profile. (For more details, see the +UMNOPROF command in SARA-R4 series AT commands manual [1] / SARA-R5 series AT commands manual [9].)
-  On SARA-R4 "02B", "63B", "73B", "83B" product versions additional steps of changing the MNO profile back and forth needs to be done to complete a factory-programmed reset if the +ULWM2MCONFIG AT command was used previously as described in section 5.1.4. i.e., AT+UMNOPROF=0 followed by AT+CFUN=15 and AT+UMNOPROF=<previously configured profile> followed by another AT+CFUN=15.
-  On SARA-R5 series: the LwM2M client keeps separate configuration sets for AT&T (+UMNOPROF: 2), Verizon (+UMNOPROF: 3) and for all other cases. If the +ULWM2MCONFIG or +ULWM2MCONFIGEXT AT commands have been previously issued, the MNO switch via +UMNOPROF AT command will select another set of configurations, but it does not erase the previous configuration. If an MNO is selected back and forth, the same configuration will be restored at the same MNO.

URCs indicate the readiness state of the LwM2M client. The +ULWM2MSTAT AT command can be used to turn on the URC, which will show up when the state changes. For detailed descriptions of the status codes, see the SARA-R4 series AT commands manual [1] / SARA-R5 series AT commands manual [9].

| Command         | Response          | Description                           |
|-----------------|-------------------|---------------------------------------|
| AT+ULWM2MSTAT=1 | OK                | Turn on the URC (enabled by default). |
| AT+ULWM2MSTAT=0 | OK                | Turn off the URC.                     |
| <b>URCs</b>     |                   |                                       |
|                 | +ULWM2MSTAT: 4, 7 | LwM2M process has shut down.          |
|                 | +ULWM2MSTAT: 4, 0 | LwM2M process up and ready.           |

-  On SARA-R5 series the LwM2M client status URC (<event>=4) is not supported.

#### 4.1.1 SARA-R5 series and SARA-R422: LwM2M client initialization URCs

It is possible to enable +ULWM2MSTAT URCs for LwM2M client initialization complete status (<event>=5). This is done by setting the <verbosity\_mask> parameter in the +ULWM2MSTAT command.

| Command            | Response          | Description                                           |
|--------------------|-------------------|-------------------------------------------------------|
| AT+ULWM2MSTAT=1, 2 | OK                | Turn on the URC (Client initialization only).         |
| AT+ULWM2MSTAT=1, 3 | OK                | Turn on the URC (Client initialization and activity). |
| <b>URCs</b>        |                   |                                                       |
|                    | +ULWM2MSTAT: 5, 1 | LwM2M initialization started                          |
|                    | +ULWM2MSTAT: 5, 2 | LwM2M initialization finished                         |
|                    | +ULWM2MSTAT: 5, 3 | LwM2M initialization stopped due to production mode   |

On SARA-R510S-00B-00, SARA-R510M8S-00B-00, and SARA-R500S-00B-00 the <verbosity\_mask> parameter and the <event>=5 are not supported.

#### 4.1.2 SARA-R5 series and SARA-R422: LwM2M server connection status URCs

It is possible to enable +ULWM2MSTAT URCs for LwM2M server connection status (<event>=6). This is done by setting the <verbosity\_mask> parameter in the +ULWM2MSTAT command.

| Command           | Response                                                                  | Description                                      |
|-------------------|---------------------------------------------------------------------------|--------------------------------------------------|
| AT+ULWM2MSTAT=1,4 | OK                                                                        | Turn on the URC (server connection status only). |
| <b>URCs</b>       |                                                                           |                                                  |
|                   | +ULWM2MSTAT: 6,721,0,<br>"coaps://ucsplwm2m.servic<br>es.u-blox.com:5684" | LwM2M server connection created                  |
|                   | +ULWM2MSTAT: 6,721,1,<br>1254,4588                                        | LwM2M server connection suspended                |
|                   | +ULWM2MSTAT: 6,721,2,<br>"coaps://ucsplwm2m.servic<br>es.u-blox.com:5684" | LwM2M server connection resumed                  |
|                   | +ULWM2MSTAT: 6,721,3,<br>715,443                                          | LwM2M server connection closed                   |

On SARA-R510S-00B-00, SARA-R510M8S-00B-00, and SARA-R500S-00B-00 the <verbosity\_mask> parameter and the <event>=6 are not supported.

On SARA-R510S-00B-01, SARA-R510M8S-00B-01, and SARA-R500S-00B-01 the <event>=6 is not supported.

On SARA-R422 / SARA-R422S / SARA-R422M8S / SARA-R422M10S the <server\_connection\_status>=1 (connection suspended), 2 (connection restored) parameter values are not supported.

## 4.2 View existing objects

| Command                                                | Response                                                                                                                                                                                                                                                                                                                                                                                                                  | Description                                                                                                                                                                             |
|--------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AT+ULWM2MLIST="/"                                      | +ULWM2MLIST: "/1/1","/2/1","/2/2","/2/3","/2/4","/2/5","/2/6","/2/7","/2/8","/2/9","/2/10","/2/11","/2/12","/2/0","/3/0","/4/0","/5/0","/6","/7","/10","/11/0","/14/1","/14/2","/14/3","/14/4","/14/5","/14/6","/14/7","/14/0","/16","/0/1","/3300"<br>OK                                                                                                                                                                 | List all the objects and object instances on the device.<br>The response /3300 means this object has no instances yet but the object ID is available for use.                           |
| Command                                                | Response                                                                                                                                                                                                                                                                                                                                                                                                                  | Description                                                                                                                                                                             |
| AT+ULSTFILE=0,"XLWM2M"                                 | +ULSTFILE: "object_apn_connection_profile.lua","object_cellular_connectivity.lua","object_connectivity_monitoring.lua","object_connectivity_statistics.lua","object_device.lua","object_firmware_update.lua","object_generic_sensor.lua","object_location.lua","object_lwm2m_access_control.lua","object_lwm2m_security.lua","object_lwm2m_server.lua","object_lwm2m_software_component.lua","object_portfolio.lua"<br>OK | List all the objects and object instances on the device.<br> For SARA-R5 series, see the note below. |
| AT+ULSTFILE=2,"object_generic_sensor.lua","XLWM2M"     | +ULSTFILE: 11479<br>OK                                                                                                                                                                                                                                                                                                                                                                                                    | List file size of an object.                                                                                                                                                            |
| AT+ULSTFILE=1,"XLWM2M"                                 | +ULSTFILE: 9994240<br>OK                                                                                                                                                                                                                                                                                                                                                                                                  | List available space.<br>This is an estimated size. Practical usable space could be smaller based on bad blocks or flash memory conditions.                                             |
| AT+URDFILE="object_generic_sensor.lua","XLWM2M"        | +URDFILE: "object_generic_sensor.lua",11479, <contents of the file><br>OK                                                                                                                                                                                                                                                                                                                                                 | Display the file contents.                                                                                                                                                              |
| AT+URDBLOCK="object_generic_sensor.lua",0,186,"XLWM2M" | +URDBLOCK: "object_generic_sensor.lua",186, <contents of the file><br>OK                                                                                                                                                                                                                                                                                                                                                  | Display a file content based on offset and length.                                                                                                                                      |

 On SARA-R5 series default object definitions are embedded in the firmware, so they cannot be listed as normal files. They can only be listed by the +ULWM2MLIST AT command. But they can be redefined if a corresponding Lua object definition file is stored with the XLWM2M tag and the AT+ULWM2M=2 command is issued. The filenames must be exactly "object\_device.lua", "object\_lwm2m\_security.lua", "object\_lwm2m\_server.lua", "object\_lwm2m\_access\_control.lua", "object\_apn\_connection\_profile.lua", "object\_connectivity\_monitoring.lua", "object\_connectivity\_statistics.lua", "object\_portfolio.lua", "object\_firmware\_update.lua", "object\_att\_connectivity\_extension.lua". Any change of these internal objects will be effective after a reset of the client (with e.g. AT+ULWM2M=2, AT+UDELFILE="object.db","LWM2M" or by switching to a different MNO profile, followed by a module reset by the AT+CFUN=16 command).

## 4.3 Registration status and timer

For detailed AT command descriptions, see the SARA-R4 series AT commands manual [\[1\]](#) / SARA-R5 series AT commands manual [\[9\]](#).

The last registration time for each server is maintained in persistent storage, to calculate the need of a registration update by comparing it with the current time and the server lifetime. Changing the module time would affect this calculation. A forced registration might be needed.

### 4.3.1 Registration query and forcing a registration

The LwM2M client will register with the list of servers that have been configured in the “Server” object. The +ULWM2MREG AT command can be used to check the status on the registration if URCs are turned off. It may also report information that are not available via URC, such as a server being in “update needed” state.

| Command                                     | Response                      | Description                                                                                               |
|---------------------------------------------|-------------------------------|-----------------------------------------------------------------------------------------------------------|
| AT+ULWM2MREG?                               | +ULWM2MREG: 721,2,86281<br>OK | Server ID 721 is successfully registered (<status>=2) and the client will register once again in 86281 s. |
| <b>Force a registration</b>                 |                               |                                                                                                           |
| AT+ULWM2MREG=123                            | OK                            | Force a registration to server ID 123.                                                                    |
| <b>Force the bootstrap and registration</b> |                               |                                                                                                           |
| AT+ULWM2MREG=0                              | OK                            | Force a bootstrap and attempt registration on all configured servers.                                     |

The +ULWM2MREG read command might respond with an error result code while the LwM2M process are coming up after a reset. It could take ~60 s after a restart to respond back without an error result code.

An error result code may be provided while trying to force the registration if the module has not registered previously.

On SARA-R410M and SARA-R412M if the SIM card is locked with a PIN, the LwM2M client might not properly configure since it will not be able to retrieve SIM information. This is most relevant in VZW configuration (+UMNPROF: 3) where the SIM information is used to build UE endpoint name. It is then recommended to insert the SIM PIN, if enabled, within 10 s from module boot.

On SARA-R410M and SARA-R412M if the module boots up to +CFUN: 4 initially, the LwM2M client does not bootstrap and register. The host should issue the AT+ULWM2MREG=0 command once the AT+CFUN=1 command has been issued.

### 4.3.2 Registration URC

URCs have been added to indicate the registration state of the LwM2M client. The +ULWM2MSTAT AT command can be used to turn on the URC which will show up every ~60 s. For detailed descriptions of the status codes, see the SARA-R4 series AT commands manual [1] / SARA-R5 series AT commands manual [9].

| Command         | Response             | Description                                                                                                     |
|-----------------|----------------------|-----------------------------------------------------------------------------------------------------------------|
| AT+ULWM2MSTAT=1 | OK                   | Turn on the URC (disabled by default).                                                                          |
| AT+ULWM2MSTAT=0 | OK                   | Turn off the URC.                                                                                               |
| <b>URCs</b>     |                      |                                                                                                                 |
|                 | +ULWM2MSTAT: 1,721,3 | Event 1 is a registration status. Status 3 means registration failed with the u-blox server with server ID 721. |

| Command | Response                 | Description                                                                                                         |
|---------|--------------------------|---------------------------------------------------------------------------------------------------------------------|
|         | +ULWM2MSTAT: 1,721,2     | Status 2 means registration success with the u-blox server with server ID 721.                                      |
|         | +ULWM2MSTAT: 2,721,86305 | Event 2 means registration interval.<br>Re-registration will happen in 86305 s to u-blox server with server ID 721. |

- On SARA-R4 “63B”, “73B”, “83B” product versions the +ULWM2MSTAT URC is enabled by default.
- The u-blox LwM2M server is not supported when NTT DoCoMo MNO profile is activated. LwM2M DM and FOTA is done with the DoCoMo LwM2M server.

### 4.3.3 Forcing a deregistration

The LwM2M client can be instructed to de-register with the list of servers that have been configured in the “Server” object. The below command can be used to force deregistration from a server, or deregistration from all servers using option 0.

| Command                                         | Response | Description                                          |
|-------------------------------------------------|----------|------------------------------------------------------|
| <b>Force a de-registration</b>                  |          |                                                      |
| AT+ULWM2MDEREG=123                              | OK       | Force a deregistration from server ID 123.           |
| <b>Force a de-registration from all servers</b> |          |                                                      |
| AT+ULWM2MDEREG=0                                | OK       | Force a de-registration from all servers configured. |

- Once the deregistration has taken place, it is not possible to re-register again unless the module is reset by the +CFUN AT command.

## 4.4 Limit or remove the u-blox LwM2M server

If application wants to prevent periodic connection (24 h default lifetime) to u-blox LwM2M server (SSID 721), and shutting down the LwM2M client with the +ULWM2M AT command is not an option for the host application at boot-up, then it is possible to either extend the lifetime or remove the server from LwM2M client DB. The server is mainly used for uFOTA functionality.

- This action will limit or block uFOTA functionality, it will be not possible to deliver FOTA updates managed via LwM2M.

| Product                                                           | MNO profile                                              | Server Object URI <uri> | Description                                                                            |
|-------------------------------------------------------------------|----------------------------------------------------------|-------------------------|----------------------------------------------------------------------------------------|
| SARA-R410M /<br>SARA-R412M                                        | 2 (AT&T), 3 (Verizon), 198 (AT&T 2-4-12), 206 (FirstNet) | /1/721                  | Applicable to any VZW and AT&T-related profile                                         |
|                                                                   | 20 (NTT DoCoMo)                                          | N.A.                    | Not applicable to DoCoMo profile since u-blox server is already not present by default |
|                                                                   | Others <mno>                                             | /1/1                    |                                                                                        |
| SARA-R422-00B /<br>SARA-R422S-00B /<br>SARA-R422M8S               | Any                                                      | /1/1                    |                                                                                        |
| SARA-R5 /<br>SARA-R422-01B /<br>SARA-R422S-01B /<br>SARA-R422M10S | Any                                                      | /1/10                   |                                                                                        |

The server object is deleted with following sequence:

| Command                                                           | Response         | Description                                                                                |
|-------------------------------------------------------------------|------------------|--------------------------------------------------------------------------------------------|
| <b>Check for the desired server Object instance to be deleted</b> |                  |                                                                                            |
| AT+ULWM2MLIST="/"                                                 | "<list_of_uris>" | List of all objects and objects' instances' <uri>'s                                        |
| <b>Delete the server Object instance</b>                          |                  |                                                                                            |
| AT+ULWM2MDELETE="<uri>"                                           | OK               | Delete server <uri> as per table above                                                     |
| <b>Wait at least 40s</b>                                          |                  |                                                                                            |
| AT+CFUN=15                                                        | OK               | Reboot to apply the new configuration                                                      |
| <b>Confirm server Object instance deleted</b>                     |                  |                                                                                            |
| AT+ULWM2MLIST="/"                                                 | "<list_of_uris>" | List of all objects and objects' instances' <uri>'s<br>Confirm target server <uri> deleted |

The lifetime is modified with following sequence:

| Command                                                                       | Response                                                                                      | Description                                                                                    |
|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| <b>Check server lifetime value</b>                                            |                                                                                               |                                                                                                |
| AT+ULWM2MREAD="<uri>"                                                         | +ULWM2MREAD: {"bn": "<uri>", "e": [{"n": "0", "v": 721}, {"n": "1", "v": "<lifetime value>"}] | Use appropriate value for <uri> e.g. /1/10<br>Confirm present lifetime value for server ID 721 |
| <b>Write server lifetime</b>                                                  |                                                                                               |                                                                                                |
| AT+ULWM2MWRITE="{\"bn\": \"<uri>\", \"e\": [{\"n\": \"0\", \"v\": 2592000}]}" | OK                                                                                            | Lifetime changed for <uri> as per table above.<br>Set to suggested 30d                         |
| <b>Wait at least 40s</b>                                                      |                                                                                               |                                                                                                |
| AT+CFUN=15                                                                    | OK                                                                                            | Reboot to apply the new configuration                                                          |
| <b>Confirm updated server lifetime value</b>                                  |                                                                                               |                                                                                                |
| AT+ULWM2MREAD="<uri>"                                                         | +ULWM2MREAD: {"bn": "<uri>", "e": [{"n": "0", "v": 721}, {"n": "1", "v": 2592000}]}           | Use appropriate value for <uri> e.g. /1/10<br>Confirm applied lifetime value to server ID 721  |

Upon deletion of the server instance or changing of the server lifetime, the client will perform a registration update to the listed servers, to notify the change. Registration update success is not mandatory for the change to apply.

The new configuration is saved in the NVM. The change can be reverted with any of the following:

- Re-bootstrap via the AT+ULWM2M=2 command
- Re-bootstrap via server command
- MNO profile change by the +UMNOPROF AT command

## 4.5 Read and write to objects

The +ULWM2MREAD and +ULWM2MWRITE AT commands follow the JSON format specified in the OMA technical specification Lightweight M2M [7].

The +ULWM2MREAD AT command can be typically used to:

- To read the registration timer for an Lwm2m server
- To read the previous value of a sensor resource

As shown in the examples below, the +ULWM2MREAD AT command reads an object, object instance, or resource. For example, to read the entire object "/3300/0", which is the generic sensor object.

| Command                      | Response                                                                                                                                                                       | Description                                                     |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|
| <b>Reading an instance</b>   |                                                                                                                                                                                |                                                                 |
| AT+ULWM2MREAD="/3300/0"      | +ULWM2MREAD: {"bn":"/3300/0","e":[{"n":"5700","sv":"25"}, {"n":"5701","sv":"Celsius"}, {"n":"5601","sv":"25"}, {"n":"5602","sv":"25"}, {"n":"5750","sv":"Temperature"}]}<br>OK | Read the object instance 0 for the object 3300.                 |
| <b>Reading a resource</b>    |                                                                                                                                                                                |                                                                 |
| AT+ULWM2MREAD="/3300/0/5601" | +ULWM2MREAD: {"bn":"/3300/0/5601","e":[{"n":"5601","v":0}]}<br>OK                                                                                                              | Read the object instance 0's resource 5601 for the object 3300. |

There is a character limit of 1040 characters per line. Hence if there is an object with a lot of data, the resources can be read one at a time like the above example.

**For application developers:** the parsing of the +ULWM2MREAD information text response must be handled appropriately, because JSON permits multiple configurations for URI formatting. The "ID structure" returned by the +ULWM2MREAD AT command might vary based on the query and the object itself. See the examples below for how the "bn" field varies.

| Command                                                                                                                                                                               | Response                                                                                                    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| <b>Example 1: Read the entire object instance, the base name appears as /object/object instance of the portfolio object:</b>                                                          |                                                                                                             |
| AT+ULWM2MREAD="/16/0"                                                                                                                                                                 | +ULWM2MREAD: {"bn":"/16/0/","e":[{"n":"0/1","sv":"test2"}, {"n":"0/0","sv":"test"}, {"n":"3","v":0}]}<br>OK |
| <b>Example 2: Read the specific resource, the base name appears as /object/object instance/resource:</b>                                                                              |                                                                                                             |
| AT+ULWM2MREAD="/16/0/0"                                                                                                                                                               | +ULWM2MREAD: {"bn":"/16/0/0/","e":[{"n":"1","sv":"test2"}, {"n":"0","sv":"test"}]}<br>OK                    |
| <b>Example 3: Read the entire object instance of a custom object with only a single resource, which is multi-instance, the base name appears as /object/object instance/resource:</b> |                                                                                                             |
| AT+ULWM2MREAD="/33056/0"                                                                                                                                                              | +ULWM2MREAD: {"bn":"/33056/0/1/","e":[{"n":"1","v":0}]}<br>OK                                               |

The +ULWM2MWRITE AT command allows an external host to change the value of a resource, the values of an array of resource instances, or the values of multiple resources from an object instance.

The +ULWM2MWRITE AT command can be typically used to:

- Change the lifetime timer for the LwM2M server
- Write a measurement from a sensor object
- Updating the device location in the location object
- Writing an error code to the device

As shown in the example below, the +ULWM2MWRITE AT command writes to the object instance's resource. For example, to write to the object Instance "/3300/0" resource "5700", which could be the generic sensor's object temperature. The contents are in general not immediately saved in non-volatile memory (NVM), so it is possible to issue the command with an empty string, in this way the changes are committed to the file system and it is safe to turn off the module.

| Command                                                                                   | Response | Description                                                            |
|-------------------------------------------------------------------------------------------|----------|------------------------------------------------------------------------|
| AT+ULWM2MWRITE="{\"bn\": \"/3300<br>/0\", \"e\": [{\"n\": \"5700\", \"v<br>\": 100.5}]}\" | OK       | Write to an object 3300 instance 0's resource 5700 the value of 100.5. |
| AT+ULWM2MWRITE=""                                                                         | OK       | Save changes in NVM                                                    |

On SARA-R510M8S-00B-00, SARA-R510S-00B-00, and SARA-R500S-00B-00 the AT+ULWM2MWRITE="" command is not supported.

On SARA-R4 series modules the AT+ULWM2MWRITE="" command is not supported.

## 4.6 AT&T ODIS functionality

SARA-R410M / SARA-R412M and SARA-R422-01B / SARA-R422S-01B / SARA-R422M10S and SARA-R5 modules in +UMNOPROF: 2 configuration are certified for AT&T LwM2M DM. This means they also comply with AT&T requirement "<CDR-DVM-1600> Local Read and Write Access to Host Device Details for an IoT Module".

Modules support the +ODIS AT command which populates host device information in LwM2M Host Device Object 10241. The command is present only when AT&T MNO profile is selected by the +UMNOPROF AT command.

Host device information contains default values of factory-programmed configuration, as required by AT&T. According to AT&T:

<CDR-DVM-1602> Device Initiated Alert Upon Change to Host Device Detail: [...] The IoT module with a LWM2M client will automatically notify and report the change to the Host Device (ODIS) details inside the LWM2M Portfolio Object if there is a pre-existing Observe command on the LWM2M server.

The +ODIS settings are persistent upon power cycles. However, they need to be re-configured by host application in the following cases:

- Factory reset by the AT+UFACTORY=2,x command (where supported)
- LwM2M client reset by AT+ULWM2M=2 command
- FW update, all methods excluding uFOTA (FW update via LwM2M client)
- MNO profile change by the +UMNOPROF AT command

| Command                                              | Response                                       | Description                                                                                                   |
|------------------------------------------------------|------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| AT+ODIS?                                             | +ODIS: "HMAN0", "HMOD0", "HSW0"<br>OK          | Get ODIS factory-programmed values                                                                            |
| AT+ODIS="TestID1", "TestMAN1", "TestMOD1", "TestSW1" | OK                                             | Configure ODIS information with custom data. Notice that the first parameter (Host Device ID) is not readable |
| AT+ODIS?                                             | +ODIS: "TestMAN1", "TestMOD1", "TestSW1"<br>OK | Get custom ODIS data.                                                                                         |

## 5 Operational examples

### 5.1 Adding an additional server to the client

By default, the module communicates with u-blox server (ID 721) as defined in the bootstrap object. For testing purposes, an additional server instance can be created for the client, for example, a demo Leshan server. The following examples use CoAP / CoAPS URL of a test Leshan server.

The +ULWM2MCREATE AT command can be used to accomplish “Adding an additional server”. The +ULWM2MCREATE AT command uses JSON format as defined in the OMA technical specification Lightweight M2M [7]. Note that if the JSON data contains embedded double quotes, they must be properly escaped with a backslash character “\”.

To add a new server, a “Security” object instance and “Server” object instance needs to be created and configured. In addition, a security configuration needs to be applied. In this example a demo Leshan server hosted by the u-blox support team is added.

#### 5.1.1 Creating the security object instance

Follow one of the steps listed below to create the security object, without or with DTLS. The added instance can be deleted using the +ULWM2MDELETE AT command, see section 5.1.3.

 For details, see [http://www.openmobilealliance.org/tech/profiles/LWM2M\\_Security-v1\\_0.xml](http://www.openmobilealliance.org/tech/profiles/LWM2M_Security-v1_0.xml).

| Command                                                                                                                                                                                                                                                                          | Response | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Add a new “Security” object instance for CoAP</b>                                                                                                                                                                                                                             |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| AT+ULWM2MCREATE="{\"bn\": \"0/2/\", \"e\": [{\"n\": \"0\", \"sv\": \"coap://54.193.4.219:5683\"}], \"n\": \"1\", \"bv\": false}, {\"n\": \"2\", \"v\": 3}, {\"n\": \"10\", \"v\": 123}]", 123                                                                                    | OK       | <ul style="list-style-type: none"> <li>coap://54.193.4.219:5683 is the demo Leshan server CoAP URL.</li> <li>"false" indicates that it is not a bootstrap server</li> <li>"v":3 indicates its non-secure</li> <li>123 is the short server ID</li> <li>The server ID 123 is specified again in the +ULWM2MCREATE AT command to assign the owner of the object instance in the associated ACL object instance.</li> </ul>                                                                                                                                                     |
| <b>Add a new “Security” object instance for CoAPS (DTLS)<sup>2</sup></b>                                                                                                                                                                                                         |          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| AT+ULWM2MCREATE="{\"bn\": \"0/2/\", \"e\": [{\"n\": \"0\", \"sv\": \"coaps://54.193.4.219:5684\"}], \"n\": \"1\", \"bv\": false}, {\"n\": \"2\", \"v\": 0}, {\"n\": \"3\", \"sv\": \"MzUyNzUzMDk1Nzg3NjE4\", \"n\": \"10\", \"v\": 123}, {\"n\": \"5\", \"sv\": \"q83v\"}]", 123 | OK       | <ul style="list-style-type: none"> <li>coaps://54.193.4.219:5684 is a demo Leshan server CoAPS URL.</li> <li>"false" indicates that it is not a bootstrap server</li> <li>"v":0 indicates its secure</li> <li>MzUyNzUzMDk1Nzg3NjE4 is the base64 version of 352753095787618 [i.e. IMEI]</li> <li>:123 is the short server ID</li> <li>q83v is the base64 format of the HEX string 0xAB,0xCD,0xEF</li> <li>The server ID 123 is specified again in the +ULWM2MCREATE AT command to assign the owner of the object instance in the associated ACL object instance.</li> </ul> |

<sup>2</sup> See appendix A for details on how to add a PSK to the Leshan server

The +ULWM2MREAD AT command cannot be used to read the "/0" object as it is a security object and hence the PSK cannot be seen via the AT command.

In SARA-R5 series modules the DTLS cipher suites will be added automatically. The used cipher suites (CS) will be the ones supported by Certificates and security profiles manager (CSPM); for additional info about the +USECPRF AT command, see SARA-R5 series AT commands manual [9].

## 5.1.2 Creating the server object instance

For more details, see [http://www.openmobilealliance.org/tech/profiles/LWM2M\\_Server-v1\\_0.xml](http://www.openmobilealliance.org/tech/profiles/LWM2M_Server-v1_0.xml).

| Command                                                                                                                                                                                                                                        | Response | Description                                                                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|----------------------------------------------------------------------------------|
| AT+ULWM2MCREATE="{\"bn\":\"/1/2/\", \"e\": [{\"n\":\"0\", \"v\":123}, {\"n\":\"1\", \"v\":300}, {\"n\":\"2\", \"v\":10}, {\"n\":\"3\", \"v\":60}, {\"n\":\"5\", \"v\":86400}, {\"n\":\"6\", \"bv\":false}, {\"n\":\"7\", \"sv\":\"UQ\"}]}, 123 | OK       | 123 is the short server ID.<br>300 is the life timer (registration timer) value. |

## 5.1.3 Deleting an Instance of an object

The +ULWM2MDELETE AT command deletes an instances of a LwM2M object. The below command deletes the instance of a security object and a server object. The AT+ULWM2MDEREG=123 command deregisters the module from the server 123 (server ID 123 used as an example), which must be done prior to deleting the instances as shown below.

| Command                | Response | Description                     |
|------------------------|----------|---------------------------------|
| AT+ULWM2MDELETE="/0/2" | OK       | Deleting instance of an object. |
| AT+ULWM2MDELETE="/1/2" | OK       |                                 |

Reboot the module after having executed the above steps.

## 5.1.4 Security configuration

In addition to the above steps the below configuration step is needed to set the server connection preferences for the LwM2M client and the security feature. The configuration specifies the PDP identifier, connection type, and whether to use security. When creating a new server, after the +ULWM2MCREATE AT command is issued (see section 5.1.2), issue the +ULWM2MCONFIG AT command to set the server connection preferences. The module can obtain a PSK using the security feature as well. For more details, see u-blox security data suite application note [7].

| Command                     | Response | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AT+ULWM2MCONFIG=123,0,1,1,0 | OK       | <ul style="list-style-type: none"> <li>Server ID 123 is being configured here.</li> <li>bootstrap_on_failure: 0 means false here and the device will not attempt bootstrap after a failed registration</li> <li>pdn_type: 1 means IPv4</li> <li>pdn_context_id: 1 is the cid<br/>Note that the value for this parameter is the index returned by<br/>+CGDCONT: 1, "IP", "phone", "10.0.0.1", 0, 0, 0, 0</li> <li>usec_psk: 0 here means the device will not use security feature to obtain PSK.</li> </ul> |

-  Reboot the module to re-initialize for client/server to pick up the above changes.
-  If the `<usec_psk>=0` in an LwM2M configuration file entry for a particular LwM2M server, provide the PSK and PSK identifier as Base64 encoded values and write the associated LwM2M security object instance.
-  On SARA-R410M-02B and SARA-R412M-02B `<usec_psk>` must be 0.
-  If the `<usec_psk>=1` for a particular LwM2M server, the PSK and PSK identifier will be generated internally by the uSec application. In this case, new PSK and PSK identifier values are created prior to each full LwM2M registration attempt and are stored in the associated security object instance. In the table in section 5.1.1 `{"n":"3","sv":"MzUyNzUzMDk1Nzg3NjE4"}` and `{"n":"5","sv":"q83v"}` need not be issued in the command discussed.
-  An LwM2M server must use the u-blox uCSP service to validate the credentials. For more details, see u-blox IoT Security-as-a-Service overview [8].

### 5.1.5 Restarting and checking URCs

The following example shows the URCs with the new server ID 123 (make sure to toggle the DTR line for the URCs). For detailed URC descriptions, see the SARA-R4 series AT commands manual [1] / SARA-R5 series AT commands manual [9].

| Command                                                                                                  | Response               | Description                        |
|----------------------------------------------------------------------------------------------------------|------------------------|------------------------------------|
| <b>SARA-R410M-63B / SARA-R410M-73B / SARA-R410M-83B</b>                                                  |                        |                                    |
|                                                                                                          | +ULWM2MSTAT: 1,123,2   | Indicates successful registration. |
|                                                                                                          | +ULWM2MSTAT: 2,123,204 | Timer counting down.               |
| <b>SARA-R5 / SARA-R410M-02B / SARA-R412M-02B / SARA-R422 / SARA-R422S / SARA-R422M8S / SARA-R422M10S</b> |                        |                                    |
|                                                                                                          | +ULWM2MSTAT: 1,123,3   | Indicates successful registration. |
|                                                                                                          | +ULWM2MSTAT: 2,123,204 | Timer counting down.               |

If the above 2 steps are successfully performed, the device's IMEI would be seen on the LwM2M server's client page.

## 5.2 Modifying the registration update timer

For detailed AT command descriptions, see SARA-R4 series AT commands manual [1] / SARA-R5 series AT commands manual [9].

Every time the module connects to the LwM2M server, it maintains the connection only for ~30 s and this cannot be modified. However, changing the life timer to a smaller value like 180 s (it must be greater than 90 s at a minimum due to COAP transmit wait time) will get the client to communicate more often and hence while testing, the objects can be read more often from the server.

The registration timer of server "/1/2" which was the new server ID 123 created in the previous section was configured with 300 s. In the below example, it has been modified to 180 s.

| Command                                                                        | Response | Description                             |
|--------------------------------------------------------------------------------|----------|-----------------------------------------|
| AT+ULWM2MWRITE="{\"bn\":\"/1/2/\" OK<br>,\"e\":{\"n\":\"1\", \"v\":180}}}<br>" |          | Change the registration timer to 180 s. |

Shorter timers mean communicating with the server more often. Hence the above change to shorter timer is only for a testing purpose. In a production deployment the registration timer would probably be longer, e.g., once an hour or once a day, depending on the end application.

On SARA-R4 series Softbank MNO profile does not allow writing to the registration timer. The default is 2 weeks.

The below URCs might be received after entering the above command. For detailed URC descriptions, see the SARA-R4 series AT commands manual [1] / SARA-R5 series AT commands manual [9].

| Command                                                                                                  | Response              | Description                           |
|----------------------------------------------------------------------------------------------------------|-----------------------|---------------------------------------|
| <b>SARA-R410M-63B / SARA-R410M-73B / SARA-R410M-83B</b>                                                  |                       |                                       |
|                                                                                                          | +ULWM2MSTAT: 1,123,2  | Indicates successful registration.    |
|                                                                                                          | +ULWM2MSTAT: 2,123,90 | New registration timer counting down. |
| <b>SARA-R5 / SARA-R410M-02B / SARA-R412M-02B / SARA-R422 / SARA-R422S / SARA-R422M8S / SARA-R422M10S</b> |                       |                                       |
|                                                                                                          | +ULWM2MSTAT: 1,123,3  | Indicates successful registration.    |
|                                                                                                          | +ULWM2MSTAT: 2,123,90 | New registration timer counting down. |

To force a registration update (using short server ID), see section 4.3.

## 5.3 Adding a new object / instance / resource

The example shown below is for the “Generic Sensor” object. For detailed AT command descriptions, see the SARA-R4 series AT commands manual [1] / SARA-R5 series AT commands manual [9].

This object is already present on the SARA-R4 "63B", "73B", "83B" product versions. The object can be deleted and reloaded for testing purposes.

On SARA-R5 series, the “Compiled Lua” or “Lua Bytecode” format is not supported. All Lua files must be in plain text, readable Lua code.

### 5.3.1 Removing objects/instances

The +ULWM2MREMOVE AT command removes an object from the LwM2M object table, along with any existing instances from the memory. The Lua object file on the device file system is not removed and can be deleted using the +UDELFIL AT command.

An object that has been removed from the LwM2M object table cannot have a create operation performed. In the below example, the object\_generic\_sensor 3300 is removed and in the later sections the object is added again as an example.

| Command                                      | Response                                                                                                                                                                                                                                                                                   | Description                                                  |
|----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| AT+ULWM2MLIST="/"                            | +ULWM2MLIST: "/1/1","/2/1","/2/2",<br>,<br>"/2/3","/2/4","/2/5","/2/6",<br>"/2/7","/2/8","/2/9","/2/10",<br>"/2/11","/2/12","/2/0","/3/0",<br>"/4/0","/5/0","/6","/7","/10",<br>"/11/0","/14/1","/14/2","/14/3",<br>"/14/4","/14/5","/14/6","/14/7",<br>"/14/0","/16","/0/1","/3300"<br>OK | Object ID /3300 is present in the list of objects.           |
| AT+ULWM2MREMOVE="/3300"                      | OK                                                                                                                                                                                                                                                                                         | Remove object ID /3300                                       |
| <b>List the objects and object instances</b> |                                                                                                                                                                                                                                                                                            |                                                              |
| AT+ULWM2MLIST="/"                            | +ULWM2MLIST: "/1/1","/2/1","/2/2",<br>,<br>"/2/3","/2/4","/2/5","/2/6",<br>"/2/7","/2/8","/2/9","/2/10",                                                                                                                                                                                   | Object ID /3300 is no longer present in the list of objects. |

| Command                                              | Response                                                                                                                                                               | Description                                 |
|------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|
|                                                      | "/2/11","/2/12","/2/0","/3/0",<br>"/4/0","/5/0","/6","/7","/10",<br>"/11/0","/14/1","/14/2","/14/3",<br>"/14/4","/14/5","/14/6","/14/7",<br>"/14/0","/16","/0/1"<br>OK |                                             |
| <b>Delete the object file</b>                        |                                                                                                                                                                        |                                             |
| AT+UDELFILE="object_generic_sens<br>r.lua", "XLWM2M" | OK                                                                                                                                                                     | Remove the Lua object file from the module. |

| Command                 | Response                                                                                                                                                                                                                                                                                                                                                                                                                                             | Description                                       |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|
| AT+ULSTFILE=0, "XLWM2M" | +ULSTFILE: "object_apn_connection<br>_profile.lua", "object_cellular_co<br>nnectivity.lua", "object_connectiv<br>ity_monitoring.lua", "object_conne<br>ctivity_statistics.lua", "object_d<br>evice.lua", "object_firmware_updat<br>e.lua", "object_location.lua", "obj<br>ect_lwm2m_access_control.lua", "ob<br>ject_lwm2m_security.lua", "object_<br>lwm2m_server.lua", "object_lwm2m_s<br>oftware_component.lua", "object_po<br>rtfolio.lua"<br>OK | List all the object Lua files on the file system. |



On SARA-R5 series modules the object definitions embedded in the FW cannot be deleted.

### 5.3.2 Adding objects



For more details, see <http://www.openmobilealliance.org/tech/profiles/lwm2m/3300.xml>.

Contact u-blox support for getting this sample Lua object. The sample Lua provided by u-blox support will have some additional code snippets which use features like GPIO and URC for notification.

Add an object to the Lwm2M object table before to perform some "Create" or "Delete" operations. The +ULWM2MADD AT command adds an object that has been copied to the device file system to the Lwm2M object table.

| Command                                                                      | Response                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Description                            |
|------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| AT+UDWNFILE="object_generic_sens<br>r.lua", 11668, "XLWM2M"<br>> [Send data] | OK                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Adding generic sensor Lua object file. |
| AT+ULSTFILE=0, "XLWM2M"                                                      | +ULSTFILE: "object_apn_connection<br>_profile.lua", "object_cellular_co<br>nnectivity.lua", "object_connectiv<br>ity_monitoring.lua", "object_conne<br>ctivity_statistics.lua", "object_d<br>evice.lua", "object_firmware_updat<br>e.lua", " <b>object_generic_sensor.lua</b> ",<br>"object_location.lua", "object_l<br>wm2m_access_control.lua", "object_<br>lwm2m_security.lua", "object_lwm2m<br>_server.lua", "object_lwm2m_softwa<br>re_component.lua", "object_portfol<br>io.lua"<br>OK | List all the object Lua files.         |
| AT+ULWM2MADD="object_generic_sens<br>or.lua"                                 | OK                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Load the Lua object to start using it. |

It is recommended to pre-validate the custom Lua file before storing it in module. Tools like LUAC are available for free on the web to compile the Lua script and confirm it will be functional when loaded by the resident LwM2M client.

If the +ULWM2MADD AT command returned an error result code, then the file has to be removed from the file system (via the `AT+ULWM2MDELETE=<filename>, "XLWM2M"` AT command) otherwise the LwM2M client will attempt to load it at next boot, it will fail to initialize and will exit.

The successful client initialization can be checked with the command `AT+ULWM2MLIST=""`.

On SARA-R422 / SARA-R422S / SARA-R422M8S / SARA-R422M10S the URCs showed at next boot in case of error will be the following:

| URCs             | Description                  |
|------------------|------------------------------|
| +ULWM2MSTAT: 5,1 | LwM2M initialization started |
| +ULWM2MSTAT: 4,6 | LwM2M client exit            |

If the file is not removed from the file system, the LwM2M client will not start.

**For application developers:** applications should limit the addition/deletion of objects during the operational lifetime of a module. Objects are expected to be instantiated and then written to and read from.

- **Data usage:** addition and deletion of an object triggers a communication between the client and the LwM2M servers. The client controls this activity per the OMA standard.
- **Memory:** adding objects uses up memory resources on the module. The memory is finite and in addition to LwM2M there are other processes that run on the module like uFOTA, security etc. Hence it is not possible to provide an estimate on how many objects can be created during operations. It is recommended to not perform bulk addition of new objects but to add and test every single object.
- **Error:** the +ULWM2MADD AT command might respond with an OK final result code and not report an error result code when it has failed to add the object to the memory due to a lack of resources on the module.

### 5.3.3 Creating an object instance

The +ULWM2MCREATE AT command allows to create an object instance and make the given server ID the owner of the object (has full permissions to the object).

In the below example a new instance of the generic sensor object instance is created, and server ID 123 is made the owner of it. In addition, a resource 5750 is also being set to App type "Temperature".

All the LwM2M servers that the client registers to are aware of all object instances, though they may not have permissions on a given instance.

| Command                                                                                           | Response | Description                                                                                                                                                                                                                                                                                                             |
|---------------------------------------------------------------------------------------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AT+ULWM2MCREATE="{\"bn\": \"3300/ 0\", \"e\": [{\"n\": \"5750\", \"sv\": \"Temperature\"}]}", 123 | OK       | Create an object instance and populate it with some resources. The server ID is 123 specifies the owner of the object instance.<br>5750 is a resource for the object 3300's instance 0 and it represents "Temperature".<br>See section 4.4 for the +ULWM2MNOTIFY URC that might be received after running this command. |

| Command           | Response                                                                                                                                                                                                                                                    | Description                                                            |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| AT+ULWM2MLIST="/" | +ULWM2MLIST: "/1/1","/2/1","/2/2","/2/3","/2/4","/2/5","/2/6","/2/7","/2/8","/2/9","/2/10","/2/11","/2/12","/2/0","/3/0","/4/0","/5/0","/6","/7","/10","/11/0","/14/1","/14/2","/14/3","/14/4","/14/5","/14/6","/14/7","/14/0","/16","/0/1","/3300/0"<br>OK | List all the object and Instances to verify that /3300/0 being listed. |

 **For application developers:** applications should limit the creation/deletion of object instances and should not do this too often. Objects are resources that are written to or read from.

- **Data usage:** creation and deletion of an object on the LwM2M client triggers communication between the client and the LwM2M servers. The client controls this activity per the OMA standard.
- **Memory:** memory is finite and creating an object instance uses up memory resources on the module, which is shared with other background processes like uFOTA, security etc. It is recommended to not perform bulk creation of new object instances but to create and test every single object instance.
- **Error:** the +ULWM2MCREATE AT command might respond with an OK and report an error result when it has failed to add an instance to the memory due to a lack of resource on the module.

### 5.3.4 Writing and reading a value to a resource

| Command                                                                           | Response                                                                                                                                                                                                                        | Description                                                                                                                                                                                           |
|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Write a value to one of the resources</b>                                      |                                                                                                                                                                                                                                 |                                                                                                                                                                                                       |
| AT+ULWM2MWRITE="{\"bn\":\"/3300/0\", \"e\": [{\"n\":\"5700\", \"v\":\"100.5\"}]}" | OK                                                                                                                                                                                                                              | Write the value of 100.5 to a resource.                                                                                                                                                               |
| <b>Read all resources of the instance</b>                                         |                                                                                                                                                                                                                                 |                                                                                                                                                                                                       |
| AT+ULWM2MREAD="/3300/0"                                                           | +ULWM2MREAD: {"bn":"/3300/0","e":[{"n":"5601","v":100.5}, {"n":"5602","v":100.5}, {"n":"5603","v":0}, {"n":"5700","v":100.5}, {"n":"5701","sv":""}, {"n":"5750","sv":"Temperature"}, {"n":"5751","sv":""}, {"n":"5604","v":0}]} | Read all the resources of instance 0 of object ID 3300.                                                                                                                                               |
| <b>URC</b>                                                                        |                                                                                                                                                                                                                                 |                                                                                                                                                                                                       |
|                                                                                   | +ULWM2MSTAT: 3,123,/3300/0/5700                                                                                                                                                                                                 | This URC might be seen if the LwM2M server is registered for observing. Specifically, event 3 is a notification that the client is triggering the conditions to send the current value to the server. |

| Generic Sensor                    |              | /3300   |           |      |             |
|-----------------------------------|--------------|---------|-----------|------|-------------|
| Instance 0                        |              | /3300/0 |           |      |             |
| Min Measured Value                | /3300/0/5601 |         | Observe ▶ | Read |             |
| Max Measured Value                | /3300/0/5602 |         | Observe ▶ | Read | 100.5       |
| Min Range Value                   | /3300/0/5603 |         | Observe ▶ | Read | 100.5       |
| Max Range Value                   | /3300/0/5604 |         | Observe ▶ | Read | 0           |
| Reset Min and Max Measured Values | /3300/0/5605 |         | Observe ▶ | Read | 0           |
| Sensor Value                      | /3300/0/5700 |         | Exec ⚙    |      |             |
| Sensor Units                      | /3300/0/5701 |         | Observe ▶ | Read | 100.5       |
| Application Type                  | /3300/0/5750 |         | Observe ▶ | Read |             |
| Sensor Type                       | /3300/0/5751 |         | Observe ▶ | Read | Temperature |

**Figure 5: Generic sensor instance on an LwM2M server**

The generic sensor object instance should start populating with data on the LwM2M server. Since server ID 123 was associated with the “Generic Sensor Object” instance, the presence of the instance can be visually verified on the previously mentioned Leshan server.

## 5.4 +ULWM2MNOTIFY URC

The +ULWM2MNOTIFY URC can be used by the external host to perform actions.

In the below code snippet from the sample `object_generic_sensor.lua`, in the `object_generic_sensor.write()` method a call to the `lua_send_urc` function is used to send a URC notification when the “Application Type” resource (ID=5750) is set.

```
if res == RES_O_APPLICATION_TYPE then
msg = string.format("Application type changed in sensor %d", inst)
lua_send_urc(string.len(msg), msg)
end
```



On SARA-R510M8S-00B, SARA-R510S-00B, SARA-R500S-00B the syntax of the `lua_send_urc` function is different as it accepts only the string argument, without the string length:

```
msg = string.format("Application type changed in sensor %d", inst)
lua_send_urc(msg) -- pass only the string
```

For example, after executing the following +ULWM2MCREATE AT command, a URC will be seen.

| Command                                                                                     | Response                                            | Description                                                                  |
|---------------------------------------------------------------------------------------------|-----------------------------------------------------|------------------------------------------------------------------------------|
| AT+ULWM2MCREATE="{\"bn\":\"/3300/0\", \"e\":[\"n\":\"/5750\", \"sv\":\"Temperature\"]}",123 | OK                                                  | Writing the “Application type” (resource 5750) will trigger a URC to notify. |
| URC                                                                                         |                                                     |                                                                              |
|                                                                                             | +ULWM2MNOTIFY: Application type changed in sensor 0 |                                                                              |

## 5.5 Generic sensor object accessing a GPIO pin



The Lwm2M pulse feature is not supported by SARA-R5 series modules.

For detailed AT command descriptions, see the SARA-R4 series AT commands manual [\[1\]](#).

The +UGPIOC and +ULWM2MPULSE AT commands can be used to configure and operate a GPIO.

In the below code snippet from the `object_generic_sensor.lua`, a function `lua_send_pulse` is used to send a signal to id 16 of the GPIO.

```
if res == RES_M_SENSOR_VALUE then
lua_send_pulse(16)
```

In the below example the +ULWM2MWRITE AT command is issued to turn on a GPIO pin and make it go high for a few seconds according to +ULWM2MPULSE setting. This can be visually verified on an evaluation board.

| Command                    | Response                           | Description                                                                                                                                                                                                                                                                |
|----------------------------|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AT+UGPIOC=16,25            | OK                                 | The GPIO 1 is configured to take an Lwm2M pulse.                                                                                                                                                                                                                           |
| AT+ULWM2MPULSE=?           | +ULWM2MPULSE:<br>16,25,0,0,0<br>OK | Query the GPIO which is working with Lwm2M.                                                                                                                                                                                                                                |
| AT+ULWM2MPULSE=16,1,3000,1 | OK                                 | Configure the +ULWM2MPULSE to go high for 3 s and persist on the module reboot. Allowed settings: <ul style="list-style-type: none"> <li>GPIO pins identifier: 16, 19, 23, 24, 25, 42</li> <li>Low/high: 0/1</li> <li>Time: 0-10000 ms (0: to be left asserted)</li> </ul> |

| Command                                                                                     | Response | Description                                                                                                                                            |
|---------------------------------------------------------------------------------------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                             |          | <ul style="list-style-type: none"> <li>Persist: 0/1</li> </ul>                                                                                         |
| AT+ULWM2MWRITE="{\"bn\":\"/3300/0 OK<br>\", \"e\": [{\"n\": \"5700\", \"v\": 1<br>00.5}]]\" |          | To trigger the GPIO using the<br>+ULWM2MWRITE command which will<br>call the code snippet below. On an EVK,<br>the LED for the GPIO should turn green. |

## 5.6 Reset the module from an LwM2M server

The access control list object ID 2 can be used to specify the permissions for a server to execute actions on an object: For more details, see

[http://www.openmobilealliance.org/tech/profiles/LWM2M\\_Access\\_Control-v1\\_0\\_3.xml](http://www.openmobilealliance.org/tech/profiles/LWM2M_Access_Control-v1_0_3.xml).

For example, the device object ID 3 has a resource ID 4 to reboot the module: [http://www.openmobilealliance.org/tech/profiles/LWM2M\\_Device-v1\\_0\\_3.xml](http://www.openmobilealliance.org/tech/profiles/LWM2M_Device-v1_0_3.xml)

Each instance of the access control object corresponds to one object instance's permissions. Resource ID 0 specifies the object ID, and resource ID 1 specifies the object instance ID. If an object instance does not have default access permissions configured, read-write-execute permissions must be explicitly added for the new server ID.

Permissions are granted at the object instance level. A server may not be granted permissions only to specific resources in an object instance. For example, granting server ID 123 execute permissions on object instance /3/0 can allow the server to perform factory reset (/3/0/5) as well as reboot (/3/0/4).

In the below example, permission is given to the newly added server ID 123. The remote server can now execute actions on the device object to be able to reboot the module.

| Command                                                                       | Response                                                                                                                                                | Description                                                                          |
|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| AT+ULWM2MREAD="/2/1"                                                          | +ULWM2MREAD: {"bn":"/2/1/", "e":[{"n": "0", "v": 3}, {"n": "1", "v": 0}, {"n": "2/721", "v": 15}, {"n": "3", "v": 721}]}<br>OK                          | Read the object ID 2 which is the access control list object.                        |
| AT+ULWM2MWRITE="{\"bn\":\"/2/1/\", \"e\": [{\"n\":\"2/123\", \"v\":\"15\"}]}" | OK                                                                                                                                                      | Give permission to server ID 123 to reboot the module.<br>(15 is read-write-execute) |
| AT+ULWM2MREAD="/2/1"                                                          | +ULWM2MREAD: {"bn":"/2/1/", "e":[{"n": "0", "v": 3}, {"n": "1", "v": 0}, {"n": "2/123", "v": 15}, {"n": "2/721", "v": 15}, {"n": "3", "v": 721}]}<br>OK | To read the object again to verify that the ACL object is modified.                  |

A re-registration could be forced for the above to take effect immediately.

After the above steps, the LwM2M server can execute a reboot on the client.

The module should reset once it receives the execute command from the LwM2M server.

## 6 Registered functions

The following C functions are registered with the LwM2M client and are available to be used in the object scripts.

- `lua_send_urc`
  - See the section [5.4](#)
  - Sample usage (for SARA-R4 series modules):

```
if res == RES_O_APPLICATION_TYPE then
msg = string.format("Application type changed in sensor %d", inst)
lua_send_urc(string.len(msg), msg)
end
```
- `lua_send_pulse`
  - See the section [5.5](#)
  - Sample usage:

```
if res == RES_M_SENSOR_VALUE then
lua_send_pulse(16)
```
- `lua_modem_get_imei`
  - Sample usage:

```
-- returns the device's imei as a string
local imei = lua_modem_get_imei()
```
- `lua_modem_get_msisdn`
  - Sample usage:

```
-- returns the device's msisdn as a string
local msisdn = lua_modem_get_msisdn()
```
- `lua_modem_get_carrier_id`
  - Sample usage:

```
-- returns the carrier id as in integer
local carrier_id = lua_modem_get_carrier_id()
if carrier_id == lwm2m_carrier_id.LWM2M_CARRIER_SOFTBANK then
-- do something
end
```

Note: Carrier Id definitions are defined in `lwm2m_defs.lua`  
Contact u-blox support if this Information is needed.
- `lua_system_reboot`
  - Sample usage:

```
-- stops the LwM2M Client and resets the device
lua_system_reboot()
```
- `lua_system_factory_reset`
  - Sample usage:

```
-- resets the device to the default profile; requires a reboot
lua_system_factory_reset()
```



SARA-R5 series modules do not support the `lua_send_pulse` function.

## 7 Supported data formats

LwM2M u-blox implementation dynamically supports both TLV and JSON data formats for incoming / outgoing packets. A server may want to configure for TLV instead of JSON for relatively faster and light data transfer.

The LwM2M client logic is as follows:

- The LwM2M client signals JSON format support in the Register (COAP POST) message.
- The client also supports TLV format for data write/read.
- The client generally responds to data read with the same format (TLV or JSON) as the one received in the read (COAP GET) request.

Exceptions:

- If the COAP GET contains an ACCEPT option, the response will be returned with the format contained in ACCEPT option. Examples:

- GET request:

```
Constrained Application Protocol, Confirmable, GET, MID:56891
01.. .... = Version: 1
..00 .... = Type: Confirmable (0)
.... 1000 = Token Length: 8
Code: GET (1)
Message ID: 56891
Token: 324d7685225c6dad
> Opt Name: #1: Uri-Path: 3
> Opt Name: #2: Uri-Path: 0
✓ Opt Name: #3: Accept: application/vnd.oma.lwm2m+json
  Opt Desc: Type 17, Critical, Safe
  0110 .... = Opt Delta: 6
  .... 0010 = Opt Length: 2
  Accept: application/vnd.oma.lwm2m+json
[Uri-Path: /3/0]
```

- Response to GET:

```
Constrained Application Protocol, Acknowledgement, 2.05 Content, MID:56891
01.. .... = Version: 1
..10 .... = Type: Acknowledgement (2)
.... 1000 = Token Length: 8
Code: 2.05 Content (69)
Message ID: 56891
Token: 324d7685225c6dad
> Opt Name: #1: Content-Format: application/vnd.oma.lwm2m+json
End of options marker: 255
✓ Payload: Payload Content-Format: application/vnd.oma.lwm2m+json, Length: 541
  Payload Desc: application/vnd.oma.lwm2m+json
  [Payload Length: 541]
  [Uri-Path: /3/0]
  [Request In: 58]
  [Response Time: 39.690148270 seconds]
JavaScript Object Notation: application/vnd.oma.lwm2m+json
✓ Object
  > Member: bn
  > Member: e
```

- If the COAP GET is done in plain text, and the read is for an entire Object, an entire Object instance, or in general for more than one instance, the response will be returned in JSON format.

# Appendix

## A Leshan overview

### Download a Leshan demo server on Ubuntu

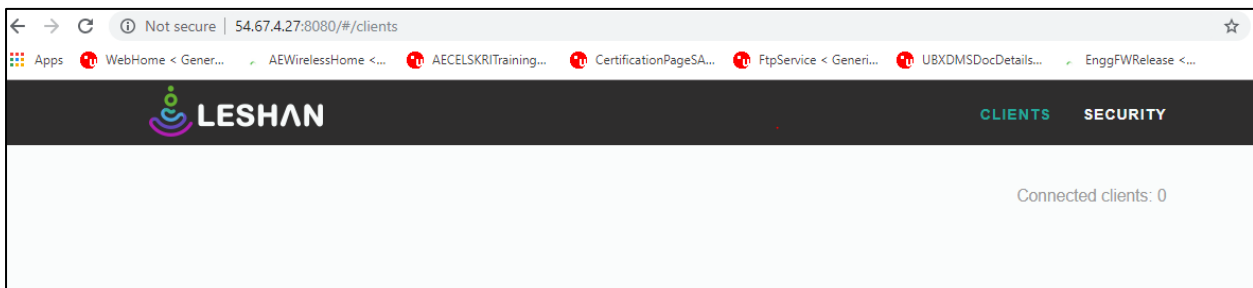
- Wget <https://hudson.eclipse.org/leshan/job/leshan/lastSuccessfulBuild/artifact/leshan-server-demo.jar>

### Start up a demo server

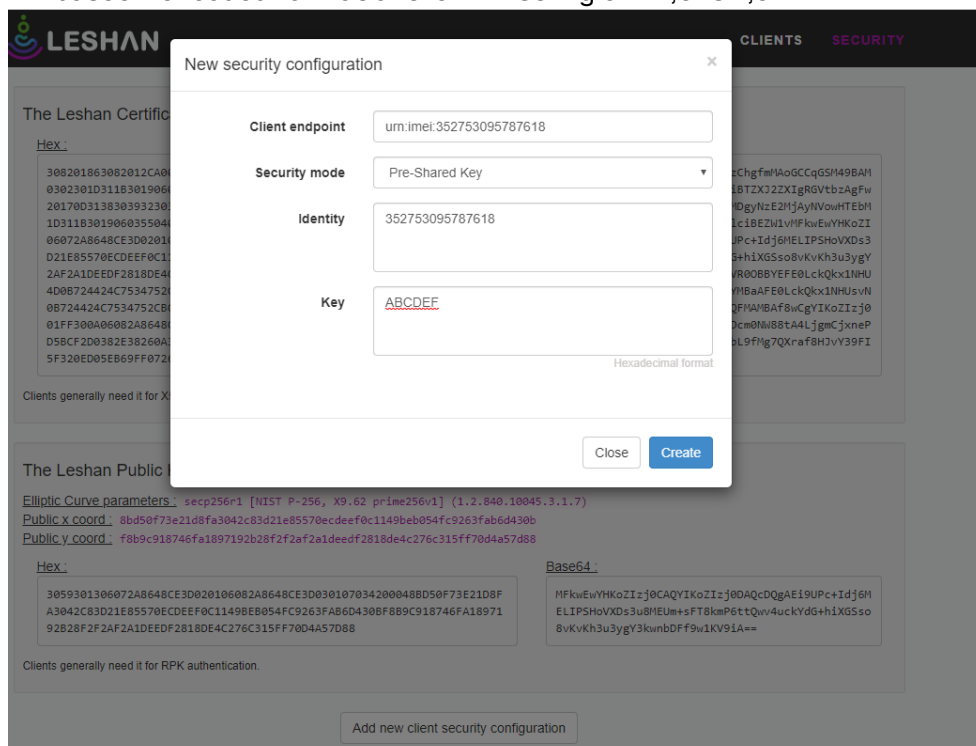
- java -jar ./leshan-server-demo.jar

### Access using: http://<IP of server>:8080

- For an external client to communicate to the Leshan server, the CoAP port 5683 and CoAPS port 5684 need to be accessible via UDP.



- Point the device to the Leshan server. For more details, see section 5.1.
- If using CoAPS, created a PSK for the client on the Leshan server.
- The key here is “ABCDEF”, whereas in the +ULWM2MCREATE AT command a value of q83v is the base64-encoded format of the HEX string 0xAB,0xCD,0xEF.



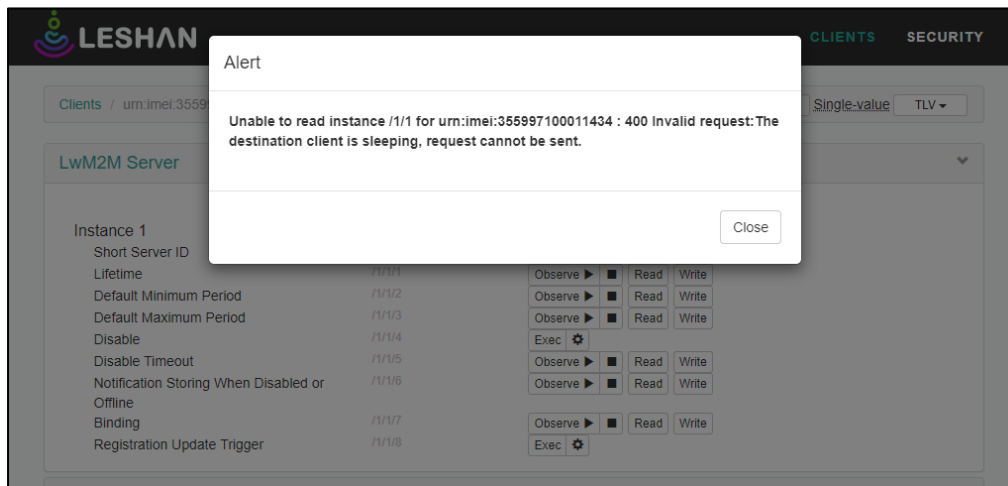
## Read objects using Leshan

Click **Read**, the Leshan server reads the object values from the client.

|                                               |            |           |      |       |              |
|-----------------------------------------------|------------|-----------|------|-------|--------------|
| Instance 2                                    | /1/2       | Observe ▶ | Read | Write | Delete       |
| Short Server ID                               | /1/2/0     | Observe ▶ | Read |       | 123          |
| Lifetime                                      | /1/2/1     | Observe ▶ | Read | Write | 60           |
| Default Minimum Period                        | /1/2/2     | Observe ▶ | Read | Write | 10           |
| Default Maximum Period                        | /1/2/3     | Observe ▶ | Read | Write | 60           |
| Disable                                       | /1/2/4     | Exec ⚙    |      |       |              |
| Disable Timeout                               | /1/2/5     | Observe ▶ | Read | Write | 86400        |
| Notification Storing When Disabled or Offline | /1/2/6     | Observe ▶ | Read | Write | false        |
| Binding                                       | /1/2/7     | Observe ▶ | Read | Write | UQ           |
| Registration Update Trigger                   | /1/2/8     | Exec ⚙    |      |       |              |
| Resource 30000                                | /1/2/30000 | Observe ▶ | Read | Write | 0=0,0, 1=1,e |

## Modify registration timer

An error can occur on a Leshan server when trying to read an object. This is because of the life timer and the finite window of ~30 s during which the connection is open. The life timer counts down to 0 and then this contact window opens again.

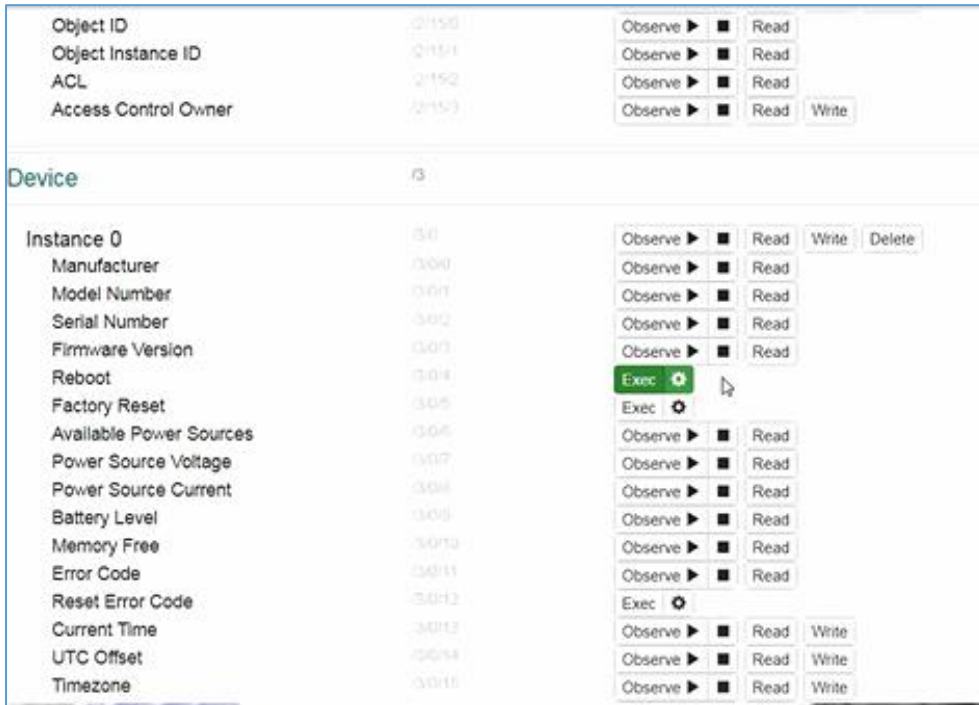


For more details, see section [5.2](#).

## Reboot the client

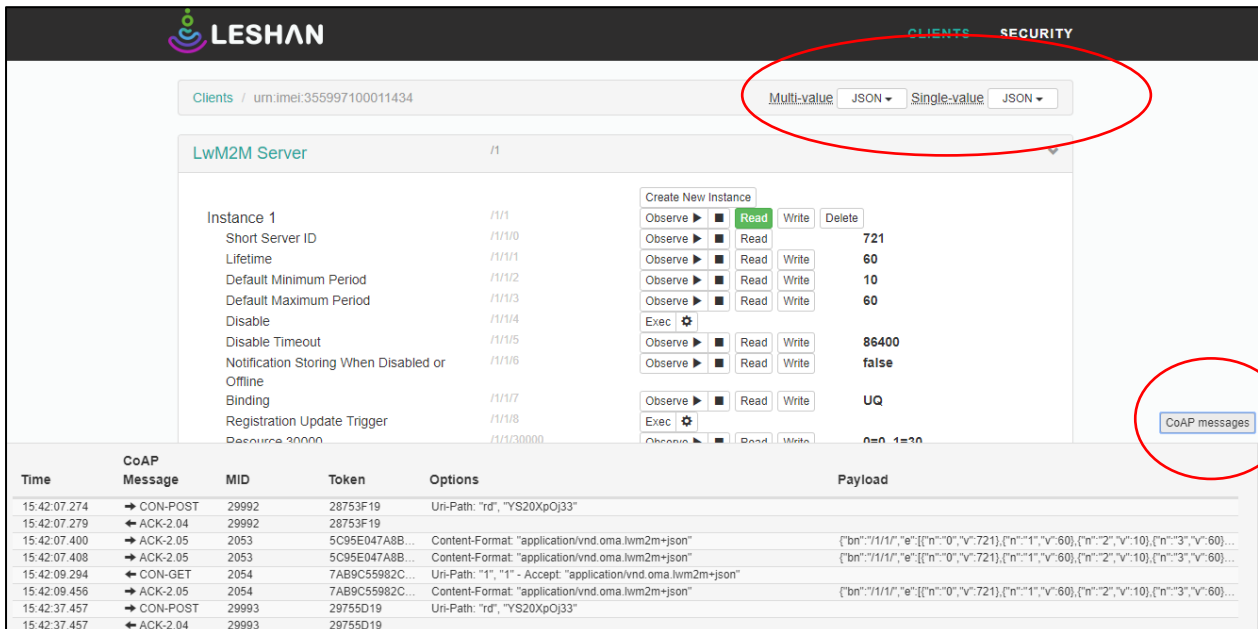
For more details, see section 5.6.

Under the “Device” object as shown in the below picture, click **Exec**.



## CoAP messaging on Leshan

The Leshan web application can display the CoAP messages going across the client and server. It's useful for debugging.



## B Installing Lua on a Linux machine

Follow the procedure below to install Lua on Ubuntu.

- `wget https://www.lua.org/ftp/lua-5.3.5.tar.gz;`
- `sudo apt-get install make ;`
- `sudo apt-get install gcc ;`
- `sudo apt-get install libreadline-dev`
- `gunzip lua-5.3.5.tar.gz;`
- `tar -xvf lua-5.3.5.tar`
- `cd lua-5.3.5/src`
- `make linux test`
- use the binary file “lua” for running
- See section [2.2](#)

## C Glossary

| Abbreviation | Definition                                              |
|--------------|---------------------------------------------------------|
| 3GPP         | 3rd Generation Partnership Project                      |
| ACL          | Access Control List                                     |
| APN          | Access Point Name                                       |
| AT           | AT Command Interpreter Software Subsystem, or attention |
| CID          | Context ID                                              |
| CoAP         | Constrained Application Protocol                        |
| DB           | Database                                                |
| FOTA         | Firmware Over The Air                                   |
| IMEI         | International Mobile Equipment Identity                 |
| IP           | Internet Protocol                                       |
| NRE          | Non Recurring Expense                                   |
| PSK          | Pre-Shared Key                                          |
| TX           | Transmission                                            |
| UDP          | User Datagram Protocol                                  |
| uFOTA        | u-blox FOTA                                             |
| UL           | Uplink                                                  |
| URC          | Unsolicited Result Code                                 |

**Table 9: Abbreviations and terms**

## Related documentation

- [1] u-blox SARA-R4 series AT commands manual, [UBX-17003787](#)
- [2] u-blox SARA-R4 series data sheet, [UBX-16024152](#)
- [3] u-blox SARA-R4 series system integration manual, [UBX-16029218](#)
- [4] u-blox SARA-R41 series application development application note, [UBX-18019856](#)
- [5] u-blox SARA-R42 series application development application note, [UBX-20050829](#)
- [6] u-blox SARA-R5 series application development application note, [UBX-20009652](#)
- [7] OMA technical specification Lightweight M2M, V1\_0-20170208-A
- [8] u-blox IoT Security-as-a-Service overview,  
<https://developer.thingsstream.io/guides/security-services>
- [9] u-blox SARA-R5 series AT commands manual, [UBX-19047455](#)
- [10] u-blox SARA-R4 series firmware update with uFOTA, FOAT and EasyFlash application note,  
[UBX-17049154](#)
- [11] AT&T device requirements document n. 13340

 For regular updates to u-blox documentation and to receive product change notifications, register on our homepage ([www.u-blox.com](http://www.u-blox.com)).

## Revision history

| Revision | Date        | Name               | Comments                                                                                                               |
|----------|-------------|--------------------|------------------------------------------------------------------------------------------------------------------------|
| R01      | 20-Dec-2019 | skri/sgod          | Initial release                                                                                                        |
| R02      | 11-Jun-2020 | skri               | Updated sections <a href="#">3.4</a> , <a href="#">4.3.2</a> , <a href="#">4.3.3</a>                                   |
| R03      | 26-Nov-2020 | acom/acam/<br>skri | Extended the document applicability to SARA-R5 series modules.<br>Added section "LwM2M impact on module functionality" |
| R04      | 26-Feb-2021 | skri / acom        | Extended the document applicability to SARA-R410M-02B-03 and SARA-R412M-02B-03                                         |
| R05      | 23-May-2022 | aoli               | Extended the document applicability to SARA-R422, SARA-R422M8S and SARA-R422S                                          |
| R06      | 24-Nov-2022 | aoli               | Extended the document applicability to SARA-R422-01B, SARA-R422M10S and SARA-R422S-01B                                 |

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