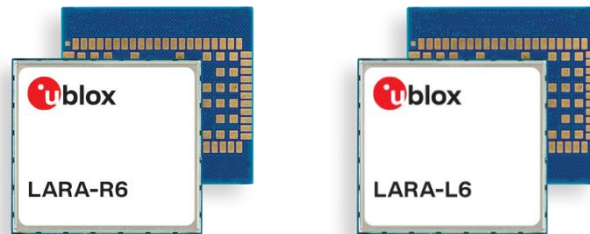


# LARA-R6 / LARA-L6 series

## 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. This application note covers all firmware (FW) update options including EasyFlash, u-blox's FW flash tool over USB; firmware over the air update (FOTA) via u-blox's uFOTA server with the LwM2M client, or via FTP / HTTP, if applicable; and tethered updates

# Document information

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

<b>Product name</b>
LARA-R6 series
LARA-L6 series

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# 1 Introduction

## 1.1 Overview

There are 4 options to update the firmware (FW) of LARA-R6 and LARA-L6 series modules:

- EasyFlash
- FOAT
- FOTA
- uFOTA

Figure 1 shows how EasyFlash and FOAT work. The u-blox EasyFlash tool for Windows flashes the FW image to the module. With FOAT, the FW image is transferred from host to module and automatically installed, with the +UFWUPD AT command.

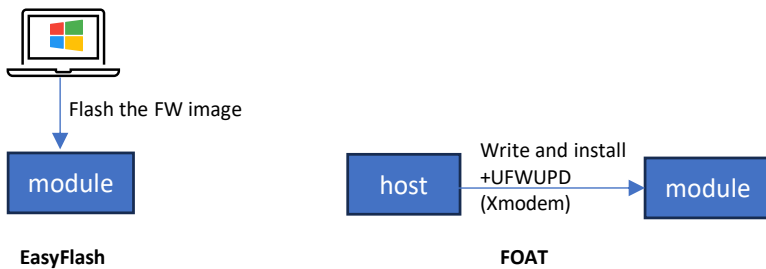
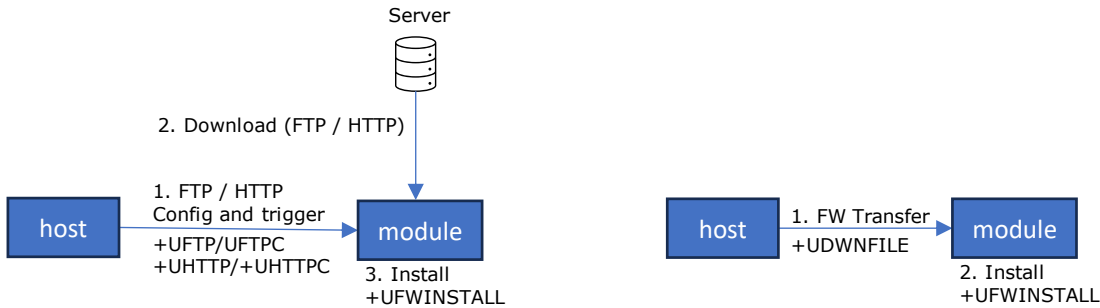


Figure 1 FW update by EasyFlash and by FOAT

Figure 2 shows how FW update by FOTA is done by 1 of the 2 options. FOTA uses dedicated AT commands to download FW delta package from the server to module, or transfer from host to module, and install, as shown in



FOTA option 1: Download FW by FTP/HTTP, then install

FOTA option 2: Transfer FW from host to module, then install

Figure 2 FW update by FOTA, with 2 options

Figure 3 shows uFOTA FW update procedure. uFOTA is u-blox’s solution to a managed and automated FOTA service based on the LwM2M protocol.

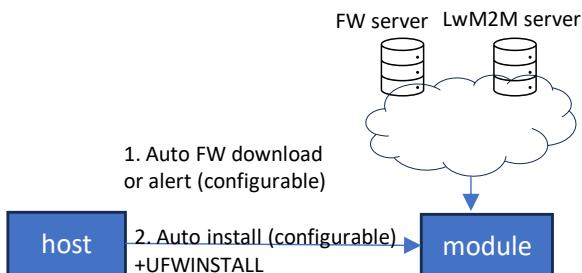


Figure 3 FW update by uFOTA

Table 1 summarizes the characters of the FW update methods.

	EasyFlash	FOAT	FOTA	uFOTA
<b>Format</b>	Full FW image	Full FW image	delta	delta
<b>Duration</b>	Fast	Medium	Slow (Download and installation)	Slow (Download and installation)
<b>Where to find FW update file info?</b>	IN/PCN	IN/PCN	IN/PCN	IN/PCN
<b>Where to get the image</b>	IN/PCN provides link to the image.	Contact u-blox technical support	Contact u-blox technical support	Contact u-blox technical support
<b>Pro</b>	Easy	No PC required.	Wireless No host storage required.	Automated No host storage required Host control and flexibility
<b>Con</b>	Require a PC	File must be stored on host. Require implementation of x-modem protocol.	An extra server required to store the delta file	Campaign requires contacting ublox tech support* (future release allow customer to start by themselves)
<b>Typical use cases</b>	Development / production	Production / Field devices	Field devices	Field devices
<b>Complexity</b>	Low	Medium	Medium	High

Table 1 Summary of module FW update methods

## 1.2 Firmware update generic process

The firmware update proceeds in three phases, as shown in Figure 4. During each phase, URCs are provided to report the progress.

- **Download phase:** The time to download the firmware update file to the module. The file size may vary depending on the downloading method (uFOTA, FOAT, FTP, HTTP, +UDWNFILE). Furthermore, when using an OTA method, even with the same file size, the download time may vary according to the network condition.
- **Validation phase:** The time to validate the file as binary content and check signature.
- **Installation phase:** 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.

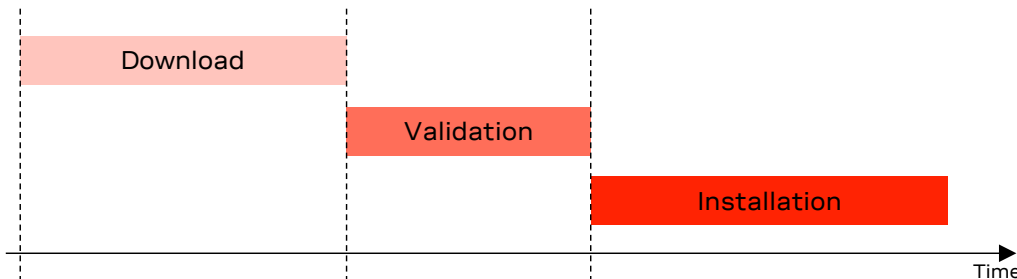



Figure 4: FW update process


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 via EasyFlash

EasyFlash is a Windows-based application tool that allows the 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. Check the notification (IN / SDN / PCN) for the recommended version.

### 2.1 OS requirements

Windows 7, 10, or 11 OS.

### 2.2 Flashing steps

1. Select the path to the FW .dof flash file in the main window of the tool (see [Figure 5](#)).

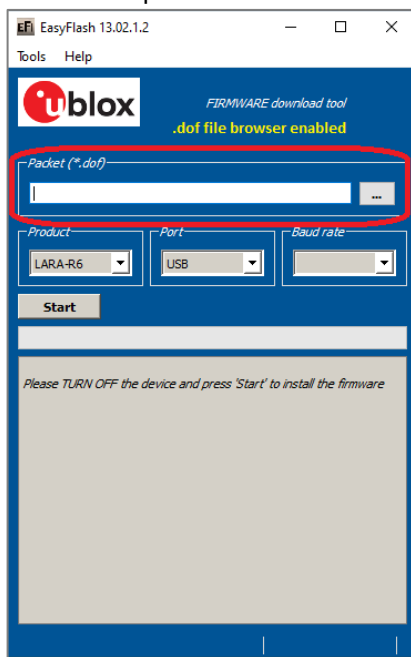
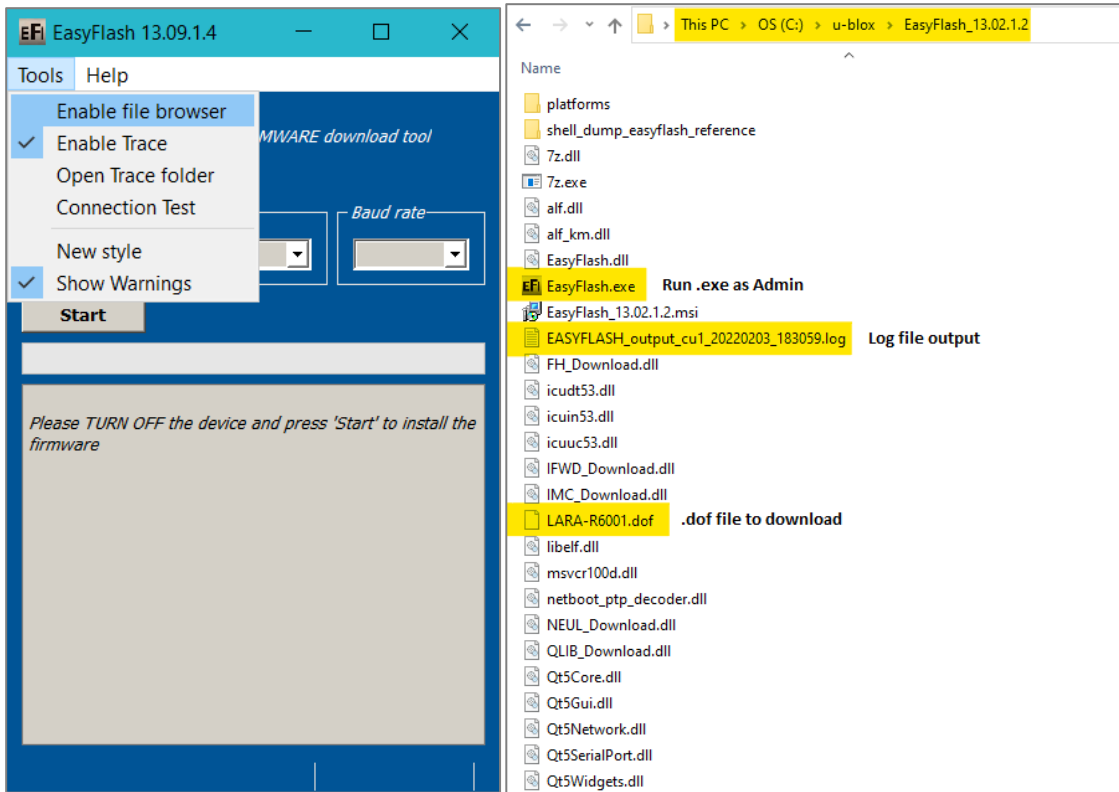


Figure 5: EasyFlash, select the ".dof" file path

Alternatively, uncheck "Enable file browser" in "Tools" to use a .dof file stored in the application folder (see [Figure 6](#)).

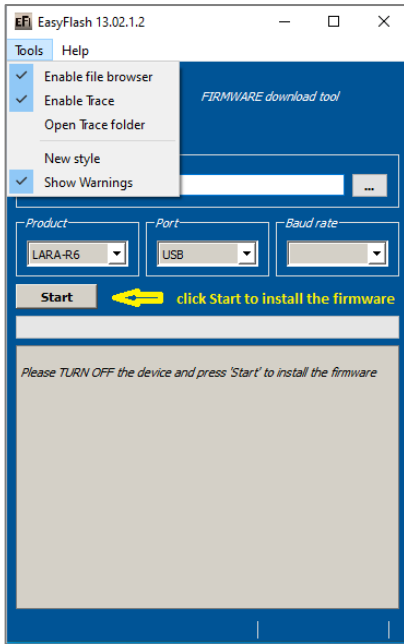


**Figure 6: EasyFlash directory and file details**

The folder where the dof file is placed **must be writable**, since temporary and trace files are written there. There is also a warning (if enabled in **Tools > Show Warnings**), for reminding this when the user selects the dof file by the file browser.

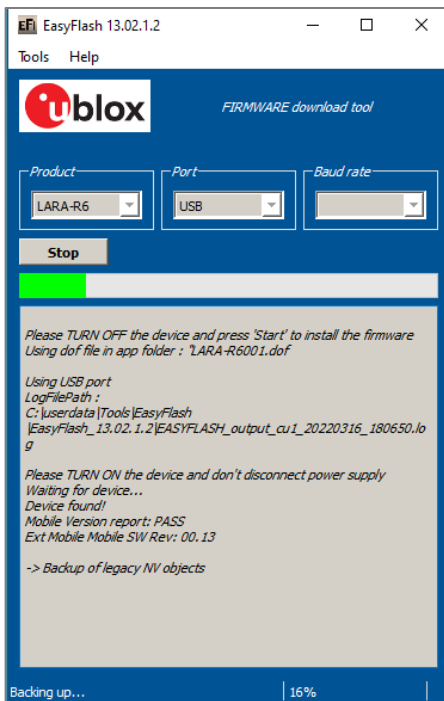
2. If there are any tools related to the module running on the computer, then close them. To ensure they are closed, terminate them in **Windows Task Manager**.
3. Open EasyFlash (run / open it as **Administrator** in Windows).
4. Select in pull down
  - a. Product: Select the correct product
  - b. Port: USB
  - c. Baud rate: leave blank
5. "Enable trace" from main menu (see [Figure 6](#)) 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 7](#)).





**Figure 7: Setting up EasyFlash and starting the FW installation**

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



**Figure 8: Flash process in progress**

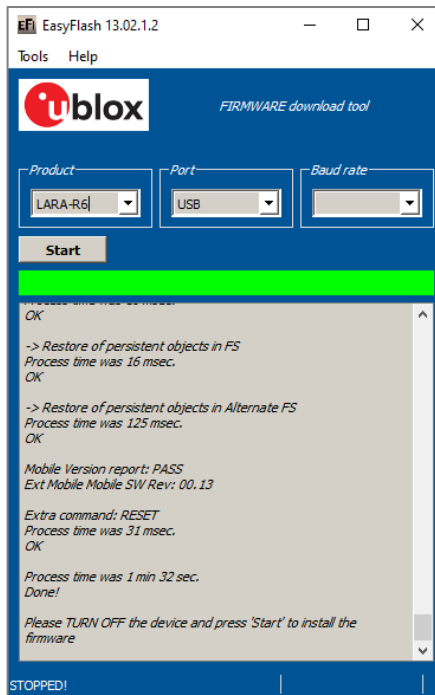


Figure 9: Flash process complete and successful

## 2.3 EasyFlash tips

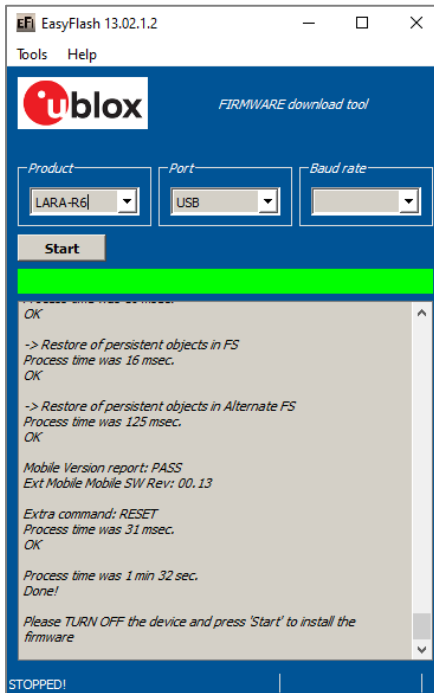
- Do not use a USB hub.
- It could be necessary to remove any other drivers for other Qualcomm chipset/products on the computer.
- If the flash process fails to complete, try again.
- During the flash process in EasyFlash version 13.00.1.0 and higher, the EasyFlash firmware update process will first 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.

## 2.4 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 10** 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.

### 2.4.1 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.

## 2.5 Typical errors

These are the typical errors and their solutions:

<b>Error message in main log window</b>	<b>Description</b>	<b>Solution</b>
"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 file with wrong signature	Wrong .dof file. Use the correct one.
"Error occurred! Device IMEI is not valid! Upgrade cannot be performed"	IMEI missing or wrong	Contact u-blox technical support

### 3 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 must be restarted after any failure, external interrupt, or timeout. The FOAT system is illustrated in

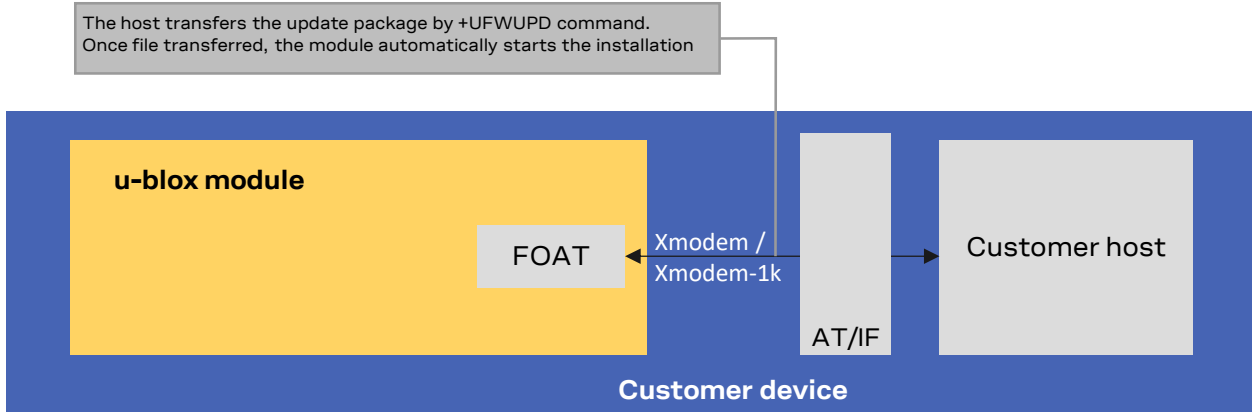


Figure 11.

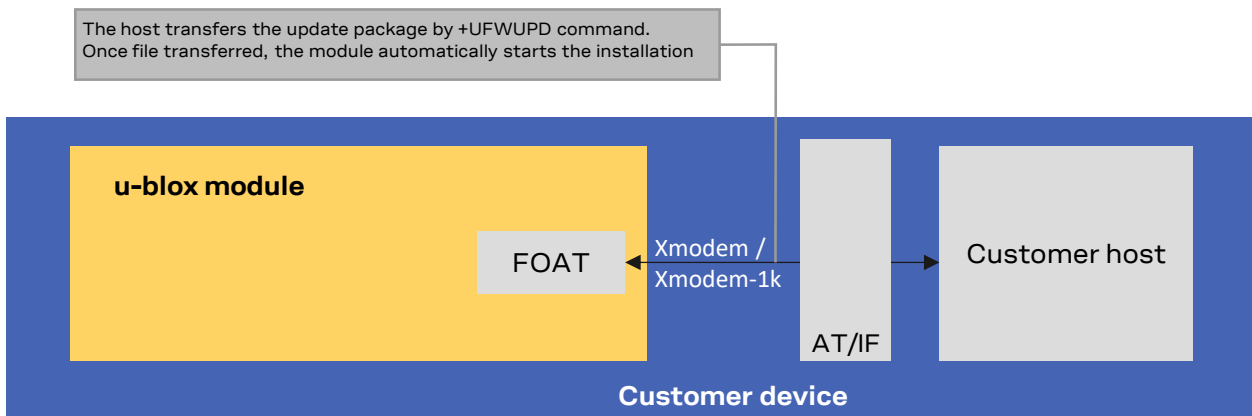


Figure 11: FOAT architecture system


#### 3.1 +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 updated 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 3000000 bit/s is not supported.

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

Product	Estimated time required for module update
LARA-R6 “00B” product versions	Up to 65 minutes.
LARA-R6 “01B” product versions and 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.

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

- +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.

### 3.1.1 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.

Command	Response	Description
		Progress URCs are issued on the primary UART interface at 115200 bit/s baud rate.
		Download completed and a reboot follows.
	+UFWPREVAL: 0 +UFWPREVAL: 3 +UFWPREVAL: 7 ... +UFWPREVAL: 90 +UFWPREVAL: 100	Firmware update file validation started.  Firmware validation completed.
	+UFWUPD: 1 +UFWUPD: 3 ... +UFWUPD: 26 +UFWUPD: 27 +UFWUPD: 30 +UFWUPD: 31 ... +UFWUPD: 72 +UFWUPD: 73 ... +UFWUPD: 92 +UFWUPD: 100 +UFWUPD: 128	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 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 The +UFWUPD URCs example (delta file must be already downloaded in flash)**


### 3.1.2 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. The example below 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.

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.

# 4 Firmware update via FOTA

## 4.1 Overview

Firmware update over the air (FOTA) provides two options:

- OTA from a remote server, via FTP or HTTP protocol
- Over tethered connection from a host processor, via UART interface.

Figure 12 shows the first option, which takes 2 steps:

1. The host configures and triggers the download of the delta package via FTP or HTTP with dedicated AT commands.
2. The host triggers the firmware installation by the +UFWINSTALL AT command.

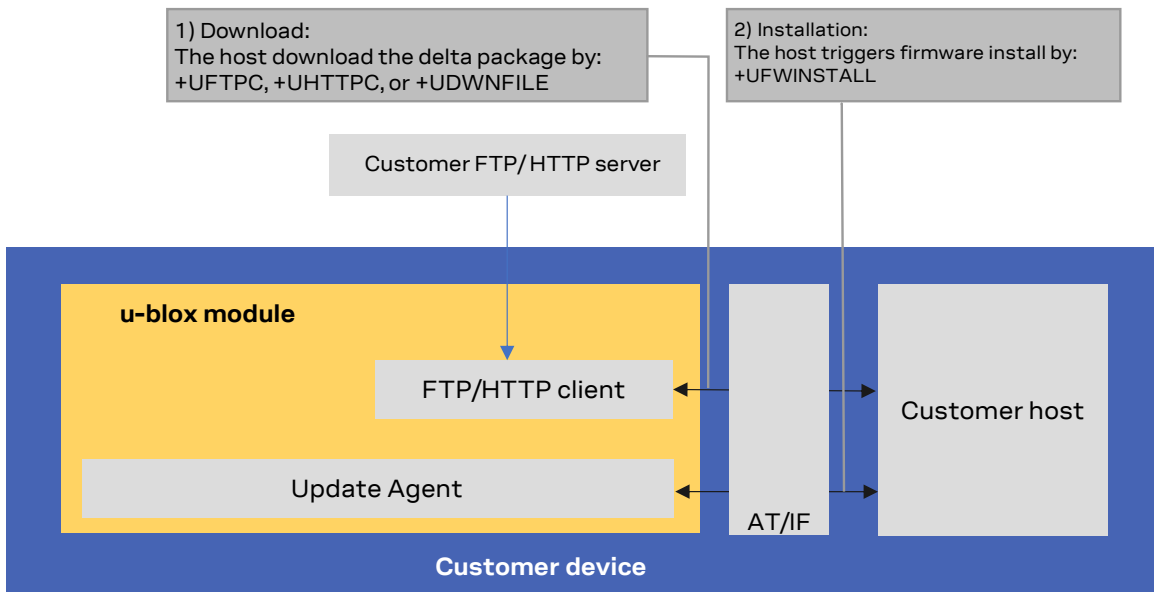


Figure 12 FOTA with FTP/HTTP

Figure 13 shows the option with tethered file transfer:

1. The host transfers the delta package from the host to the module, by +UDWNFILE AT command.
2. The host triggers the firmware installation by the +UFWINSTALL AT command.

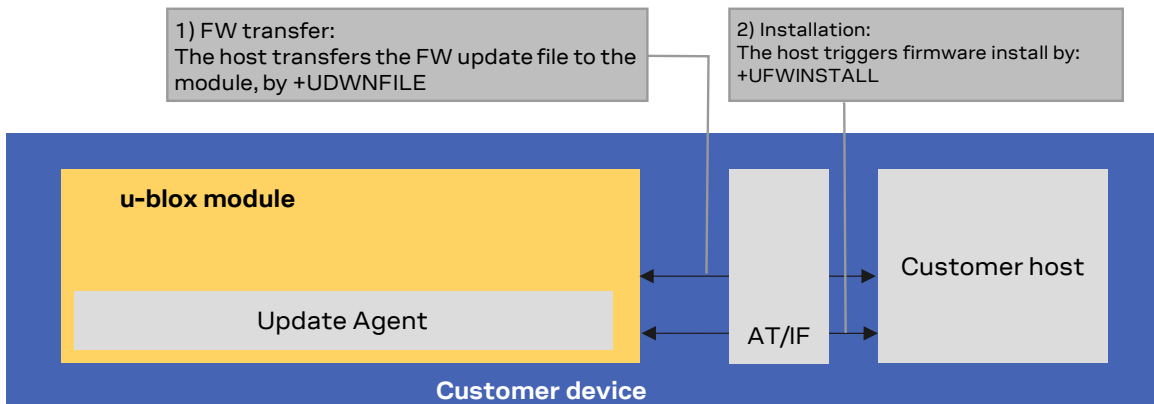



Figure 13 FOTA with FW transfer from host to module



## 4.2 Firmware download


### 4.2.1 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 [4.3](#).

 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 section [6](#).

#### 4.2.1.1 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.

For details of the FTP profile configuration, see the AT commands manual [\[1\]](#).

#### 4.2.1.2 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 must have logged in successfully before starting the download. Once the host cancels a download session, it cannot be resumed. The host must start a new download session.

The resume download feature enables the host to continue a firmware package download near the point where 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.

#### 4.2.1.3 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.

#### 4.2.1.4 Example

Command	Response	Description
AT+UFTP=1,"ftp.firmware.com"	OK	Configure server name

Command	Response	Description
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/FWu pdate_4489_HSFf.pkg"	OK	Start FTP download
	+UUFTPCR: 100,1,"960d9502ed3d7150 5b681e8aa19f03c8"	URC file transfer complete


### 4.2.1.5 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_co de> OK	+UFTPER: 8,40 OK


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

## 4.2.2 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 4.3.


 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 6.

### 4.2.2.1 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.

### 4.2.2.2 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
<b>HTTP server IP address</b>		
AT+UHTTP=<profile_id>,0,<server_IP_addr>	OK	AT+UHTTP=0,0,"192.168.1.0"
<b>HTTP server name</b>		
AT+UHTTP=<profile_id>,1,<server_name>	OK	AT+UHTTP=0,1,"server.com"
<b>Username</b>		
AT+UHTTP=<profile_id>,2,<username>	OK	AT+UHTTP=0,2,"username"
<b>Password</b>		
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
<b>Read HTTP server IP address</b>		
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
<b>HTTP reset all parameters</b>		
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 [\[1\]](#).

### 4.2.2.3 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.

### 4.2.2.4 Example

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

### 4.2.2.5 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_cla AT+UHTTPER=0
                                ss>,<error_code>          +UHTTPER: 3,23
                                OK                          OK
```

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

### 4.2.3 Firmware download via +UDWNFILE AT command

The command +UDWNFILE downloads a firmware delta package by the specific file tag ("FOAT"):

Command	Response	Description
AT+IPR=3000000	OK	Set the baud rate to 3000000 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=filename,12300,"FOAT"	OK	The download will be at 3000000 bit/s.

Note that firmware delta packages can contain just an MNO profile update. The stream of bytes can be entered after the '>' prompt has been provided to the user.

The +UDWNFILE AT command can also be used with its "profile" file tag to download and automatically install an 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">

## 4.3 Firmware installation +UFWINSTALL

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

Once the +UFWINSTALL AT command issued, the FW installation process shall begin. If the firmware update includes a boot code update, an interruption during the update process of this code section can lead to unrecoverable image corruption of the module. The interruptions include:

- Removing or loss of power supply to the module
- Unstable supply to the module
- Host application applying an external reset to module
- 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 (or 'update file') has been downloaded successfully to the device via AT command +UDWNFILE, OTA with +UFTPC or +UHTTFC (where supported). This command provides an error result code if it is issued under other circumstances (including a successful firmware download via LwM2M).

If the +UFWINSTALL command returns the "OK" final result code, the device will automatically reset and start 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 +UFWINSTALL URC.

If the validation fails, the procedure will be suspended and a +UFWINSTALL 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 +UFWINSTALL 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 the AT, AT+I 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.

### 4.3.1 +UFWINSTALL AT command

During the install operations, the +UFWINSTALL 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 appendix A. After this last result code, the device will reset and enter a normal mode of operation with updated firmware.

#### 4.3.1.1 Installation performance

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

#### 4.3.1.2 Firmware installation with +UFWINSTALL example

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


Command	Response	Description
AT+UDWNFILE=filename,8388608,"FOA T"	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 +UFWINSTALL: 1 +UFWINSTALL: 3 ... +UFWINSTALL: 92 +UFWINSTALL: 100 +UFWINSTALL: 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.
	+UFWINSTALL: 1 +UFWINSTALL: 3 ... +UFWINSTALL: 92 +UFWINSTALL: 100	Firmware installation started.

Command	Response	Description
	+UFWINSTALL: 128	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)**

### 4.3.1.3 Recovery mechanism

In case of a failure (for instance due to power loss or cable detach), the FW installation procedure starts again until the installation is completed. 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.

### 4.3.1.4 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, as the device is up to date.

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

### 4.3.1.5 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 AT commands manual [\[1\]](#) and the application development guide [\[4\]](#).

## 5 Firmware update via uFOTA

uFOTA is u-blox’s solution to a managed and automated FOTA service based on the LwM2M protocol. Section 5.1 describes the behavior of the module during the uFOTA procedure. This service uses “campaigns” to manage the FW upgrading of multiple. Section 5.8 describes the process to start an update campaign. Figure 14 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 update

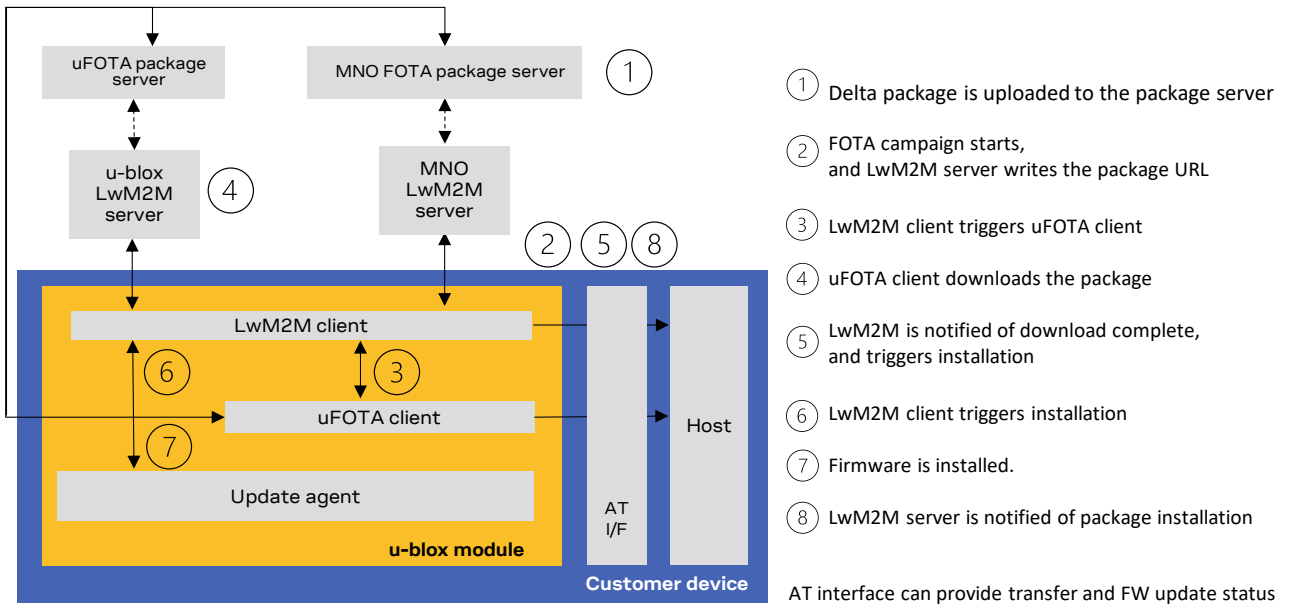


Figure 14: uFOTA system architecture

### 5.1 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. It will also notify 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 6.

## 5.2 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 disabled by default.

 It is recommended to enable URCs for uFOTA download.

### 5.2.1 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.

### 5.2.2 Download resume example

The uFOTA download can be resumed if it was interrupted by:

- 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.

## 5.3 Download control

 The pause (AT+UFOTA=1), resume (AT+UFOTA=2) and read (AT+UFOTA?) features are not applicable to LARA-L6 and LARA-R6 "00B" 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.
...		Download cancellation in progress...
	+UFOTASTAT: 2,3,100	The uFOTA download is cancelled by the host.

 Create another uFOTA "Campaign" (section 5.8) to start the uFOTA download process again if the current one was cancelled.

Similarly, you can pause the uFOTA download with AT+UFOTA=1, and resume it with AT+UFOTA=2, even after the module has been turned off and then on again, or after a reboot. Furthermore, you can use the AT+UFOTA read command to check 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 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.

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

## 5.4 uFOTA configuration

 This section is not applicable to LARA-L6 and LARA-R6 "00B" product versions.

Through AT+UFOTACONFIG 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 5.3, 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.

### 5.4.1 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 update.
	+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

### 5.4.2 Wait for ack

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


#### 5.4.2.1 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 update.
	+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.

#### 5.4.2.2 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 update.
	+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.

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

## 5.5 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, +UUFWPREVAL 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 update.

Command	Response	Description
<Module reboot>		
	+UUFWPREVAL: 0	Firmware delta validation started.
	+UUFWPREVAL: 3	
	+UUFWPREVAL: 7	
	...	
	+UUFWPREVAL: 90	Firmware validation completed. The progression of the validation is incremental, but the increment can be different from 1. The +UUFWPREVAL: 100 URC may not be issued, and the module can start the installation phase issuing the +UUFWINSTALL URC.
	+UUFWPREVAL: 100	
	+UUFWINSTALL: 1	Firmware installation started.
	+UUFWINSTALL: 3	
	...	Firmware installation completed. Once the last URC (+UUFWINSTALL: 128) is received, the module reboots again to new firmware release.
	+UUFWINSTALL: 92	
	+UUFWINSTALL: 100	
	+UUFWINSTALL: 128	

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 4 reports the delta package update estimates.

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

Table 4: Delta uFOTA package update estimates

## 5.6 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 update to. The factory-programmed value is 24 hours.

The SRLT value may be changed by the LwM2M server.

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 forces 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 small lifetime values are not recommended and may result in higher-than-expected data usage.

See the example below.

Command	Response	Description
AT+ULWM2MLIST="/"	+ULWM2MLIST: "/1/10", "/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": 86400}, {"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": "30000/1", "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\": 604800}]}"	OK	Write new timer to this instance with 604800 s (1 week). Setting the timer will trigger a check-in to the LwM2M server.

<sup>1</sup> Values are just guidelines and are fixed expected limits.


## 5.7 Application design for FOTA compliance

The host must 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 and must not do for a correct LwM2M FOTA operation.

### 5.7.1 FOTA procedure

Below is 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 starts. 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, server ID 102.
<FOTA campaign starts>		The FOTA server triggers the FW update.
	+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 +UFWINSTALL URC.
<New firmware installation>		New firmware installation, for more details on the process duration, see section 5.5.
<Wait>	+UFWINSTALL: 1 +UFWINSTALL: 3 ... +UFWINSTALL: 92 +UFWINSTALL: 100 +UFWINSTALL: 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.


## 5.7.2 Enable the uFOTA URC

The host application can monitor the following URCs to handle an update:

- +ULWM2MSTAT URC reports status of the LwM2M client.
- +UFOTASTAT URC reports the download and update status.
- +UUFWPREVAL URC reports the FOTA package validation status.
- +UUFWINSTALL URC reports the FOTA package installation status.

## 5.7.3 Firmware download

Depending on the delta package file size, the download of new firmware could be high 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 until the download complete URC (+UFOTASTAT: 2,2,100) is received.

Some AT commands may affect the download and must not be used, see section 6.

## 5.7.4 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 4.3.

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 update.


The +UUFWPREVAL 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 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:


- Removing or loss of power supply to the module
- Unstable supply to the module
- Host application applies an external reset to module
- Turning off the module with PWR\_ON or RESET\_N pin


### 5.7.5 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.

### 5.7.6 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 update 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 6](#) for details on the data persistency after update.

 The imported certificates and the private keys are persistent during the uFOTA firmware update.

At the wake-up, the module will re-register to 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.

## 5.8 uFOTA campaign

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

### 5.8.1 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

### 5.8.2 Approval

The campaign request must be approved by u-blox before the campaign starts. The module’s host must be approved to make sure it is able to cope with the LwM2M update process and a test campaign shall be executed before the final campaign happens.

### 5.8.3 Application design review

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

- 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.

### 5.8.4 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.

### 5.8.5 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.

## 5.9 uFOTA server access

### 5.9.1 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: ucsphhttpcontent.services.u-blox.com (port 80)



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

## 5.10 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).



## 5.11 uFOTA sequence diagram

Figure 15 is the sequence diagram of the entire uFOTA procedure showing all the parts involved.

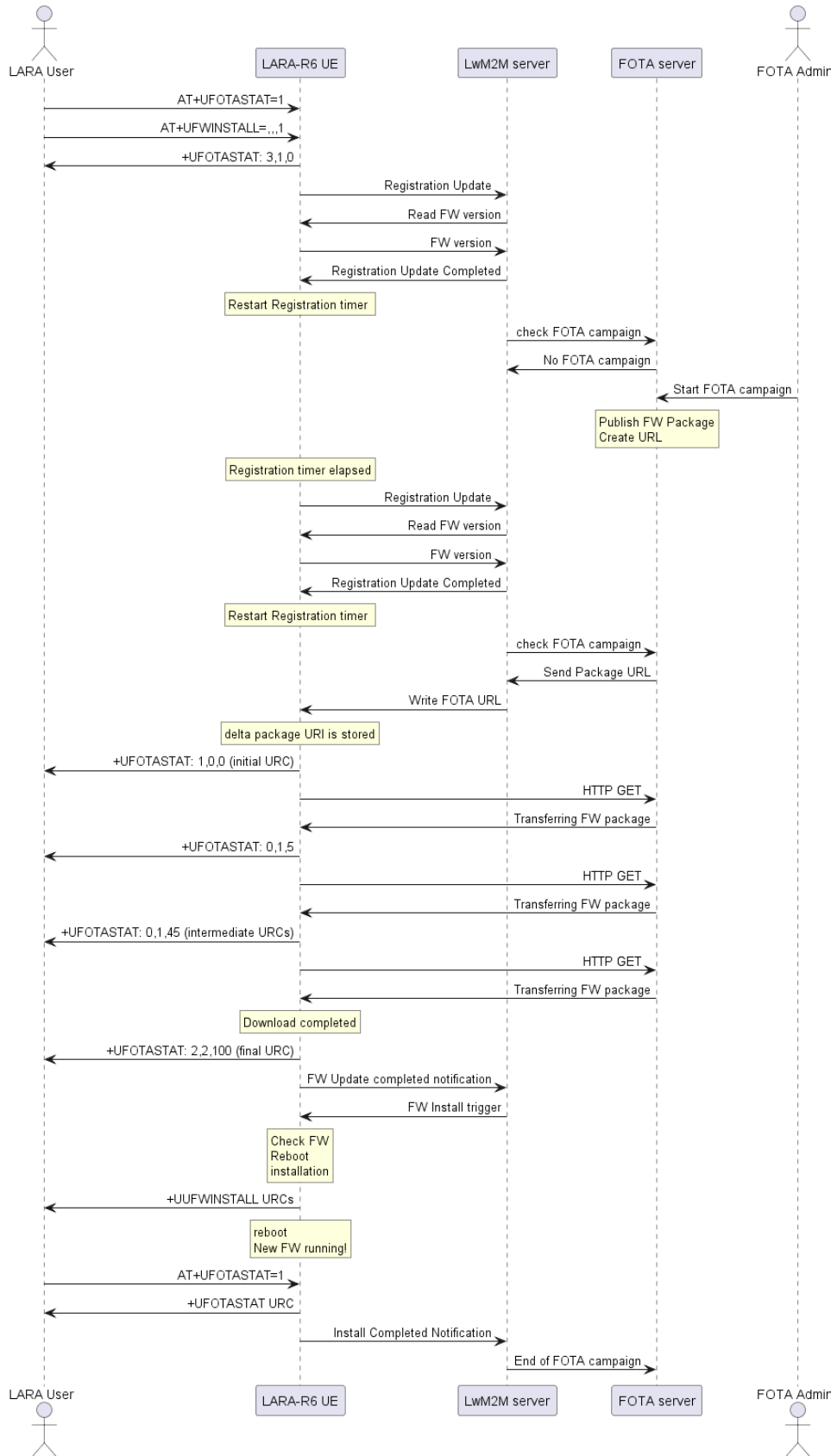



Figure 15: uFOTA sequence diagram

## 6 AT commands forbidden during FW download

Only one download method can be active at a time. [Table 5](#) presents the AT commands and firmware download methods that are mutually exclusive.

 An error result code is returned if a command listed in [Table 5](#) 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 5: Firmware download methods and forbidden AT commands**

## 7 Impacts of different FW update methods

Table 6 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 6 Impact to device files and settings of each firmware update method**

# Appendix

## A Extended error result codes

Table 7 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 7: 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 update 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 [5.7.1](#).

## 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](http://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.
R05	02-May-2024	yatu	Improved document structure. Improved diagrams.

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