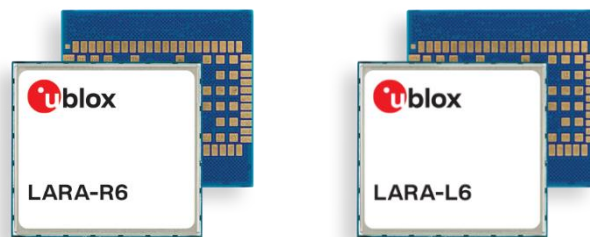# LARA-R6 / LARA-L6 series

Firmware update with uFOTA, FOAT and EasyFlash

Application note

Abstract

LARA-R6 and LARA-L6 series modules offer flexibility with multiple options of firmware updates. The options include Firmware Over The Air update (FOTA) via u-blox's uFOTA server with the LwM2M client, or via FTP, if applicable, and tethered updates via Firmware Over AT command (FOAT). In addition, the module can be flashed directly via USB with u-blox's EasyFlash tool. This application note covers all these available options.

Document information

Title	**LARA-R6 / LARA-L6 series**	
Subtitle	Firmware update with uFOTA, FOAT and EasyFlash	
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This document applies to the following products:

Product name
LARA-R6 series
LARA-L6 series

Contents

1 Introduction

The device firmware (FW) management is a key feature for devices integrating a cellular module.

Firmware updates to u-blox cellular modules take three steps: firmware download, validation and installation. During the firmware download the new firmware image is stored on the module file system, either by Over-the-Air (OTA) or via tethered connection. In OTA techniques, the new image is downloaded over cellular technology using either the LwM2M protocol via the u-blox uFOTA service or via FTP/HTTP. Tethered downloads use the UART interface to transfer the new image from a connected host processor and store it into the module. Once the new firmware image downloaded to the module, it can be applied during the firmware installation process. Figure 1 depicts the firmware update ecosystems.

This document describes u-blox implementation of both OTA and tethered methods and provides design-in details and recommendations. It describes two update methods, each including both download and installation: uFOTA, which is an OTA update (see section 3); and FOAT, which is a tethered update (see section 6). Then, it analyzes some other methods to download a firmware in section 4 and in section 5. These firmware images can then be installed as described in section 7. Finally, the document provides guidelines about the EasyFlash tool, used to flash an update via a UART interface, in section 9.
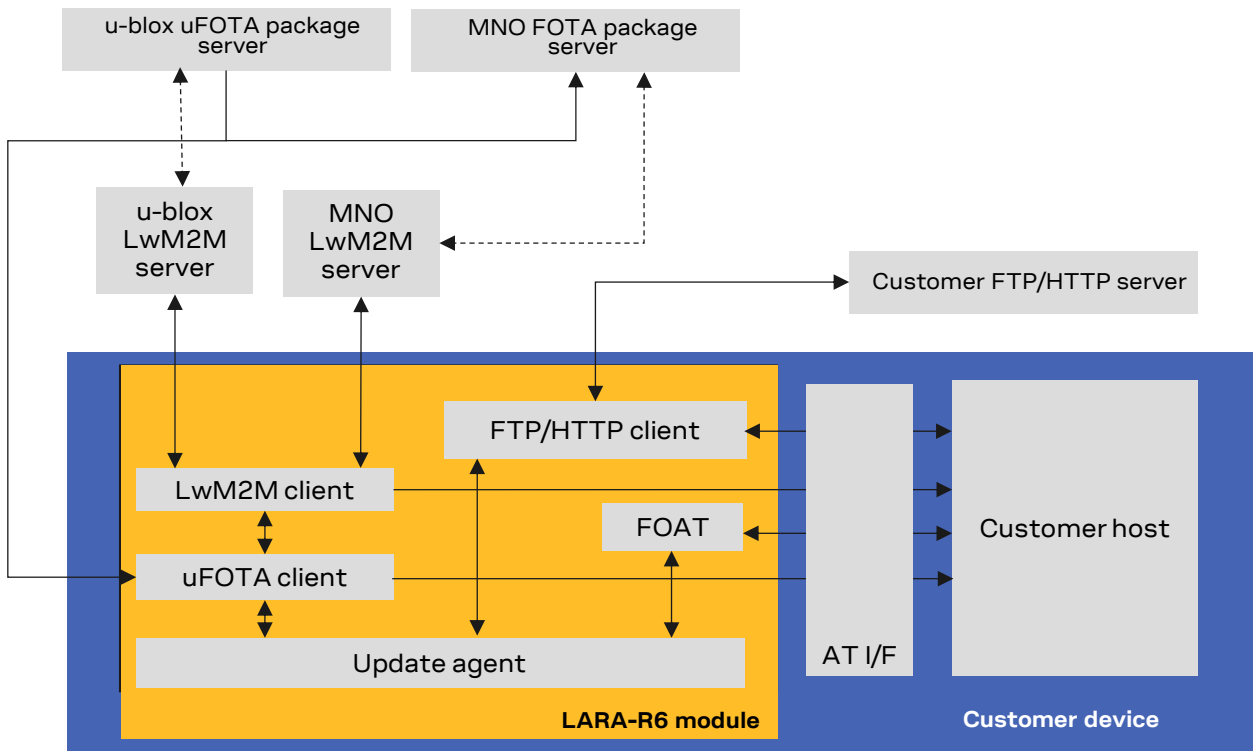
Figure 1: uFOTA, FOTA, FOAT ecosystem

The following symbols are used to highlight important information within the document:

☞   An index finger points out key information pertaining to integration and performance.

⚠   A warning symbol indicates actions that could negatively impact or damage the module.

2   Firmware update process

The firmware update process can be split in three different stages, as shown in Figure 2:

- Download
- Validation
- Installation

The download phase is the time to download the firmware update file to the module. Different methods can be used to download the file (uFOTA, FOAT, FTP, HTTP, +UDWNFILE), and the file size may be different, so the time to complete the download may vary. Therefore, when using an OTA method, even with the same file size, the download time may vary according to the network condition.

The validation phase is the time to validate the file as binary content and check signature.

The installation phase is the time to install the new firmware. The time needed to install the new firmware depends on the file size. The installation time for a FOAT file does not depend on the installed firmware because it is not a differential file; the installation time of the uFOTA file depends on the delta between the installed and the target firmware.

☞   The "validation" step is not implemented in the LARA-R6001D-00B product version.
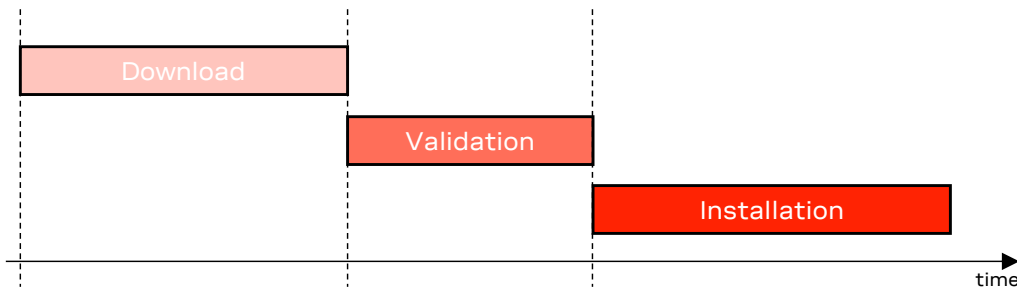
Figure 2: FW update process

3   Firmware update via uFOTA

uFOTA is u-blox's solution to a managed and automated FOTA service based on the LwM2M protocol. Section 3.1 describes the behavior of the module during the uFOTA procedure. This service uses "campaigns" to manage the FW upgrading of multiple. Section 3.8 describes the process to start an upgrade campaign.

Figure 3 depicts an overview of the uFOTA system architecture.

The embedded LwM2M client offers below LwM2M features:

- Device management
- Secure communication with LwM2M server over DTLS (using PSK provided by u-blox/MNO)
- Secure communication with HTTPS u-blox/MNO FOTA package server over TLS (using server-only authentication)
- Full control of the application logic including firmware upgrades
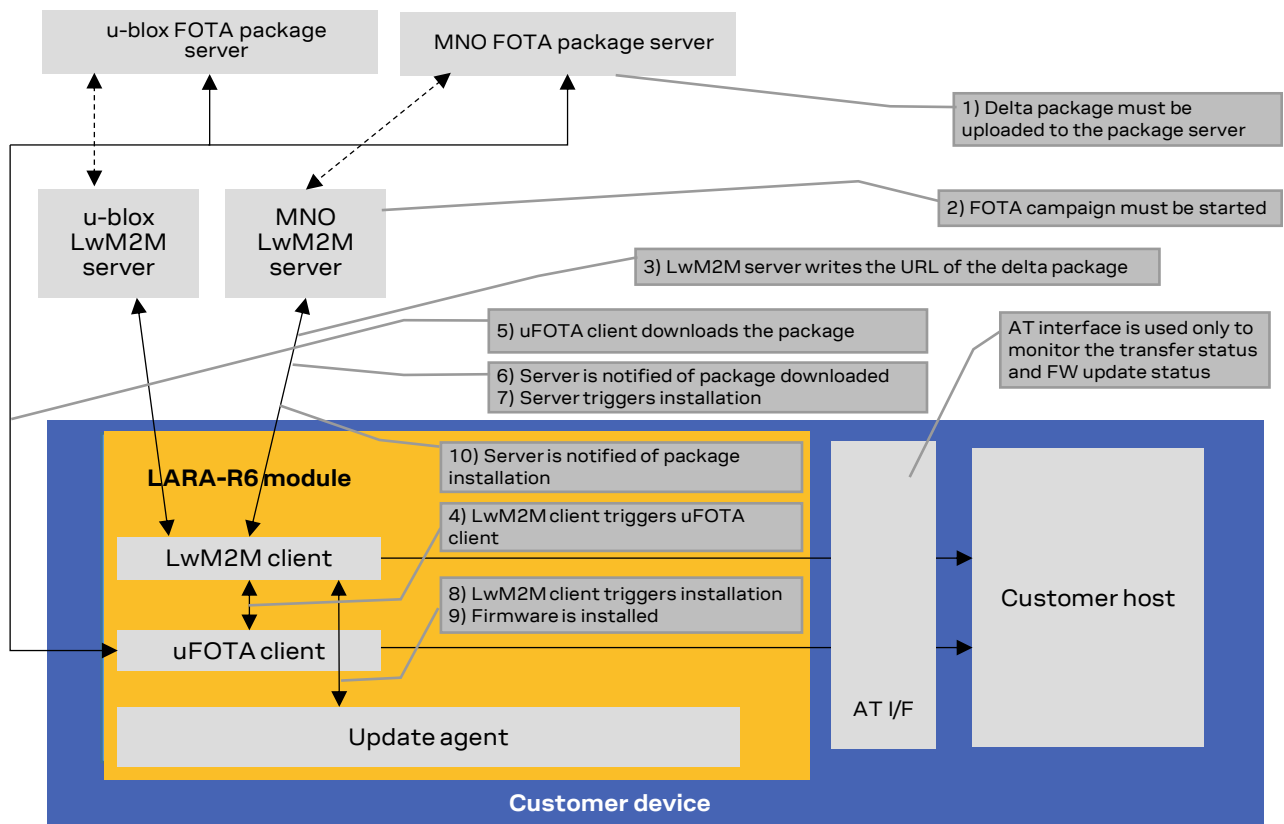
Figure 3: uFOTA system architecture

3.1   Functional overview

When the module powers up for the first time (factory-programmed configuration) after the module is attached to a cellular network, and if the active MNO profile set by the host application has both LwM2M and uFOTA enabled, the LwM2M client starts and registers to the uFOTA server. The LwM2M client will then check the uFOTA server upon the expiration of the server registration lifetime (SRLT).

Registration update with the uFOTA server is performed to:

1. Extend the lifetime of a registration.

2. Notify the uFOTA server of a parameter change.
3. Indicate that objects and/or object instances have been added or removed.

By default, the lifetime value is 86400 s (1 day). If there are no changes to the lifetime, binding mode, SMS number, or objects and object instances, then there is no communication with the server during the remainder of the period.

During a registration update, if the uFOTA server finds an active campaign for the module and a firmware delta package is available, then the server will initiate an observation request on the Firmware Update Object's State and Update Result resources and will write the URL of the firmware delta package to the package URI resource. This will trigger the LwM2M client to start the download at the next practical opportunity.

The LwM2M client will send unsolicited response codes (URCs) to indicate download start, progress, and result. The LwM2M client notifies the uFOTA server of changes to the Firmware Object's State and Update Result resources.

The package download can be transferred over HTTP or HTTPS.

☞ The delta packages are signed.

The uFOTA server will send an execute command on the firmware object's update resource when the firmware object's state transitions to downloaded. As a result, the module will reset and attempt to install the delta package.

During this phase, the device will send unsolicited result codes (URCs) to indicate the progress of delta package validation and installation. When the installation is complete, the module will restart. At the next registration update, the uFOTA server will initiate observation requests for the firmware update object's state and update result resources. The LwM2M client will notify the server of the state and update result.

The approximate data payload size of the LwM2M server registration procedure depends on these factors:

- Number of LwM2M servers
- Types and numbers of LwM2M object instances
- LwM2M server(s) may request additional information

Typical registration payload for only the u-blox's uFOTA server is about 1.1 kB to 1.4 kB.

If FOAT download or FTP/HTTP download commands are issued while the u-blox LwM2M client is downloading a firmware package an error result code will be returned. For more details, see section 8.

3.2 Unsolicited result codes (URCs) management

The +UFOTASTAT, +ULWM2MSTAT and +UFWINSTALL AT commands enable/disable the URCs events which are reported back to the host. These URCs are not enabled by default.

For a detailed description of the command syntax, see the LARA-R6 / LARA-L6 series AT commands manual [1].

☞ It is recommended to enable URCs for uFOTA download.

3.2.1 Download success example

When a uFOTA download is successful, a URC is displayed to indicate the status.

Command	Response	Description
	+UFOTASTAT: 2,2,100	100% downloaded.

3.2.2 Download resume example

The uFOTA download can be resumed if it was interrupted for any of the following reasons:

- Signal fade / lost
- Power loss
- Unsolicited device reset
- Reset caused by AT command issued by external application (AT+CFUN=16 for example)

In case of signal loss, when the device is active, a pending uFOTA download will resume. Resume retry algorithm follows this timing:

1. 60 s
2. 120 s after the first attempt
3. 180 s after the second attempt
4. 240 s after the third attempt

The total retry time is 10 minutes, after which uFOTA download failure is declared towards the server.

In case of power loss, unsolicited device reset or reset caused by AT+CFUN=16, the uFOTA download is restarted.

To resume the download, after AT+CFUN=0 or AT+CFUN=4 command is issued, a reboot is required.

During the uFOTA resume, +UFOTASTAT URCs will be issued to indicate the resuming status and the percentage of uFOTA that has been downloaded.

Command	Response	Description
		Download is resuming…
	+UFOTASTAT: 0,1,63	63% downloaded.

3.3 Download control

☞ The pause (AT+UFOTA=1), resume (AT+UFOTA=2) and read (AT+UFOTA?) features are available only in LARA-L6 "01B" and LARA-R6 "01B" product versions.

While the LwM2M session is in progress and the firmware is being downloaded to the device, the download can be cancelled by issuing the AT+UFOTA=0 command. A URC will be issued once the download has been cancelled.

Command	Response	Description
AT+UFOTA=0	OK	Cancel the download.

Command	Response	Description
…		Download cancellation in progress…
	+UFOTASTAT: 2,3,100	The uFOTA download is cancelled by the host.

☞ Create another uFOTA "Campaign" (section 3.8) to start the uFOTA download process again if the current one was cancelled.

Similarly, it is possible to pause and resume the uFOTA download with the commands AT+UFOTA=1 and AT+UFOTA=2, respectively. In addition, the AT+UFOTA? command can be used to find out the download status, the number of bytes currently downloaded and the total size of the delta packet.

Command	Response	Description
	+UFOTASTAT: 0,1,8	Download in progress.
	+UFOTASTAT: 0,1,9	Download in progress and 9% of the delta package has been downloaded.
AT+UFOTA=1		Pause the download.
		Pausing the download in progress.
	+UFOTASTAT: 0,2,10	The uFOTA download is paused by the host when 10% of the delta package has been downloaded.
AT+UFOTA?	+UFOTA: 1,6864144,710656 OK	The download has been paused, and currently 710656 bytes out of 6864144 have been downloaded.
AT+UFOTA=2	OK	Resume the download.
	+UFOTASTAT: 1,0,0	Resuming the download in progress.
	+UFOTASTAT: 0,1,11	Download in progress.

After pausing the download of the delta package with AT+UFOTA=1, the resume of the download can be performed with AT+UFOTA=2 even after the module has been turned off and then on again or after a reboot.

For more details of +UFOTA AT command, see the LARA-R6 / LARA-L6 AT commands manual [1].

3.4 uFOTA configuration

Through AT+UFOTACONFIG and AT+UFOTAACK, the host can configure the uFOTA management.

By default, when the uFOTA server initiates a FW update campaign on a device, the process of downloading and delta installation take place without the host being able to intervene. As explained in section 3.3, the only action granted to the host is to cancel, pause or resume the download by the AT+UFOTA command.

AT+UFOTACONFIG allows the following modes to manage the delta download and installation process.

For product variant applicability see the LARA-R6 / LARA-L6 series AT commands manual [1].

3.4.1 Download only

When this mode is set, the device only performs the delta download and does not automatically install it at the end of the download. Then the host can install it using the AT+UFWINSTALL command.

Command	Response	Description
AT+UFOTACONFIG=721,1,255	OK	Set the mode to "Download only".
<FOTA campaign starts>		The uFOTA server triggers the FW upgrade.

Command	Response	Description
	+UFOTASTAT: 1,0,0	The download is triggered.
	+UFOTASTAT: 0,1,30	Download in progress. 30% downloaded.
	+UFOTASTAT: 2,2,100	100% downloaded. The download is complete and successful.
AT+UFWINSTALL	OK	The device reboots and installs delta

3.4.2 Wait for ack

When this mode is set, an URC informs that the uFOTA server is requesting a FW update and is waiting for approval or rejection from the host.

3.4.2.1 Approve the FW update

Command	Response	Description
AT+UFOTACONFIG=721,2,255	OK	Set the mode to "Wait for ack".
<FOTA campaign starts>		The uFOTA server triggers the FW upgrade.
	+UFOTASTAT: 0,3,0	There is a pending request from the uFOTA server to start the download (and subsequent automatic installation) of delta.
AT+UFOTAACK=30	OK	The host accepts the download of the delta and decides to start the download in 30 seconds.
	+UFOTASTAT: 1,0,0	30 seconds later, the download is triggered. Delta is downloaded and installed at the end of the download.

3.4.2.2 Reject the FW update

Command	Response	Description
AT+UFOTACONFIG=721,2,255	OK	Set the mode to "Wait for ack".
<FOTA campaign starts>		The uFOTA server triggers the FW upgrade.
	+UFOTASTAT: 0,3,0	There is a pending request from the uFOTA server to start the download (and subsequent automatic installation) of delta.
AT+UFOTAACK=0	OK	The host rejects the download of the delta.
	+UFOTASTAT: 2,3,100	The download is rejected by the host.

☞ If the host does not accept or reject within an hour, the device automatically accepts the FW update request and starts the download.

3.4.3 uFOTA disabled

When this mode is set, FW update is disabled. The device receives the FW update request from the uFOTA server, but automatically rejects it.

Command	Response	Description
AT+UFOTACONFIG=721,3,255	OK	Set the mode to "uFOTA disabled".
<FOTA campaign starts>		The uFOTA server triggers the FW upgrade.

	`+UFOTASTAT: 1,0,0`	The download is triggered.
	`+UFOTASTAT: 2,3,100`	The download is rejected by the device.

3.5   Delta package installation

After a uFOTA delta package is successfully downloaded, the uFOTA server shall command the device to reboot and automatically complete the firmware update process. During the firmware update, +UFWPREVAL URCs and +UUFWINSTALL URCs will be issued to indicate the progress of delta package validation and the progress of delta package installation respectively. The AT interface is not available during the firmware upgrade.

Command	Response	Description
<Module reboot>		

	`+UFWPREVAL: 0`
	`+UFWPREVAL: 3`
	`+UFWPREVAL: 7`
	…
	`+UFWPREVAL: 90`
	`+UFWPREVAL: 100`
		Firmware delta validation started.
		
		Firmware validation completed.
		The progression of the validation is incremental, but the increment can be different from 1.
		The +UFWPREVAL: 100 URC may not be issued, and the module can start the installation phase issuing the +UUFWINSTALL URC.

	`+UUFWINSTALL: 1`
	`+UUFWINSTALL: 3`
	…
	`+UUFWINSTALL: 92`
	`+UUFWINSTALL: 100`
	`+UUFWINSTALL: 128`
		Firmware installation started.
		
		Firmware installation completed.
		Once the last URC (`+UFWINSTALL: 128`) is received, the module reboots again to new firmware release.

☞   The "validation" step is not implemented in the LARA-R6001D-00B product version.

☞   It is not possible to cancel a firmware update in progress.

Table 1 reports the delta package update estimates.

Delta package size	Estimated OTA download times	FW installation time
2 MB – 9 MB[1] (depends on image difference)	Up to 3 minutes (depends on package size and signal strength)	Up to 20 minutes (depends on package size)

Table 1: Delta uFOTA package update estimates

3.6   Server registration life timer (SRLT)

The server registration life timer (SRLT) is the time the module waits before performing an LwM2M registration update to the u-blox uFOTA server to see if there is any new firmware to download and upgrade to. The factory-programmed value is 24 hours.

The SRLT value can be potentially changed by the LwM2M server.

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[1] Values are just guidelines and are fixed expected limits.

The host can also change the SRLT value using the +ULWM2MWRITE AT command, which can change the resource 1 of the corresponding LwM2M server object instance.

The +ULWM2MDEREG AT command can be used to deregister from the LwM2M server, until reboot or a further call to +ULWM2MREG AT command. This can be used by the host to control when to perform an LwM2M registration.

As mandated by the LwM2M specification, a change to the lifetime value will trigger a registration update. Frequent changes to the lifetime value, or lifetime values very small are not recommended and may result in data usage being higher than expected.

See the example below.

Command	Response	Description
AT+ULWM2MLIST="/"	+ULWM2MLIST: "/1/10","/2/2 ","/2/1","/2/2 ","/2/3","/2/4","/2/5","/2/6","/2 /7","/2/8","/2/9","/2/10","/2/11" ,"/2/0","/3/0","/4/0","/5/0","/7/ 0","/11/1","/11/2","/11/3","/11/4 ","/11/0","/14/0","/16/0","/10308 ","/0/10" OK	List all existing LwM2M objects and instances.
AT+ULWM2MREAD="/1/10"	+ULWM2MREAD: {"bn":"/1/10/","e":[{"n":"0","v":721},{"n":"1","v":86 400},{"n":"2","v":10},{"n":"3","v ":60},{"n":"5","v":86400},{"n":"6 ","bv":false},{"n":"7","sv":"UQS" },{"n":"10","ov":"11:0"},{"n":"30 000/1","v":30},{"n":"30000/0","v" :0},{"n":"12","v":0},{"n":"18","v ":30},{"n":"17","v":4},{"n":"16", "bv":false}]} OK	Read LwM2M server object instance to confirm that resource 0 (short server id) is 721, which is for the u-blox FOTA server.
AT+ULWM2MWRITE="{\"bn\":\"/1/10/\ ",\"e\":[{\"n\":\"1\",\"v\":60480 0}]}"	OK	Write new timer to this instance with 604800 s (1 week). Setting the timer will trigger a check-in to the LwM2M server.

3.7   Application design for FOTA compliance

The host needs to behave correctly when the LwM2M FOTA process has started, as it might disturb the download or installation process. This section describes what the application must do and not do for a correct LwM2M FOTA operation.

3.7.1   FOTA procedure

Here below is showed an example with a delta package update triggered by the LwM2M FOTA server.

Command	Response	Description
AT+ULWM2MSTAT=1,7	OK	Enable LwM2M FOTA URCs. They are disabled by factory-programmed configuration.
AT+UFOTASTAT=1	OK	Enable download and update URCs. They are disabled by factory-programmed configuration.
AT+UFWINSTALL=1,115200,, 1	OK	Enable installation URCs. They are disabled by factory-programmed configuration.
	+UFOTASTAT: 3,1,0	LwM2M client start. Typically seen when either the device boots up or when client is stopped then started by the host.
	+ULWM2MSTAT: 1,102,3	LwM2M client registers with Verizon DM server, which has server ID 102.
<FOTA campaign starts>		The FOTA server triggers the FW upgrade.

Command	Response	Description
	+UFOTASTAT: 1,0,0	The FOTA download is triggered: the delta package URI is stored on resource /5/0/1.
	+UFOTASTAT: 0,1,30	Download in progress. 30% downloaded.
…	+UFOTASTAT: 0,1,65	65% downloaded.
	+UFOTASTAT: 2,2,100	100% downloaded. Download is complete and successful.
	+ULWM2MSTAT: 3,102,/5/0/3	Notification to the server of FW related resource (State) change.
	…	The FOTA server sends a command to the module to reboot and install.
<Module reboot>		
<Wait>	+UFWPREVAL: 0 +UFWPREVAL: 3 +UFWPREVAL: 7 … +UFWPREVAL: 90 +UFWPREVAL: 100	Firmware delta validation started. Firmware validation completed. The progression of the validation is incremental, but the increment can be different from 1. The +UFWPREVAL: 100 URC may not be issued and the module can start the installation phase issuing the +UUFWINSTALL URC.
<New firmware installation>		New firmware installation, for more details on the process duration, see section 3.5.
<Wait>	+UUFWINSTALL: 1 +UUFWINSTALL: 3 … +UUFWINSTALL: 92 +UUFWINSTALL: 100 +UUFWINSTALL: 128	Firmware installation started. Firmware installation completed. Once the last URC (+UFWINSTALL: 128) is received, the module reboots again to new firmware release.
<Module reboot>		
AT	OK	Send "AT" to see if the module is ready yet. The final result code is returned: the module has rebooted.

☞ After the firmware update, re-enable +UFOTASTAT and +ULWM2MSTAT URCs at the module reboot.

3.7.2 Enable the uFOTA URC

The +ULWM2MSTAT URC provides the status of the LwM2M client. The download and update status are reported by the +UFOTASTAT URC. The FOTA package validation status is reported by +UFWPREVAL URC. The FOTA package installation status is reported by +UUFWINSTALL URC. All these URCs can be monitored by the host application to handle an update.

3.7.3 Firmware download

Depending on the delta package file size, the download of new firmware can be quite intensive with the amount of data being transferred. When the host device receives the +ULWM2MSTAT: 2,100 or +UFOTASTAT: 2,2,100 URC the download is complete.

☞ Ensure that the host application closes all open sockets when or before the download complete URC (+UFOTASTAT: 2,2,100) is received.

Some AT commands may affect the download or may be blocked, see section 8.

3.7.4   Firmware installation

The +UFWINSTALL AT command enables the +UUFWINSTALL URC to be able to specify the serial interface where this URC will be reported. For the complete description of the +UFWINSTALL AT command, see the LARA-R6 / LARA-L6 AT commands manual [1] or section 7.

When the LwM2M client receives the execute operation on the /5/0/2 ("update") resource , the module will reset to apply the update.

At this stage the host cannot cancel the upgrade.

The +UFWPREVAL URCs display the progress for the delta file validation. If the validation fails, the procedure will be suspended and a +UUFWINSTALL URC with an error result code will be issued. Otherwise, the firmware installation procedure will continue, notified by the +UUFWINSTALL URCs.

During the update process, the observation of receiving the URC (+ULWM2MSTAT: 2,100 or +UFOTASTAT: 2,2,100) can be used to track the update states: update mode and when the device has completed its update. After the host receives the +ULWM2MSTAT:2,100 or +UFOTASTAT: 2,2,100 URC, it should then move into an AT interface check loop which regularly checks for when it is available again.

During the installation operations, the +UUFWINSTALL URCs display the progress and the operation result on the serial interface set via the +UFWINSTALL AT command. The progression of the installation is incremental, but the increment can be different than 1. The last URC with a value greater than 100 indicates the update operation result (e.g., 128 means operation completed with success). For more details about firmware install final result codes, see the LARA-R6 / LARA-L6 series AT commands manual [1].

Depending on the size of the update package, the installation may take a significant amount of time. The host device should use the state information to avoid resetting the module unnecessarily while the update is being applied.

⚠️   Do not remove the power supply or reset the module during the installation procedure. The module will reboot automatically at the end of update procedure.

⚠️   If the firmware update includes a boot code update, then an interruption during the update process of this code section can lead to image corruption of the module that is not recoverable. Types of interruptions include:

   o   Removing or loss of power supply to the module
   o   Unstable supply to the module
   o   Host application applies an external reset to module
   o   Turning off the module with PWR_ON or RESET_N pin

3.7.5   Cancelling the uFOTA process

The host can only cancel the uFOTA download (AT+UFOTA=0) of the new firmware while it is receiving the +UFOTASTAT: 0,1,xx URCs.

3.7.6   Actions after firmware installation

Once the new firmware has been installed, the module will reboot. If the MNO profile set prior to the start the FW upgrade process is different from the global profile (+UMNOPROF: 90), then it will be restored.

☞   The NVM and data profiles are set to the new factory-programmed values. If a custom APN different from factory-programmed is required for LTE Attach, it is necessary to re-configure the +CGDCONT <cid>: 1 with correct APN. Same holds for other data APNs, if any, and for other module configurations such as eDRX. See Table 5 for details on the data persistency after update.

☞ The imported certificates and the private keys are persistent towards the firmware update by means of uFOTA.

At the wake-up, the module will re-register with the network and the LwM2M client will connect with the server(s).

The LwM2M client notifies a change in the observed "/5/0/3" (State) and "/5/0/5" (Update Result) resources of the firmware update object.

3.8　uFOTA campaign

To start the uFOTA upgrade process, a "campaign" must be requested for the modules to be updated. Send the request to the nearest u-blox office or sales representative.

3.8.1　Requirements

To specify a campaign the following information is required:

- The product type
- The starting and destination FW version (modem and application)
- The IMEI list of the devices participating to the campaign
- The location area
- The requested schedule (date, time, duration) for the campaign
- Transfer over HTTPS

3.8.2　Approval

The campaign request will need to be approved by u-blox before the campaign starts. The module's host should be approved to make sure it is able to cope with the LwM2M upgrade process and a test campaign should be executed before the final campaign happens.

3.8.3　Application design review

Before starting the campaign, a design review of the application shall be performed by u-blox support:

- The application shall not reset the module during the FOTA process
- The application shall have the ultimate decision on performing the FOTA update
- The application shall be aware of the duration of FOTA process
- The application shall disable eDRX during the FOTA process
- At least from one device it should be possible to get an AT log and/or trace log for debugging

3.8.4　Test campaign

Before all the modules in the campaign will be updated via uFOTA, it is strongly suggested to perform a test campaign first. This small trial run would involve a few of the modules, up to 5, from the full list of modules.

This test campaign will verify the host is working for uFOTA and that the network/deployment is adequate for the uFOTA download & update.

3.8.5　Final campaign

If the test campaign is successful, u-blox will provide a report back to the customer. If the user is satisfied with the test campaign, the final campaign can start.

The u-blox service team will monitor the uFOTA progress and provide a report once finished.

3.9 uFOTA server access

3.9.1 u-blox uFOTA server

On some product types, 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 LARA-R6 / LARA-L6 series AT commands manual [1]. To enable LwM2M client or uFOTA server, see LARA-R6 series LwM2M object and commands application note [5].

If the MNO profile supports the u-blox uFOTA server, then it is necessary that the network provides access to the following uFOTA LwM2M and download server domain names:

- LwM2M server: lwm2m-fota.services.u-blox.com (port 5684)
- FOTA package download server: ucsphttpcontent.services.u-blox.com (port 80)

☞ If a private APN is used, make sure that the above domain names are reachable.

3.10 Debug-ability

In general, it is suggested to design an application so that it collects the log of AT commands sent and received to/from the module, possibly with timings.

Additionally, follow the recommendations below to ensure an effective troubleshooting in case of problems during the uFOTA process:

Always enable the +UFOTASTAT and +ULWM2MSTAT URCs (also after the firmware update).

3.11 uFOTA sequence diagram

Figure 4 is the sequence diagram of the entire uFOTA procedure showing all the parts involved.
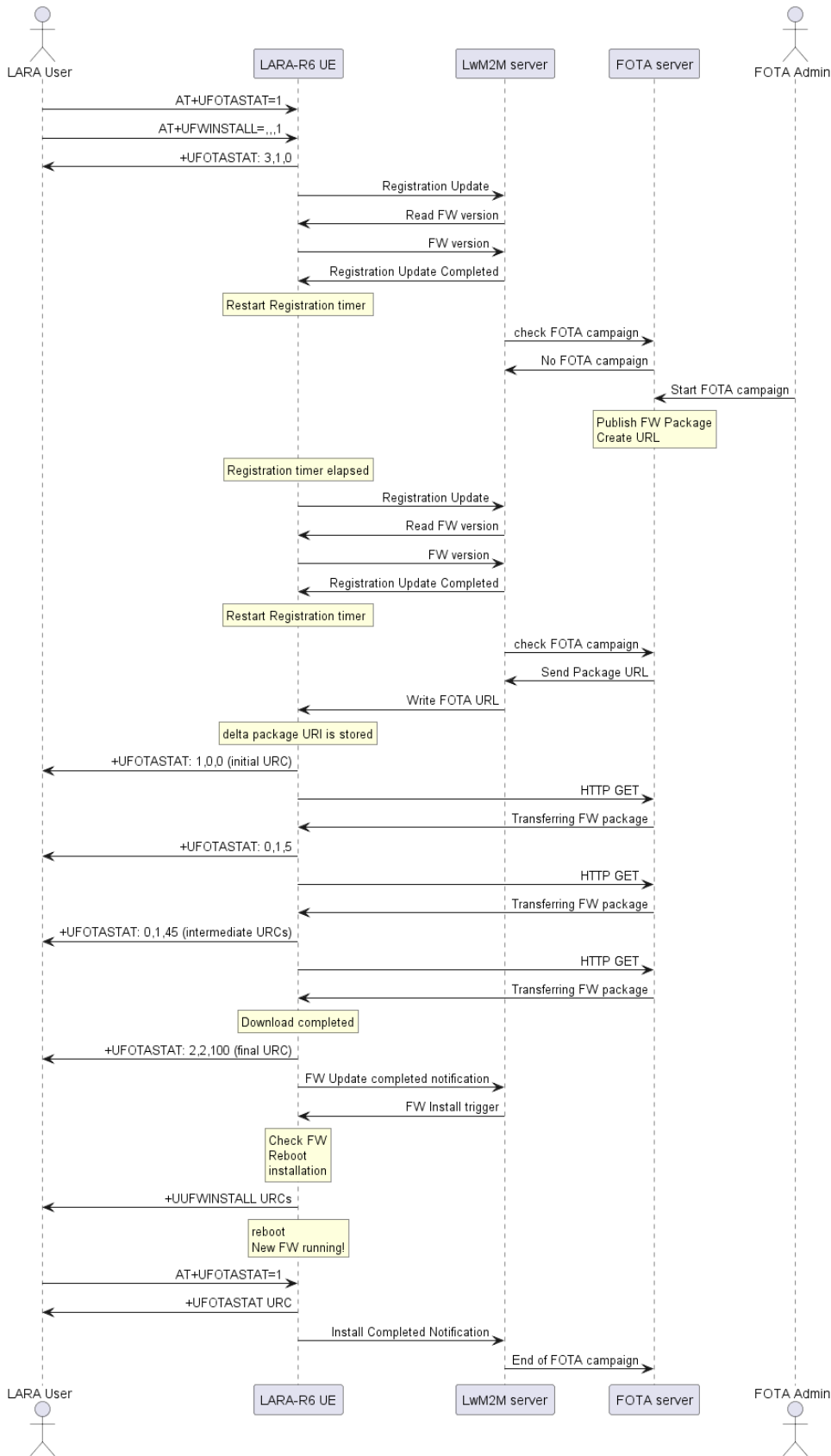
Figure 4: uFOTA sequence diagram

4   Firmware download via FTP

☞   LARA-L6 series modules do not support the firmware download via FTP.

The firmware for the LARA-R6 series modules can be downloaded using standard FTP. This section goes through the AT commands required to download a firmware delta file from an FTP server.

The host shall first configure an FTP profile with the server parameters to start the FW download.

After the firmware update has been downloaded, install the new firmware using the +UFWINSTALL AT command. For more details, see section 7.

⚠   If the FTP FOTA download command is issued while a firmware package downloading is already in progress, an error result code will be returned. For more details, see the section 8.

4.1   FTP service configuration +UFTP

Before starting a firmware download via FTP the host needs to first configure the FTP profile with the FTP server and other parameters.

The +UFTP AT command sets up a parameter for the FTP service or resets a parameter to its factory-programmed value. The set/reset command must be executed for each single <op_code>. The read command returns the current setting of all the FTP parameters, one per line (i.e., the FTP profile). The FTP parameter values set with this command are all volatile, i.e., not stored in non-volatile memory (NVM).

☞   If the set command is issued without <param1> parameter, the corresponding <op_code> parameter is reset to the default value.

4.1.1   Syntax

Syntax	Response	Example
Generic syntax		
AT+UFTP=<op_code>[,<param1>[,<param2>]]	OK	AT+UFTP=7,21
FTP server IP address		
AT+UFTP=0,<ip address>	OK	AT+UFTP=0,"192.168.1.0"
FTP server name		
AT+UFTP=1,<server name>	OK	AT+UFTP=1,"ftp.server.com"
Username		
AT+UFTP=2,<username>	OK	AT+UFTP=2,"username"
Password		
AT+UFTP=3,<password>	OK	AT+UFTP=3,"password"

For a complete description of the FTP profile configuration, see the LARA-R6 series AT commands manual [1].

4.2   FTP command +UFTPC

The AT+UFTPC=100,<remote_filename>[,<fw_download_status>] command is used to trigger, cancel, or resume a firmware delta package download from an FTP server. The host must be properly configured as an FTP client and needs to have logged in successfully before starting the download. Once the host cancels a download session, it cannot be resumed, and the host shall need to start a new download session.

The resume download feature enables the host to continue a firmware package download near the point at which it was stopped (even if due to a power cycle). At the time of the interruption, all the downloaded data may not have yet been stored. Therefore, when the resume download starts, the resume point (the <stored_byte> in the status URC) may be smaller than displayed in the last known status URC of the previously uncompleted session.

⚠   If the host cancels a download session, the host should wait for the +UUFTPCR: 100,0 URC before it starts a new download session.

4.2.1   Syntax

Syntax	Response	Example
AT+UFTPC=100,<remote_file_name>	OK	AT+UFTPC=100,"/ublox-ftp/fota/update_file.bin"
AT+UFTPC=100,<remote_file_name>,0	OK	AT+UFTPC=100,"/ublox-ftp/fota/update_file.bin",0
AT+UFTPC=100,<remote_file_name>,1	OK	AT+UFTPC=100,"/ublox-ftp/fota/update_file.bin",1

4.3   FTP download operation URCs

The +UUFTPCR URC provides the final result of the download operation. In case of success the URC provides the MD5 checksum of the file downloaded.

4.3.1   Syntax

Type	Syntax	Response	Example
Result		+UUFTPCR: 100,<ftp_result>[,<md5_sum>]	+UUFTPCR: 100,1,"960d9502ed3d71 505b681e8aa19f03c8"

4.3.2   Defined values

Parameter	Type	Description
<ftp_result>	Number	Operation result: • 0: fail • 1: success
<md5_sum>	Number	MD5 checksum of the FOTA update file downloaded

4.4   Example

Command	Response	Description
AT+UFTP=1,"ftp.firmware.com"	OK	Configure server name
AT+UFTP=2,"username"	OK	Set username
AT+UFTP=3,"password"	OK	Set password
AT+UFTP=6,1	OK	Set passive mode
AT+UFTPC=1	+UUFTPCR: 1,1 OK	FTP login
AT+UFTPC=100,"/ublox-ftp/fota/FWupdate_4489_HSFf.pkg"	OK	Start FTP download
	+UUFTPCR: 100,1,"960d9502ed3d71505b681e8aa19f03c8"	URC file transfer complete

4.5   Error result codes

If a download session returns "+UUFTPCR: 100,0", the host can retrieve the error reason using the +UFTPER AT command. It retrieves the last +UFTPC operation result. See the definition of the <error_close> and <error_code> parameters in the "FTP class error codes" section of the LARA-R6 series AT commands manual [1].

Type	Syntax	Response	Example
Action	AT+UFTPER	+UFTPER:<error_class>,<error_code> OK	+UFTPER: 8,40 OK

In the example above, the host canceled a download session.

5 Firmware download via HTTP

☞ LARA-L6 series modules do not support the firmware download via HTTP.

This section goes through the AT commands required to download a firmware delta file from a server via HTTP.

The host needs to first configure a HTTP profile with the server parameters before starting the FW download. After the firmware delta file has been downloaded, install the new firmware using the +UFWINSTALL AT command; for more details, see section 7.

⚠ If the HTTP FOTA download command is issued while a firmware package download is already in progress, an error result code will be returned. For more details, see section 8.

5.1 HTTP profile configuration +UHTTP

Before starting a firmware download via HTTP, the host needs to first configure the HTTP application profile parameters.

The +UHTTP AT command defines one or more HTTP profiles and configures their parameters. The set command needs to be executed for each single parameter. The HTTP parameter values set with this command are all volatile (not stored in non-volatile memory).

☞ It is not possible to read the current setting for all parameters of a given HTTP profile, but it is possible to read one parameter at a time by issuing the set command specifying the profile and the parameter code.

☞ It is possible to reset all parameters of a given HTTP profile to their factory-programmed values by issuing the set command with only the profile ID parameter.

5.1.1 Example

The following command sequence indicates the HTTP profile parameters required to start a successful firmware download; the selected HTTP profile identifier is 0.

Syntax	Response	Example
HTTP server IP address		
AT+UHTTP=<profile_id>,0,<server_IP_addr>	OK	AT+UHTTP=0,0,"192.168.1.0"
HTTP server name		
AT+UHTTP=<profile_id>,1,<server_name>	OK	AT+UHTTP=0,1,"server.com"
Username		
AT+UHTTP=<profile_id>,2,<username>	OK	AT+UHTTP=0,2,"username"
Password		
AT+UHTTP=<profile_id>,3,<password>	OK	AT+UHTTP=0,3,"password"

The following syntax shows how to read a specific parameter of a HTTP profile and how to reset a given HTTP profile.

Syntax	Response	Example
Read HTTP server IP address		
AT+UHTTP=<profile_id>,0	+UHTTP: profile_id>,0,<server_ IP_addr> OK	AT+UHTTP=0,0 +UHTTP: 0,0,"192.168.1.0" OK
HTTP reset all parameters		
AT+UHTTP=<profile_id>	OK	AT+UHTTP=0

For a complete description of the HTTP profile configuration, see the LARA-R6 series AT commands manual [1].

5.2 HTTP command +UHTTPC

The AT+UHTTPC=<profile_id>,100,<path> command triggers a firmware package download from a server via HTTP. When the file transfer is complete the +UUHTTPCR URC, reporting the md5 checksum of the FOTA update file, is sent to output.

5.2.1 Example

Syntax	Response	Example
Download the update file		
`AT+UHTTPC=<profile_id>,100,<path>`	OK	`AT+UHTTPC=0,100,"/test/plain/uploads/update_file.zip"`
Download success		
	`+UUHTTPCR: <profile_id>,100,1,<status_code>,<md5_sum>`	`+UUHTTPCR: 0,100,1,200,"960d9502ed3d71505b681e8aa19f03c8"`
Download failure		
	`+UUHTTPCR: <profile_id>,100,0,0`	`+UUHTTPCR: 0,100,0,0`

5.3 Error result codes

If a download session returns "+UUHTTPCR: 100,0", the host can retrieve the error reason using the +UHTTPER AT command. It retrieves the last +UHTTPC operation result for a given profile. For the definition of the <error_class> and <error_code> parameters, see the "HTTP class error codes" section of the LARA-R6 series AT commands manual [1].

Syntax	Response	Example

`AT+UHTTPER=<profile_id>`	`+UHTTPER: <profile_id>,<error_class>,<error_code>`
	OK
		`AT+UHTTPER=0`
		`+UHTTPER: 3,23`
		OK

In the example above, the operation failed due to server hostname lookup failure.

6   Firmware update via AT (FOAT)

FOAT download provides tethered data transfer methods to perform firmware download over USB/UART interfaces with a host processor.

FOAT download does not support the resume feature. Therefore, the download will need to be re-started after any type of failure, external interrupt, or timeout. The FOAT system is illustrated in Figure 5.
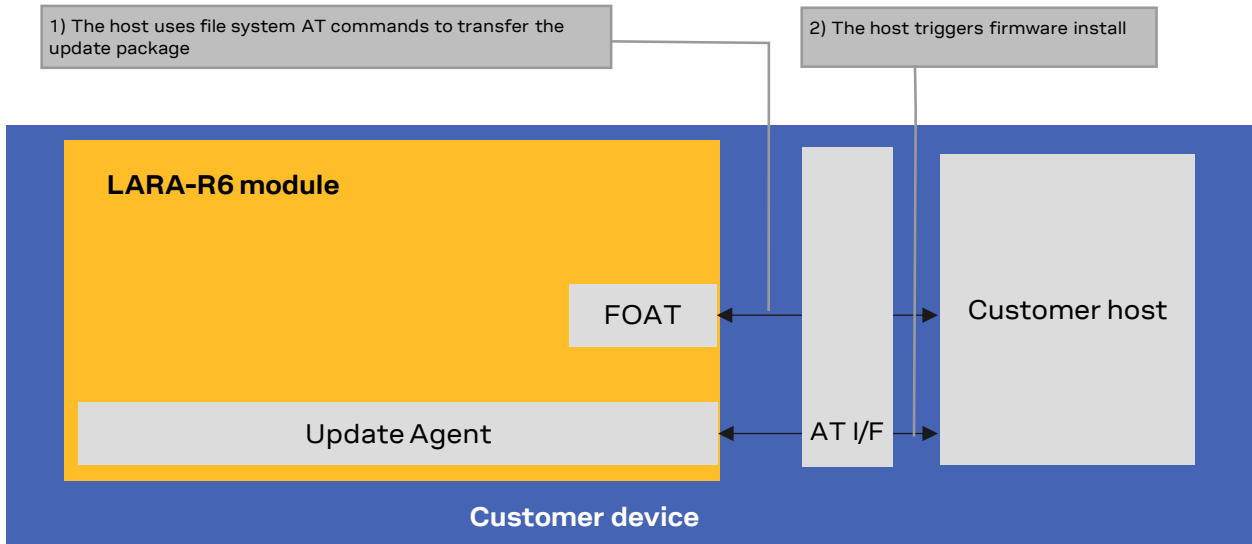

Figure 5: FOAT architecture system

6.1   +UFWUPD AT command

The +UFWUPD AT command triggers the download of the update package using the Xmodem or Xmodem-1k protocol. The host can start the download process on the USB interface or on any UART interface at speed set by the +IPR AT command (the factory-programmed value is 115200 bit/s). After the successful download, the module automatically starts the firmware update procedure with the downloaded update package (.upd) in flash memory. First stage of the update procedure is the package verification. Second stage is the package installation. If the verification is successful, the FW installation procedure will start with the +UFWUPD URCs. Otherwise, the update procedure will be suspended, and a +UFWUPD URC error result code will be issued. The module exits from the update procedure mode and returns to the normal mode since the firmware is unchanged and usable.

During the update operations, +UFWUPD URCs indicate the progress and the result operation on the primary UART interface. Progress URCs are issued on the primary UART interface at the 115200 bit/s baud rate. When the firmware update is completed, a URC will notify the final result of the operation.

☞ The relevant URC along with result codes will not be received on any USB interface. Therefore, if the UART is not accessible for monitoring the URC progress messages, we recommend monitoring the time and wait at least 65 minutes to ensure that FW has been correctly upgraded and flashed on the module. Once the procedure is completed, the module reboots to new firmware release, then it is ready to receive AT commands. Send AT command and wait for OK reply from the device to be sure the update is completed.

☞ On LARA-L6004-00B and LARA-R6004D-00B product version the FOAT file transfer on UART with baud rate 3'000'000 bit/s is not supported.

☞ The time required to ensure that FW has been correctly upgraded differ between different product variants, as shown in the table below:

Product	Estimated time required for module upgrade
LARA-R6	Up to 65 minutes.
LARA-L6	Up to 3 minutes.

☞ For +UFWUPD URC error result code, see section A.

On receiving the +UFWUPD AT command, the module sends the "+UFWUPD: ONGOING" URC to the host terminal via the AT interface, followed by up to three "C" (0x43) characters and up to ten <NACK> (0x15) characters. The first three "C" characters are sent with a 3 s timeout after the last one, and the next ten <NACK> characters are sent with a 10 s timeout after the last one. The total timeout is 109 s. This is the timeout within which the host terminal must send TX data. During this time interval the module will not accept any AT commands.

If data is sent while the "C" character is coming, the protocol uses the CRC method to detect transmission errors, otherwise the standard CHECKSUM method is used.

In the event of a timeout (109 s) while sending the update file via Xmodem protocol, the "ERROR1" error result code is issued on the UART interface; the FW is unchanged and still usable.

During the installation process, the module cannot be used to make calls, even emergency calls. It is not available for communication via USB or UART interfaces. With the EVK on a Windows based PC, there will be no USB ports enumerated.

6.1.1 Syntax specifications

Type	Syntax	Response	Example

Set	`AT+UFWUPD=<filetype>`	`+UFWUPD: ONGOING`
		`CCC•••••`
		`OK`
			`AT+UFWUPD=3`
			`+UFWUPD: ONGOING`
			`CCC•••••`
			`OK`

Test	`AT+UFWUPD=?`	`+UFWUPD: (list of supported <filetype>s)` `OK`	`+UFWUPD=3` `OK`

6.1.2 Defined values

Parameter	Type	Description
`<filetype>`	Number	Indicates download type: • 3: firmware package download

The following example shows the FOAT procedure and provides more command details and times.

Command	Response	Description
`AT+UFWUPD=3`	`+UFWUPD: ONGOING`	The host starts the download process on the primary UART interface at speed set by +IPR AT command.
	`CCC<NACK><NACK><NACK><NACK><NACK><NACK><NACK><NACK><NACK><NACK>`	Up to 3 "C"s and up to 10 <NACK>s. • "C" rate: 1/3 s • <NACK> rate: 1/10 s
\<Send firmware image using Xmodem or Xmodem-1k protocol at speed set by +IPR AT command over the primary UART interface>		See Additional Rate note below

☞ It takes approximately 5 s to prepare the FOAT command to download binary data. The following will be displayed for the following commands:

o +UFWUPD displays "+UFWUPD: ONGOING"

☞ Once the +UFWUPD AT command is ready to transfer binary data, it will not accept any AT commands for approximately 109 s.

☞ When the file transfer is complete, the final result code will be issued. Upon completion, the module will accept and respond to AT commands.

6.1.3 Timeout event example

The following example shows a timeout expiring while sending the update file via Xmodem protocol.

Command	Response	Description
AT+UFWUPD=3	+UFWUPD: ONGOING CCC••••••••• Timeout ERROR1 OK	The "Timeout" and "ERROR1" error result code is issued on the UART interface; after a timeout event while sending the update file via Xmodem protocol.

6.1.4 Firmware installation with +UFWUPD example

Table 3 provides an example of firmware installation using the +UFWUPD AT command.

Command	Response	Description
AT+UFWUPD=3	+UFWUPD: ONGOING CCC<NACK><NACK><NACK><NACK><NACK><NACK><NACK><NACK><NACK><NACK>	After the successful download, the module automatically starts the firmware update with the downloaded update package.
	OK	If the updated package validation is successful, the FW installation procedure will start with the +UFWUPD URCs. Progress URCs are issued on the primary UART interface at 115200 bit/s baud rate.
		Download completed and a reboot follows.
	+UUFWPREVAL: 0 +UUFWPREVAL: 3 +UUFWPREVAL: 7 … +UUFWPREVAL: 90 +UUFWPREVAL: 100	Firmware update file validation started. Firmware validation completed.
	+UUFWUPD: 1 +UUFWUPD: 3 … +UUFWUPD: 26 +UUFWUPD: 27 +UUFWUPD: 30 +UUFWUPD: 31 … +UUFWUPD: 72 +UUFWUPD: 73 … +UUFWUPD: 92	Firmware installation started. The progression of installation is incremental (the subsequent increment of <progress_install> can be more than 1) The last URC with a value greater than 100 indicates the update operation result (e.g., 128 means operation completed with success). For more

Firmware update via AT (FOAT)

Command	Response	Description
	`+UUFWUPD: 100` `+UUFWUPD: 128`	details see the +FWINSTALL error result codes in LARA-R6 / LARA-L6 series AT commands manual [1]). Firmware installation completed. The module reboots again to new firmware release, then it is ready to receive further commands.

Table 2 UFWUPD URCs example (delta file must be already downloaded in flash)

6.1.5   Recovery mechanism

In the event of a timeout (109 s) while sending the update file via Xmodem protocol, a "Timeout" and "ERROR1" error result code will be issued on the interface where the host started the download process. The module will still run with the old firmware, no update will take place.

In case of power loss during the download by the +UFWUPD AT command, at the next module wake up the module is again in normal mode.

If a power loss should happen during the installation phase, at the next module wake-up a fault is detected, and the module remains in Firmware Install Mode until the end of the procedure (installation terminated).

⚠️ Even if the procedure is fault tolerant, it is strongly recommended to not remove the power supply or reset the module on purpose during the installation process! The module will reboot automatically at the end of the update procedure.

7   Firmware installation +UFWINSTALL

☞   This command is not applicable if LwM2M was used to download the firmware update package.

⚠   Once the +UFWINSTALL AT command has been issued, the FW installation process shall begin. If the firmware update includes a boot code update, then an interruption during the update process of this code section can lead to image corruption of the module that is not recoverable. Types of interruptions include:

- o   Removing or loss of power supply to the module
- o   Unstable supply to the module
- o   Host application applies an external reset to module
- o   Turning off the module with PWR_ON or RESET_N pin

The +UFWINSTALL AT command triggers the firmware installation procedure once the firmware delta package (namely also 'update file') has been downloaded successfully to the device via AT command +UDWNFILE, OTA with +UFTPC or +UHTTPC (where supported). See Figure 6 for an overview diagram. This command provides an error result code if it is issued under other circumstances (including a successful firmware download via LwM2M).
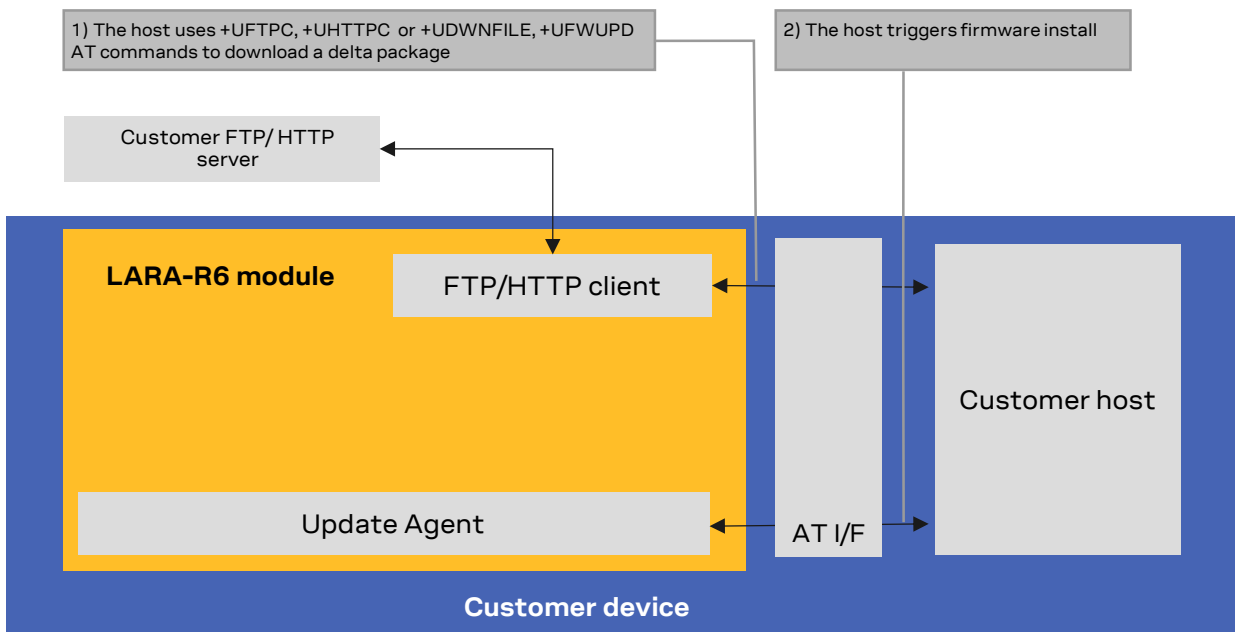
Figure 6: Firmware installation after FTPC, for FOAT file transfer

If the +UFWINSTALL command returns the "OK" final result code, the device will automatically reset and boot back up in boot loader mode, at which point it will process the firmware update.

The +UFWPREVAL URCs indicate the progress of the delta file validation. The progression of the validation is incremental, but the increment can be different from 1. The +UFWPREVAL: 100 URC may not be issued and the module can start the installation phase issuing the +UUFWINSTALL URC.

If the validation fails, the procedure will be suspended and a +UUFWINSTALL URC with the <progress_install> error result code will be issued. The module exits from the update procedure mode and returns to the normal mode since the firmware is unchanged and usable. Otherwise, in case of a

successful validation, the firmware installation procedure will continue, notified by the +UUFWINSTALL URCs.

Once the firmware installation completes, the device will reset again and enter a normal mode of operation with new firmware updated.

The result of the firmware update can be confirmed by means of the ATI, ATI9 or +CGMR AT commands which indicate the firmware version.

If a firmware package is not found, the "+CME ERROR: operation not allowed" error result code is displayed.

During the update / installation process, the module cannot be used to make calls, even emergency calls. It is not available for communication via USB or UART interfaces. With the EVK on a Windows based PC, there will be no USB ports enumerated.

7.1 +UDWNFILE AT command

The command +UDWNFILE allows to download a firmware delta package by means of the specific file tag ("FOAT"):

Command	Response	Description
`AT+IPR=3000000`	`OK`	Set the baud rate to 3,000,000 bit/s.
		☞ The host can start the download process on the USB interface or on any UART interface at speed set by the +IPR AT command (the factory-programmed value is 115200 bit/s).
`AT+UDWNFILE=,12300,"FOAT"`	`OK`	The download will be at 3,000,000 bit/s.

Note that firmware delta packages can contain just a MNO profile update.

☞ It takes approximately 5 s to prepare the +UDWNFILE AT command to download binary data. The following will be displayed for the following commands.

o +UDWNFILE displays ">"

The +UDWNFILE AT command can also be used with its "profile" file tag to download and automatically install a MNO profiles file (.mbn file) that has not been packaged in a delta file:

Type	Syntax	Response	Example for MNO profile download
Set	`AT+UDWNFILE=<filename>,<size>[, <tag>]` `>`	`OK`	`AT+UDWNFILE="PROFILE",12000,"PROFILE"` `>`

7.2 +UFWINSTALL AT command

During the install operations, the +UUFWINSTALL URCs display the progress indication and the operation result on the serial interface set via the +UFWINSTALL AT command, at the baud rate set by the same command as well. The progression of the installation is incremental, but the increment can be different from 1.

The last URC with a value greater than 100 indicates the update operation result (e.g., 128 means operation completed with success). For more details about firmware install final result codes, see the section A. After this last result code, the device will reset and enter a normal mode of operation with updated firmware.

7.2.1 Syntax specifications

Type	Syntax	Response	Example
Firmware upgrade			
Set	`AT+UFWINSTALL[=<Serial_Port_Number>[,<BaudRate>]]`	`OK`	`AT+UFWINSTALL=1,115200` `OK`
Configure uFOTA FW update URCs			
Set	`AT+UFWINSTALL=[<Serial_Port_Number>],[<BaudRate>],,<uFOTA_URC>`	`OK`	`AT+UFWINSTALL=1,115200,,1` `OK`
Test	`AT+UFWINSTALL=?`	`+UFWINSTALL: (list of supported <Serial_Port_Number>s),(list of supported <BaudRate>s),,(list of supported <uFOTA_URC>s)` `OK`	`+UFWINSTALL: (0-2),(115200,230400,460800,921600,3000000),,(1)` `OK`
URC		`+UUFWINSTALL: <progress_install>`	

7.2.2 Defined values

Parameter	Type	Description
`<Serial_Port_Number>`	Number	Serial interface where the progress percentage and the information text responses will be sent: • 0: no info will be shown. In this case the <BaudRate> parameter is ignored • 1: UART interface • 2: AUX UART interface If omitted, the command will take as default value for <Serial_Port_Number> the port where the command is issued.
`<BaudRate>`	Number	Available baud rates in bit/s: • 115200 • 230400 • 460800 • 921600 • 3000000 If omitted, the command will take the current value set for the parameter as the baud rate to be used during the FW installation.
`<uFOTA_URC>`	String	Allowed value: • 1: enables the +UUFWINSTALL URCs during the next FW upgrade by means of uFOTA; the URCs will be issued on the specified <Serial_Port_Number> using the specified <BaudRate>. If the <Serial_Port_Number> parameter is omitted, the URCs will be issued on the port where the command has been issued. If the <BaudRate> parameter is omitted, the current value set for the <BaudRate> parameter will be used. The parameter setting is stored in the flash and is persistent across power cycles.
`<progress_install>`	Number	Provide the installation progress from 1 to 100 and the update result

7.2.3 Installation performance

The installation time depends on the delta file size and the sections changed in the software memory map between two software versions.

7.2.4 Firmware installation with +UFWINSTALL example

Table 3 provides an example of firmware installation using the +UFWINSTALL AT command.

Command	Response	Description
AT+UDWNFILE=,8388608,"FOAT"	OK	Download the delta file in flash.
AT+UFWINSTALL=1,115200	OK	Start the installation procedure. The cellular module response is sent at 115200 bit/s. The module reboot follows, after which every module response is sent at 115200 bit/s.
	+UFWPREVAL: 0 +UFWPREVAL: 3 +UFWPREVAL: 7 … +UFWPREVAL: 90 +UFWPREVAL: 100 +UUFWINSTALL: 1 +UUFWINSTALL: 3 … +UUFWINSTALL: 92 +UUFWINSTALL: 100 +UUFWINSTALL: 128	Firmware delta validation started. Firmware validation completed. Firmware installation started. Firmware installation completed. Once the last URC (+UFWINSTALL: 128) is received, the module reboots again to new firmware release, then it is ready to receive further commands.
	+UUFWINSTALL: 1 +UUFWINSTALL: 3 … +UUFWINSTALL: 92 +UUFWINSTALL: 100 +UUFWINSTALL: 128	Firmware installation started. Firmware installation completed. Once the last URC (+UFWINSTALL: 128) is received, the module reboots again to new firmware release, then it is ready to receive further commands.

Table 3: +UFWINSTALL URCs example (delta file must be present in flash)

7.2.5 Recovery mechanism

In case of a failure (for instance due to power loss or cable detach), the FW installation procedure starts again until the end of the procedure (installation terminated). In the event of a firmware install failure but where the update process has still not written anything in the flash memory, the update procedure stops and runs the old firmware.

⚠️ Even if the procedure is fault tolerant, it is strongly recommended to not remove the power supply or reset the module on purpose during the installation process! The module will reboot automatically at the end of the update procedure.

7.2.6 Destination version already installed in the device

If the user applies a delta package "release X to release B" to a device which has already the destination firmware version, release B, the update procedure will immediately issue result code 128, no update will be run. This is because the device is up to date. The procedure is shown in the table below.

Start DUT FW	UPD SRC	UPD DST	Expected update result	End DUT FW	Note
FW B	FW X	FW B	128	FW B	Immediate result expected

7.3 Performing EFS backup after flashing FW update with delta package

On both LARA-R6 and LARA-L6, after a successful update through FOTA / uFOTA, a backup is automatically performed by the module itself.

For more details on the +UBKUPDATA AT command, see the LARA-R6 / LARA-L6 series AT commands manual [1] and LARA-R6 / LARA-L6 series application development guide [4].

8 AT commands forbidden during FW download

Only one download method can be active at a time. Table 4 presents the AT commands and firmware download methods that have a dependency upon one another.

☞ An error result code is returned if a command listed in Table 4 is issued during a firmware download.

Active download method	Forbidden AT commands	Note

LwM2M client FOTA download	`AT+UFTPC=100,`
	`AT+UFWUPD=3,`
	`AT+UDWNFILE=,,"FOAT",`
	`AT+UHTTPC=<profile_id>,100`
		When a FOTA download is in progress by LwM2M client, the forbidden AT commands will return an error.

`AT+UFTPC=100`	`AT+UFWUPD=3,`
	`AT+UDWNFILE=,,"FOAT",`
	`FOTA download via LwM2M client`
	`AT+UHTTPC=<profile_id>,100`
		When AT+UFTPC=100 is in progress, the FOTA download via the forbidden commands will return an error.

`AT+UFWUPD=3`	`AT+UFTPC=100,`
	`AT+UDWNFILE=,,"FOAT",`
	`FOTA download via LwM2M client`
	`AT+UHTTPC=<profile_id>,100`
		When +UFWUPD is in progress, the FOTA download via the forbidden commands will return an error.

`AT+UDWNFILE="FOAT"`	`AT+UFTPC=100,`
	`AT+UFWUPD=3,`
	`FOTA download via LwM2M client`
	`AT+UHTTPC=<profile_id>,100`
		When +UDWNFILE with "FOAT" tag is in progress, the FOTA download via the forbidden commands will return an error.

`AT+UHTTPC=<profile_id>,100`	`AT+UFTPC=100,`
	`AT+UFWUPD=3,`
	`AT+UDWNFILE=,,"FOAT",`
	`FOTA download via LwM2M client`
		When AT+UHTTPC=<profile_id>,100 is in progress, the FOTA download via the forbidden commands will return an error.

Table 4: Firmware download methods dependency

9   Firmware update via EasyFlash

EasyFlash is a Windows-based application tool that allows LARA-R6 and LARA-L6 series modules to be flashed via the USB interface.

☞ For each firmware release, there is a recommended version or minimal version of EasyFlash to be used with it. Consult u-blox support to identify which EasyFlash version shall be used. It is good practice to have the latest version available to have all the improvements and fixes.

OS requirements

EasyFlash requires a computer with either Windows 7 or 10 OS.

Flashing steps

1. Select the path to the FW .dof flash file in the main window of the tool (see Figure 7).
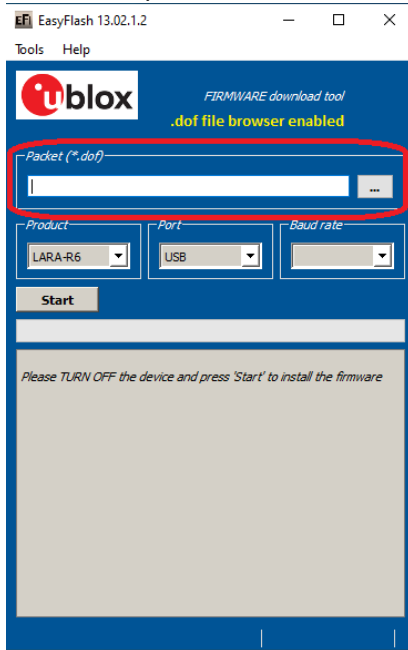

Figure 7: EasyFlash, select the ".dof" file path

☞ Alternatively, uncheck "Enable file browser" in "Tools" to use a .dof file stored in the application folder (see Figure 8).
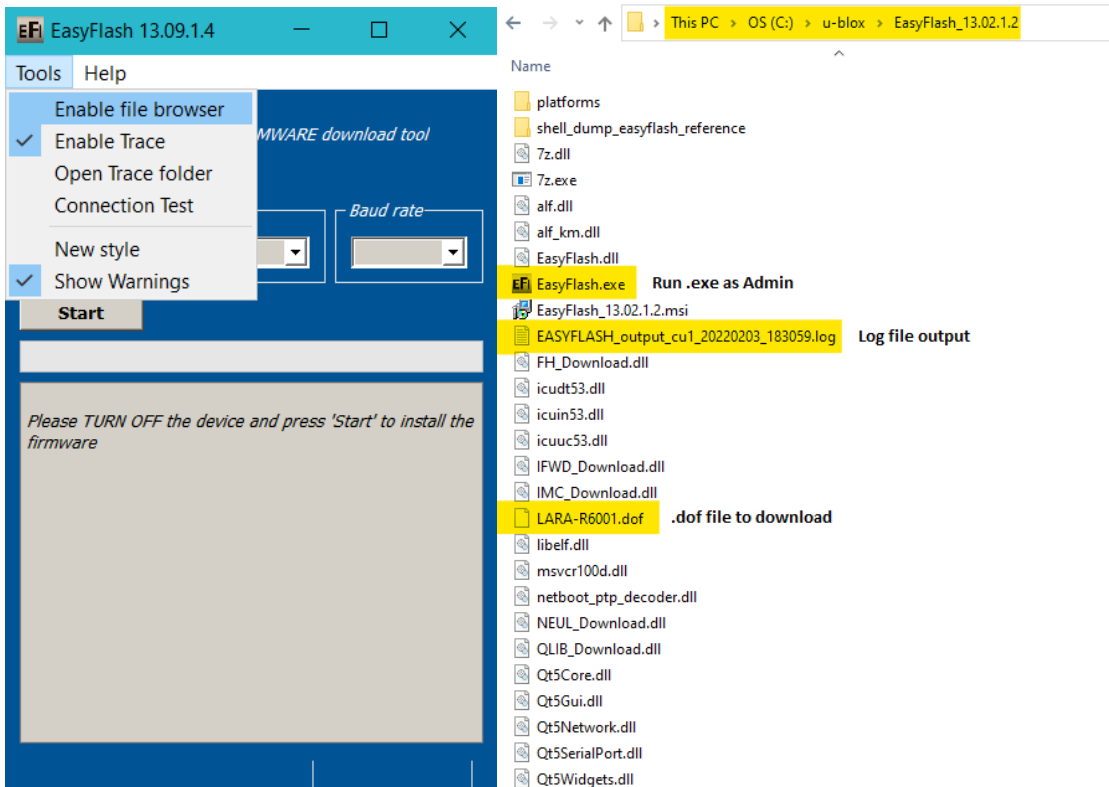

Figure 8: EasyFlash directory and file details

2. If there are any tools related to the module running on the computer, then close them. To ensure they are closed it may require checking and terminating them in Windows Task Manager.
3. Open EasyFlash (run / open it as "Administrator" in Windows).
4. Select in pull down
   a. Product: LARA-R6
   b. Port: USB
   c. Baud rate: leave blank
5. "Enable trace" from main menu (see Figure 8) is ticked by default. This will create a log per flash attempt. It is useful if something goes wrong, and it is needed to report the issue.
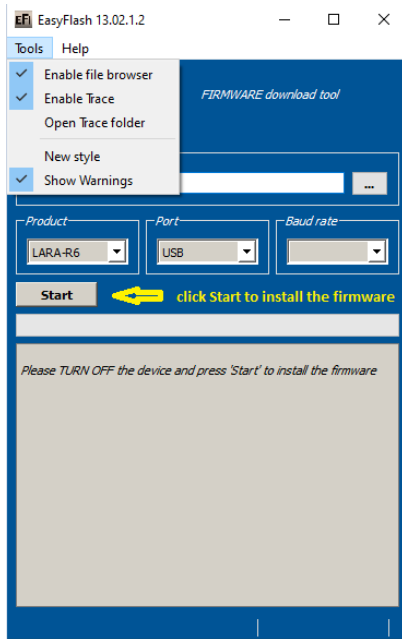6. Click "Start" button (see Figure 9).

Figure 9: Setting up EasyFlash and starting the FW installation

7. Power up the module.
8. Flash will start, wait for flash to complete (see Figure 10 and Figure 11)
9. Close EasyFlash.

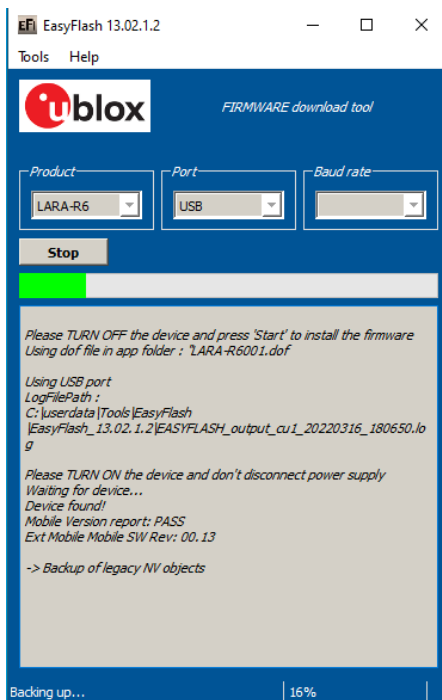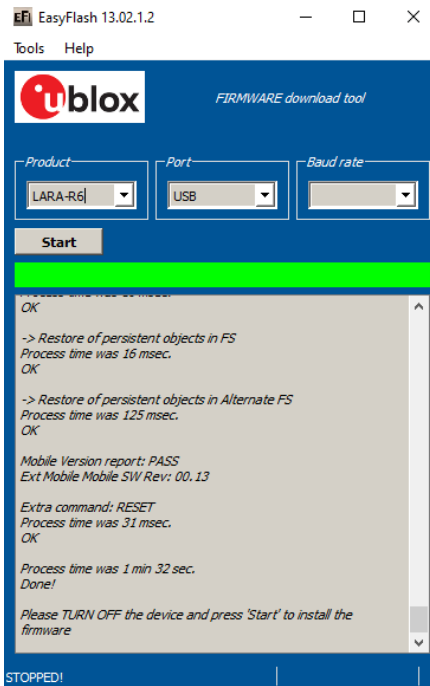**Figure 10: Flash process in progress**

Figure 11: Flash process complete and successful

EasyFlash tips

- Do not use a USB hub.
- It could be necessary to remove any other drivers for other Qualcomm chipset/products on the computer.
- If the flash process fails to complete, try again.
- During the flash process in EasyFlash version 13.00.1.0 and higher, the EasyFlash firmware update process will first generate a backup file for the device in the root directory where the EasyFlash executable file is located, and store it on the PC until it restores it.
  - This file contains specific device data such as calibration data and IMEI value among other configuration values too.
  - If the EasyFlash firmware update process does not successfully complete due to some error (which will be reported by EasyFlash) and the error occurs between these two events:
    - a) after it creates the backup file
    - b) before it restores this backup file back to the device during the last stage of the EasyFlash update process

    then the backfile will reside on the PC and can be seen in the Windows file system.
    - If the device should undergo a subsequent EasyFlash update again on the same PC that contains this backup file, a complete and successful update run will restore this backup file to the exact same device it was backed-up from and will not restore it to any other module.
    - Once the file is restored to the module, it is deleted from the PC.
  - Example backup file name:
    - EASYFLASH_archive_a9e1ce86_354679090348445.qbackup
- Try rebooting the PC if a flash fails a few times, and then try again after reboot.

9.1   EasyFlash and Backup & Restore feature

This section describes how to use EasyFlash and update the module to a firmware that offers the Backup & Restore feature.

After a successful firmware update using EasyFlash, the module is armed to trigger a backup upon the first boot. Do allow the boot-up and backup time for the backup process, as guided in LARA-R6-L6 series application development guide [4].

If the device is left powered on after the EasyFlash process is complete, it will automatically boot and perform the backup.
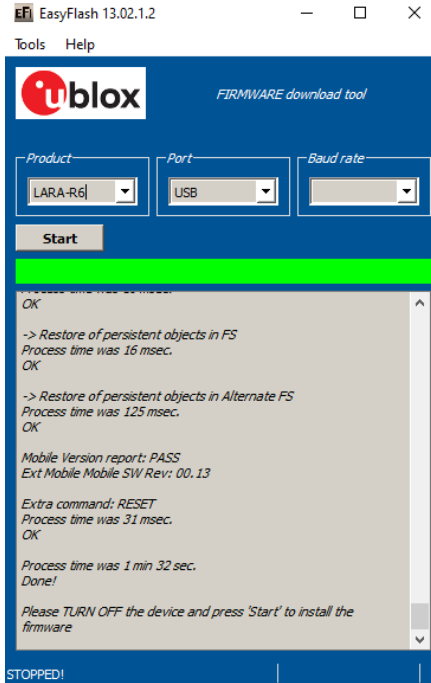

Figure 12 Flashing module is completed. The module will boot-up after success and perform first Backup.

After the first backup is performed automatically post updating the firmware by means of EasyFlash, confirm the backup copy.

Command	Response	Description
AT+UBKUPDATA?	+UBKUPDATA: 0,0,1,0,0,0,"" OK	Backup copy confirmed as indicated by the "1" for one backup performed.

9.1.1 Setting preferred message storage after FW update

If a firmware build with the Backup & Restore feature is being deployed onto a module by EasyFlash, after a successful FW update when the device boots up, then the host is required to set preferred SMS message storage by means of the +CPMS AT command just once after the firmware update. This step is required if the host application should use SMS. If it does not intend to use SMS, then this step can be ignored. Even if the host intends to use the +CPMS AT command factory-programmed setting, the storage setting still needs to be set.

9.2 Typical errors

These are the typical errors and their solutions:

Error message in main log window	Description	Solution
"Please TURN ON the device and don't disconnect power supply Waiting for device..." This message remains, even after turned on the device	Download does not start after power on	Check USB connection. Install u-blox USB driver.
"LoadFlashProg failed! (Maybe wrong dof signature?)"	Signature fails. Attempting to download a .dof filen with wrong signature	Wrong .dof file. Use the correct one.

Error message in main log window	Description	Solution
"Error occurred! Device IMEI is not valid! Upgrade cannot be performed"	IMEI missing or wrong	Contact u-blox technical support

10 Impacts of different FW update methods

Table 5 summarizes the update methods and their impact on user files and settings.

Item	EasyFlash	FW delta package via uFOTA / FOTA	FW package via FOAT
Description	Complete FW package applied by u-blox EashFlash tool	Differential update package applied with +UFWINSTALL	Non-differential FW update package applied with +UFWUPD
Package name example	`LARA-L6004-00B-00-IP-0316A0001-008K00.dof`	`LARA-L6004-00B-00-ES-0315A0001-008K00_LARA-L6004-00B-00-IP-0316A0001-008K00.upd`	`LARA-L6004-00B-00-IP-0316A0001-008K00.upd`
Files in user file system	Erased, then set to what is configured with FW image (if any).	No changes. Files are preserved.	No changes. Files are preserved.
LwM2M files stored in user file system	Erased, then set to what is configured with FW image (if any).	No changes. Files are preserved.	No changes. Files are preserved.
MNO profiles	Erased, then MNO profiles are loaded to only what is included in the FW image. After flashing select MNO profile with +UMNOPROF.	MNO profiles included in update package are modified. MNO profiles not included is restored by the new FW.	MNO profiles included in update package are modified. MNO profiles not included is restored by the new FW.
User NVM settings (i.e. +UBANDMASK)	Erased, then set to default values as configured in FW build image.	NVM items included in update package are modified, otherwise no change.	NVM items included in update package are modified, otherwise no change.
User certificate and private keys	User certificate and private keys are preserved		
SMS	Erased.		

Table 5 Impact to device files and settings of each firmware update method

Appendix

A Extended error result codes

Table 6 lists the final result codes that may be issued at the finalization of the install procedure by the +UFWINSTALL and +UFWUPD AT commands.

☞ Most of the following result codes are sent through the UART interface with the baud rate set by the +UFWINSTALL AT command. Where it is not possible to read the +UFWINSTALL configuration port, the UART and baud rate used is the primary UART interface and the baud rate of 115200 bit/s.

Error code	Description	+UFWINSTALL: URC UART port and baud rate	+UFWUPD: URC UART port and baud rate
128	FW installation successfully performed	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s
129	Firmware installation generic failure	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s
130	Flash access failure	Primary UART, baud rate: 115200 bit/s	Primary UART, baud rate: 115200 bit/s
131	RAM allocation error	Primary UART, baud rate: 115200 bit/s	Primary UART, baud rate: 115200 bit/s
132	Retrieve partition table error	Primary UART, baud rate: 115200 bit/s	Primary UART, baud rate: 115200 bit/s
134	Bad Block Flash init failure	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s
140	Generic decompression engine error	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s
141	RAM error	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s
144	Requested file does not exist during installation (it could be a working file/partition in flash or FW file/partition to be updated. Could be flash error.	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s
145	Attempt to do file operation when file system access is not available	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s
148	Delta file is corrupted	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s
158	Delta file not recognized. It happens trying to update from a non-delta file format	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s
160	Flash writing failure	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s
168	Source firmware in flash mismatch with the one expected by the delta file.	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s
173	Calculated digital signature does not match pkg header value – probably wrong signature or some byte corrupted	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s
174	Delta file version is not supported	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s
178	RAM memory corruption (Null Pointer assignment)	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s
180	Size of the delta file in flash mismatch with the real delta file size	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s
195	Data corruption found in a component/partition/file updated in flash. Probably cause by power loss cause or flash problem	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s
224	Generic error in finalizing the end of the install procedure. Last check before exiting install.	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s
227	FOTA public key is not found or invalid	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s
230	File operation (write/read/delete) in flash fail	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s

Error code	Description	+UFWINSTALL: URC UART port and baud rate	+UFWUPD: URC UART port and baud rate
247	Pre-validation of the delta file failed.	Set by +UFWINSTALL	Primary UART, baud rate: 115200 bit/s

Table 6: Common error result codes during +UFWINSTALL / +UFWUPD procedure

If a different error result code is provided, contact u-blox technical support.

B Glossary

Abbreviation	Definition
eDRX	Enhanced Discontinuous Reception
EVK	Evaluation Kit
FOAT	Firmware update AT command
FOTA	Firmware Over-The-Air
FW	Firmware
IMEI	International Mobile Equipment Identity
LwM2M	Light weight Machine to Machine
OTA	Over The Air
SRLT	Server Registration Life Timer
UART	Universal Asynchronous Receiver-Transmitter
uFOTA	u-blox FOTA
URC	Unsolicited Result Code

C MNO certification notes

C.1 Verizon

The u-blox LwM2M client can also handle a firmware upgrade process triggered by the LwM2M Verizon server (this is not managed by u-blox), downloading the FOTA packages provided by u-blox but stored on Verizon servers. For more details on the procedure to follow, see the instructions in section 3.7.1.

Related documentation

[1] u-blox LARA-R6 / LARA-L6 AT commands manual, UBX-21046719
[2] u-blox LARA-R6 series data sheet, UBX-21004391
[3] u-blox LARA-R6 series system integration manual, UBX-21010011
[4] u-blox LARA-R6 / LARA-L6 application development application note, UBX-22001850
[5] u-blox LARA-R6 / LARA-L6 LwM2M objects and commands application note, UBX-22008379
[6] OMA technical specification Lightweight M2M, V1_0-20170208-A

☞ For regular updates to u-blox documentation and to receive product change notifications, register on our homepage (www.u-blox.com).

Revision history

Revision	Date	Name	Comments
R01	29-Apr-2022	mvoc	Initial release
R02	16-Feb-2023	mreb	Introduced FW validation function
R03	04-Apr-2023	mreb	Extended the document applicability to LARA-L6 series modules.
R04	27-Feb-2024	mreb	Extended +UFOTA to support pause and resume download functionalities.

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