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# HL78xx Firmware Over-The-Air Guidelines

## APPLICATION NOTE

This application note provides all necessary information to perform Firmware Over-The-Air (FOTA) on HL78xx modules implementing OMA LwM2M protocol.

# 1 Introduction

This document is provided to Semtech distributors and clients to aid more rapid development of embedded applications using the Semtech portfolio of cellular solutions. To request a new application note, contact your regional Semtech Product Marketing Manager.

# 2 FOTA Workflow

The figure below depicts an end-to-end FOTA workflow. It assumes that FW packages (test or final packages) have been made available in AirVantage. This workflow is applicable for validation purposes (prior to customer acceptance and deployment) or for field deployment purposes.

The operational process to validate FW packages is not described in this application note.

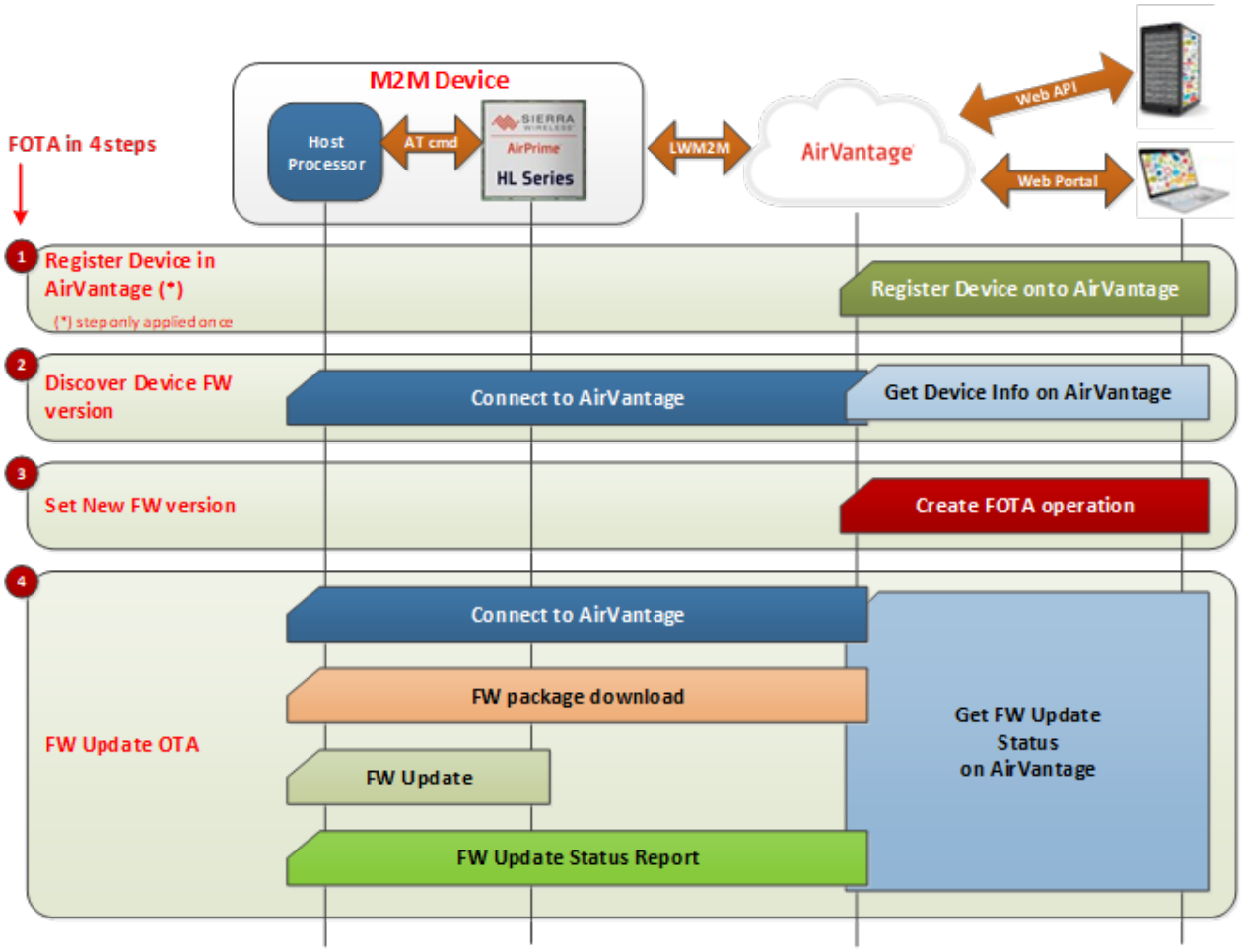



*Figure 1: FOTA E2E Workflow*

There are 4 main FOTA steps:

1. Register the device in AirVantage (this step has to be applied only once). This registration enables AirVantage to authenticate the module and to perform device management operation. Refer to Register Device in AirVantage for how to register the device.
2. Discover your device module's FW version. Usually, you would need to know the current firmware version before deciding whether a firmware update is needed. This step is performed automatically by the module when connecting to AirVantage for the first time. During this connection, module information (i.e. model, firmware version) is sent to AirVantage. Refer to Connecting to AirVantage for details.
3. You can manage FOTA manually using the AirVantage web portal (via a web browser) or programmatically using Web API (this option is not covered in this application note). Your FOTA operations are persisted until the device connects to AirVantage. Refer to Create FOTA Operation on AirVantagefor details.
4. Manage FOTA operation on the device side. Refer to Firmware Update OTAfor details.

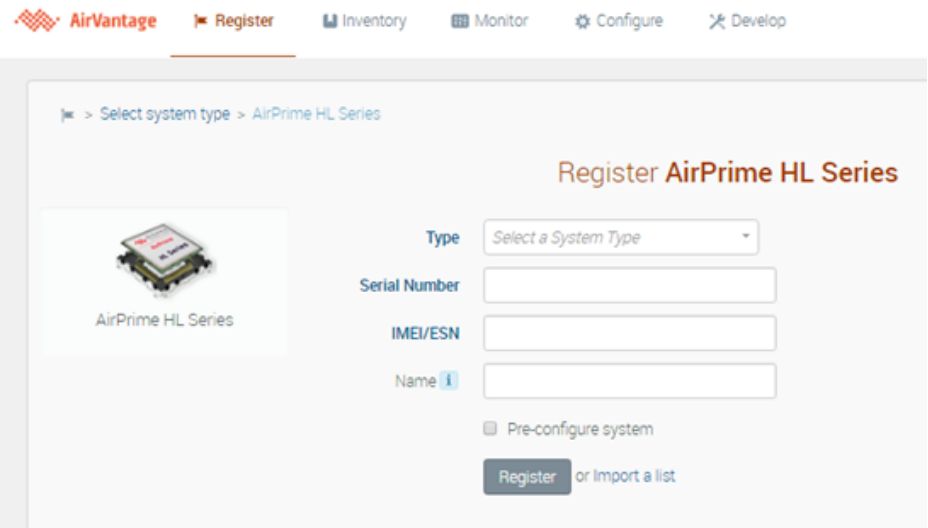
# 3 Register Device in AirVantage

The device must be registered in AirVantage, so that:
- the device can be authenticated by the server, and
- the server knows which protocol and what data model to use to communicate with the device.

Collect the following information from your embedded module using AT commands:
- Module Type (AT+CGMM)
- Module Serial Number (AT+KGSN=3)
- Module IMEI (AT+CGSN)

To register a device in AirVantage, follow these steps:

1. Login to AirVantage.
2. If you don't have an account, sign up for a free trial here.
3. Go to the Register page.




4. Select Type, and fill in the Serial Number and IMEI/ESN fields with the information retrieved from the module using AT commands.
5. Provide a Name for your device; this helps find your system easily.
6. Click Register to complete the registration procedure.

# 4 Connecting to AirVantage

Device application uses AT commands to connect to AirVantage and to control FOTA flows.

## 4.1 Device Management Protocol

HL78xx modules connect to the AirVantage DM Server over OMA Lightweight M2M protocol. The DM functions can only be enabled upon successful mutual authentication with AirVantage. If the device fails to authenticate with the DM server (i.e. due to invalid credentials), it will connect to AirVantage Ligthweight M2M Bootstrap Server to bootstrap the necessary credentials before reattempting to connect to AirVantage DM Server. For further information, please refer to the OMA Lightweight M2M protocol specification.

Once a DM session is started, AirVantage can send DM commands to the device to execute a FOTA (download then install firmware package). The device can also send device information (e.g. FW version, signaling quality) and DM command result back to AirVantage.

The next sub-sections describe how to setup PDP context for this connection and provides two options to trigger a DM session.

### 4.1.1 PDP Context

The module uses UDP (CoAP) to communicate with AirVantage to create DM sessions.

A PDP context can be assigned for this connection using AT+WDSS=2,<cid>, where <cid> is the PDP context identifier as configured with AT+CGDCONT. The change initiated by AT+WDSS=2,<cid> only takes effect while syncing with the AVMS server. It does not affect the FOTA package download. For HL780x, HL780x always uses CID1 for FOTA whatever the CID setting in +WDSS command is.

Send AT+WDSS? to check the current APN settings. If an APN has not been specified, CME Error 650 will occur when trying to initiate a connection.

### 4.1.2 Host Processor Initiated DM Session

The host processor should issue AT+WDSS=1,1 to start a DM session.

Note that:

- Only one DM session is open even if AT+WDSS=1,1 has been entered multiple times. Subsequent AT+WDSS=1,1 commands do not create new connections, but reuses the existing connection.
- The session will remain open until the user closes it with AT+WDSS=1,0.

Refer to Figure 2 for the AT command sequence.

### 4.1.3 Module Initiated DM Session – Polling Mode

The host processor can activate the polling mode on the module and specify a polling timer. Upon timer expiration, the module will automatically start a DM session.

The polling timer can be using AT+WDSC=3,<pollingDelayMinutes>.

Refer to Figure 3 for the AT command sequence.

## 4.2 Indications

It is highly recommended to activate Device Services Indications. It enables the host processor application to receive Event Notification asynchronously from the module. The embedded application can selectively subscribe up to 10+ event types. Refer to the HL78xx AT Commands Reference Guide for details.

Use AT+WDSI to check for indication flag range and to activate all indications. This should be done once before starting a DM session.

AT+WDSI=? — This command returns the indication flag range, e.g. +WDSI: (0-4479).

AT+WDSI=4479 — This will activate all indications.

AT+WDSI? — This will check current indication subscription.

Activating all indications helps the host processor application to keep track of DM session status and progress. The table below is an excerpt of indications. Refer to the HL78xx AT Commands Reference Guide for the full list.

**Table 1: Device Services Indications**

| Indication | Event |
|---|---|
| +WDSI: 0 | Raised at startup if the credentials for the Bootstrap Server are present on the device so the device can communicate with the AirVantage server (requires a usable network interface) |
| +WDSI: 1 | The device requests a user agreement to connect to AirVantage |
| +WDSI: 2 | AirVantage requests the device to download firmware package |
| +WDSI: 3 | AirVantage requests the device to install the firmware package |
| +WDSI: 4 | The module is starting authentication with AirVantage Bootstrap Server or DM Server |
| +WDSI: 5 | Authentication ended with failure (not available for new device registration; refer to Register Device in AirVantage and key rotation in Connection Flows and AT Commands) |
| +WDSI: 6 | Authentication succeeded, starting session with the server |
| +WDSI: 23,0 | Session is started with Bootstrap server, i.e. bootstrapping |
| +WDSI: 23,1 | Session is started with DM server, i.e. registering |
| +WDSI: 7 | Connection is denied by server (i.e. Bootstrap server rejects the device, not registered in AirVantage) |
| +WDSI: 8 | DM session has been closed |
| +WDSI: 9 | Firmware package is available for download, also indicates file size |
| +WDSI: 10 | A firmware package has been downloaded and stored in flash |
| +WDSI: 11,<x> | Firmware download issue, x indicates failure reason:<br>0 = out of memory, 1 = HTTP/HTTPS errors, 2 = error in pkg (e.g. corrupted) 3 = RAM issue, reboot to resume the download, 4 = download issue, can be resumed, 5 = Flash issue |
| +WDSI: 12 | The downloaded package has been verified and is a certified package |
| +WDSI: 13 | The downloaded package is not a certified package |
| +WDSI: 14 | Starting Firmware update |
| +WDSI: 15 | Failed to update firmware |
| +WDSI: 16 | Firmware has been updated successfully |
| +WDSI: 18 | Download in progress, also indicating the percentage of progress |

The host processor must not power off the module upon receiving +WDSI: 14 and will wait for FOTA completion (+WDSI: 16) if it needs to do so.

When indication +WDSI: 0 is received, the host processor can start a DM session (AT+WDSS=1,1) anytime. When not receiving it soon after module boot up, the APN will then be set (AT+WDSS=2,<cid>) and the SIM may need to be unlocked.

## 4.3 User Agreements

Activating User Agreements enables the host processor application to control the FOTA flow. For instance, the host processor application, busy fulfilling a service (e.g. car is operating, ongoing payment transaction), can decide to postpone firmware download or install operations, as accepting a firmware installation will lead the embedded module to reboot upon FOTA completion.

However, user agreements may be deactivated for other use cases. For instance, the device is not using the module and the device initiates a DM session.

If a selected User Agreement has been enabled (+WDSC), the module will send a User Agreement request for the corresponding DM action through an indication (+WDSI). The host processor application will then return a response to this request using +WDSR.

The table below is a list of user agreements.

**Table 1: User Agreements**

| User agreement for a DM action | Enable User Agreement | Indication Request | Agreement Response | |
|---|---|---|---|---|
| | | | Accept | Defer (can't refuse) |
| Module requests the user/application to connect to AirVantage | AT+WDSC=0,1 | +WDSI: 1 | AT+WDSR=1<br>or<br>AT+WDSS=1,1 | AT+WDSR=0,delay<br>(delay unit is minute) |
| AirVantage requests the device to download a firmware package | AT+WDSC=1,1 | +WDSI: 2 | AT+WDSR=3 | AT+WDSR=2,delay<br>(delay > 0) |
| AirVantage requests the device to install the downloaded firmware package | AT+WDSC=2,1 | +WDSI: 3 | AT+WDSR=4 | AT+WDSR=5,delay<br>(delay > 0) |

If the device is not ready to handle one of the requested DM actions above, it is recommended to postpone the request by specifying a delay in number of minutes. Requests can't be refused. Upon expiration of the delay, the indication will be issued again.

Note that indication +WDSI: 1 is used to request connection to AirVantage upon FOTA completion and module reboot.

## 4.4 Connection Flows and AT Commands

The previous sections described the principle and corresponding necessary AT commands to start a DM session, and configure indication and user agreements.

Upon connection trigger (host initiated or module initiated), the HL78xx module will attempt to connect to the AirVantage DM server:

- Authenticate with DM server, using credentials provided by AirVantage Bootstrap server
- Register with the DM server to send all information about the module to the server e.g. end point name of the module to be contacted by the server, lifetime, queue mode, LwM2M2 objects and instances within the module. This Registration enables DM server(s) to record the connection information of the registration message (e.g. source IP address and port) and uses this information for all future interactions with the registered HL78xx module (for instance, FOTA).

However, if credentials are missing (at the very first connection) or invalid (i.e. 5 consecutive failures to authenticate with the DM server), then the HL78xx module will automatically connect to the AirVantage Bootstrap server:

- Authenticate with a bootstrap server (bootstrap server credentials have been provisioned by Semtech in the factory).
- Start bootstrapping credentials: the module issues a bootstrap request, the bootstrap server writes credentials (to connect to the DM server) to module LwM2M server objects.

Note that the module may delete the DM credentials upon five consecutive Registration failures. This will force the module to reconnect to the bootstrap server to update credentials.

To increase security, AirVantage implements key rotation which forces the module to connect to the bootstrap server on a regular basis to receive new credentials. Upon authentication failure:

- The DM Server invalidates the device credentials every 90 days. The device will fail (upon 5 successive attempts) to authenticate to DM server forcing it to connect to the bootstrap server to update credentials.
- The bootstrap server also performs device credentials rotation at random (between 30 to 45 days interval).

Additionally, key rotation happens when:

- A device registered on the server is deleted, and then registered again.
- The device gateway is updated with a fake value and then set again with the correct value. For example, if the device FSN is 123456 and then the FSN is updated to 123455, and then changed back to 123456.

+WDSI: 23,1 indicates that the module is connected to the AirVantage DM server. This connection remains open until the host explicitly closes it with AT+WDSS=1,0 (except in polling mode where the connection is automatically initiated and automatically stopped after 20 seconds without any data exchange between the device and the server).

Figures below depict usage of these AT commands in proper sequence for each type of DM session trigger use case.

## 4.4.1 Host Processor Initiated DM Session

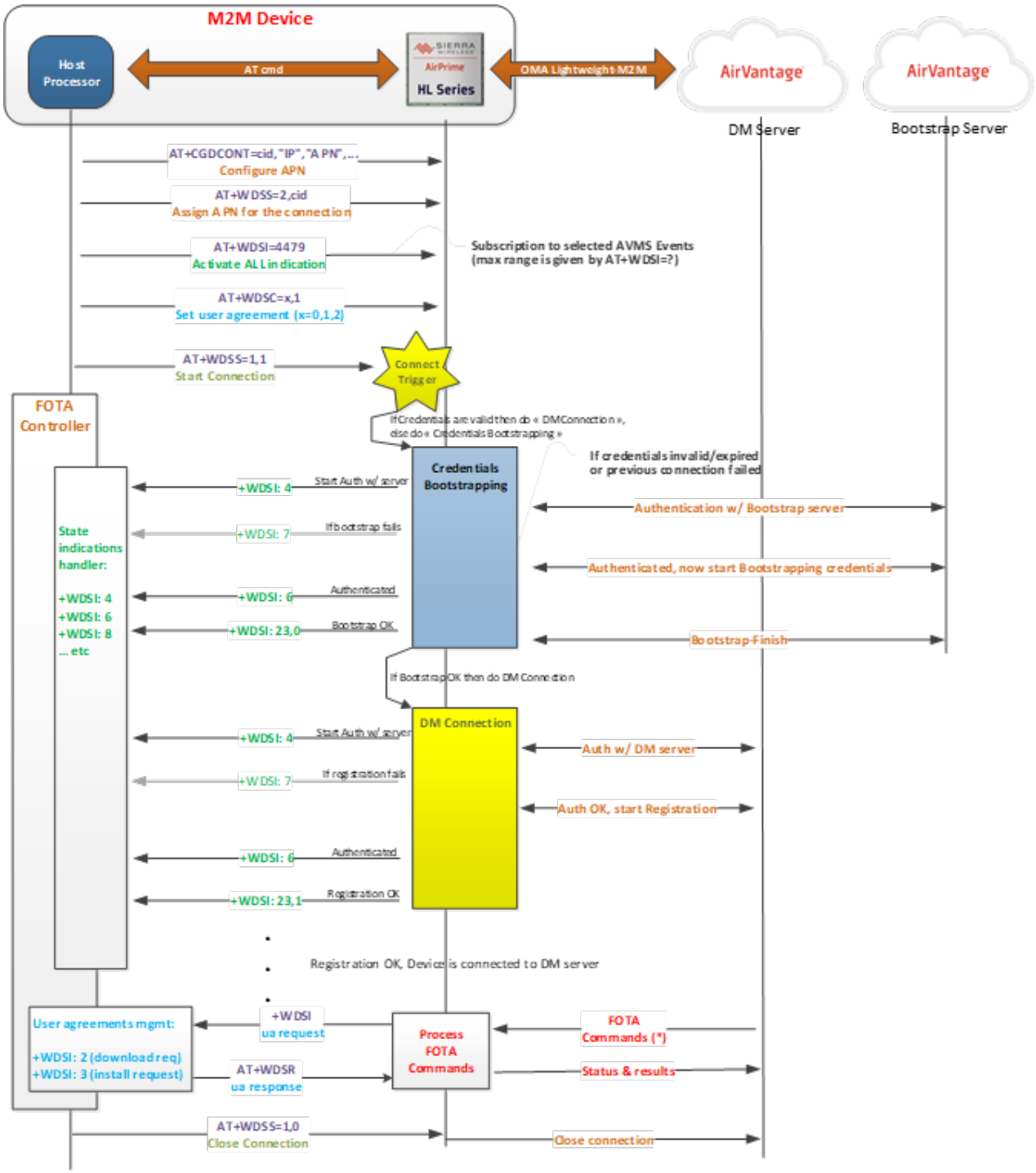



*Figure 2: AT Commands Sequence – Host Processor Initiated DM Session*

## 4.4.2 Device Initiated DM Session – Polling Mode

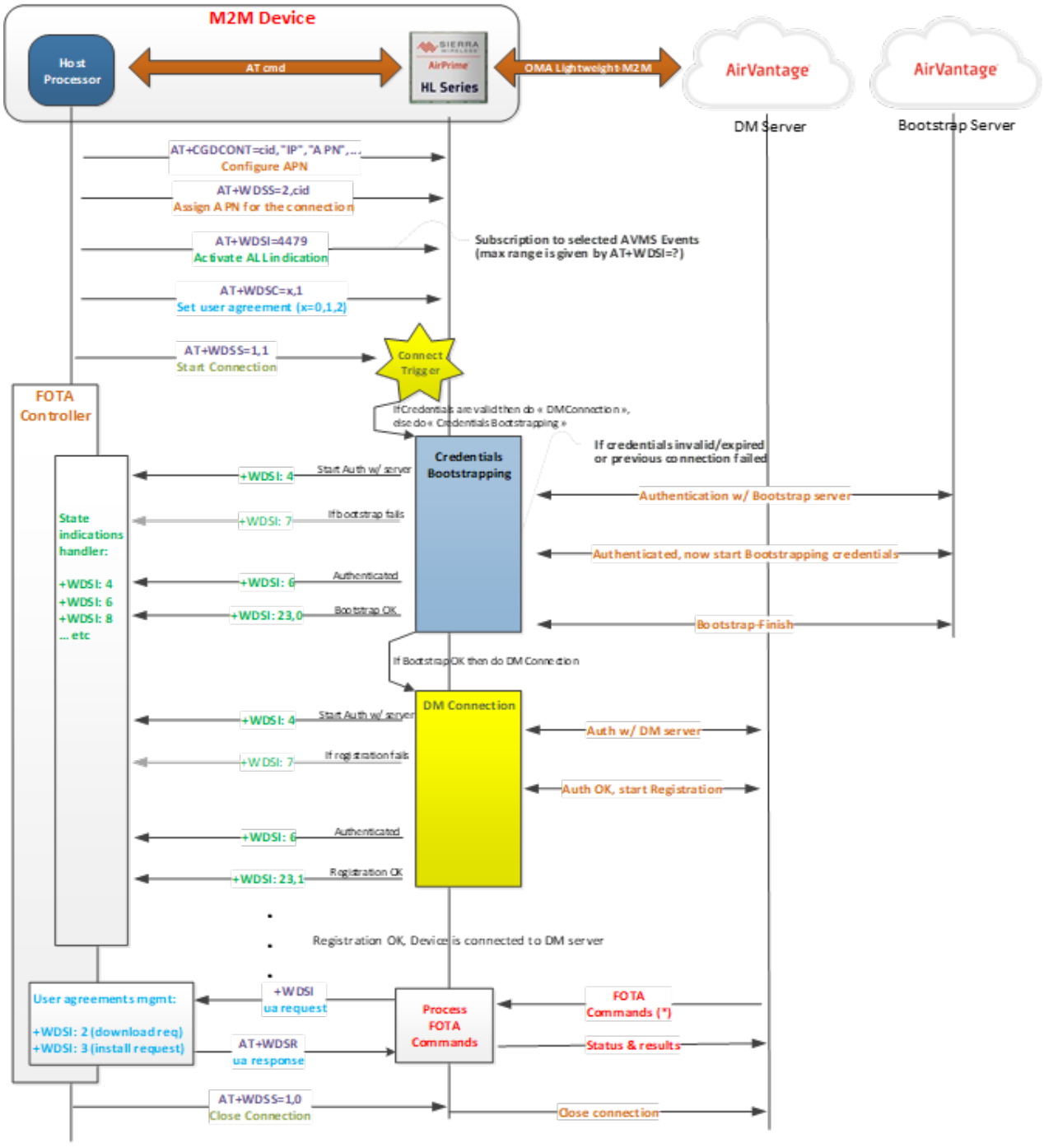



*Figure 3: AT Commands Sequence - Device Initiated DM Session, Polling Mode*

In this example, the polling timer is set to 120 minutes; the module will be connecting to the AirVantage DM Server every 2 hours. Each connection is automatically closed after 20 seconds of inactivity.

### 4.4.3 Restore Downstream Communication

When the device opens a DM session (refer to Host Processor Initiated DM Session and Device Initiated DM Session – Polling Mode), AirVantage keeps track of the device's IP address and port number so that DM operations (FOTA, synchronize, etc.) set by the user can be sent immediately to the device.

In some situations, the user's DM operations cannot be sent to the device and are queued in AirVantage such as:

- DM session is not open.
- DM session has been started but the network operator has released the NAT after a short period of inactivity on the network.

The term "session" used above is related to a DM session (from LWM2M Register to Deregister). A DM session remains open until the user closes it (refer to Host Processor Initiated DM Session). LWM2M protocol is based on UDP which is not a connection-oriented protocol. If there is no network activity, the operator network may release the NAT to yield the resource to other users. When the NAT is released, the device's external IP address and port number are no longer valid, the downstream communication is broken and AirVantage cannot send user DM operation to the device. However, the DM session is still active as the device can still send data to AirVantage.

To restore downstream communication, the device can stop (AT+WDSS=1,0) then restart the session (AT+WDSS=1,1).

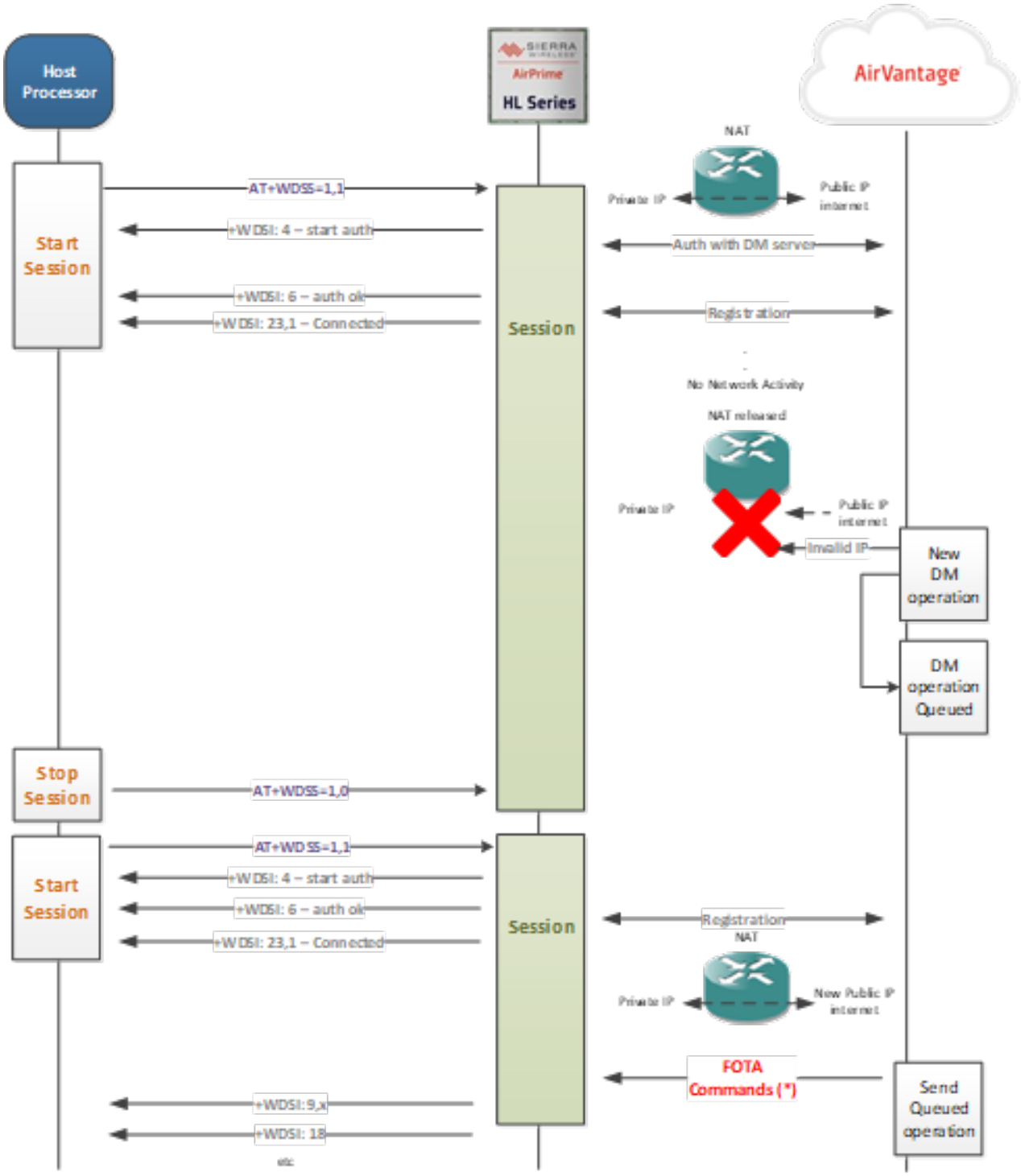



*Figure 4: Network Operator NAT Release – Restoring Downstream Communication*

## 4.5 Testing

The following tests verify the connectivity of a DM session.

### 4.5.1 Create New System in AirVantage

As an example, a new system (FOTA_TEST_HL78) is created in AirVantage after registering (as explained in Register Device in AirVantage). Go to Monitor/Systems or Upgrade/Systems (if UFOTA account) view then select the newly created system.

In the "System Communication" widget, the "Last seen" field is empty as the new system has never connected to AirVantage.

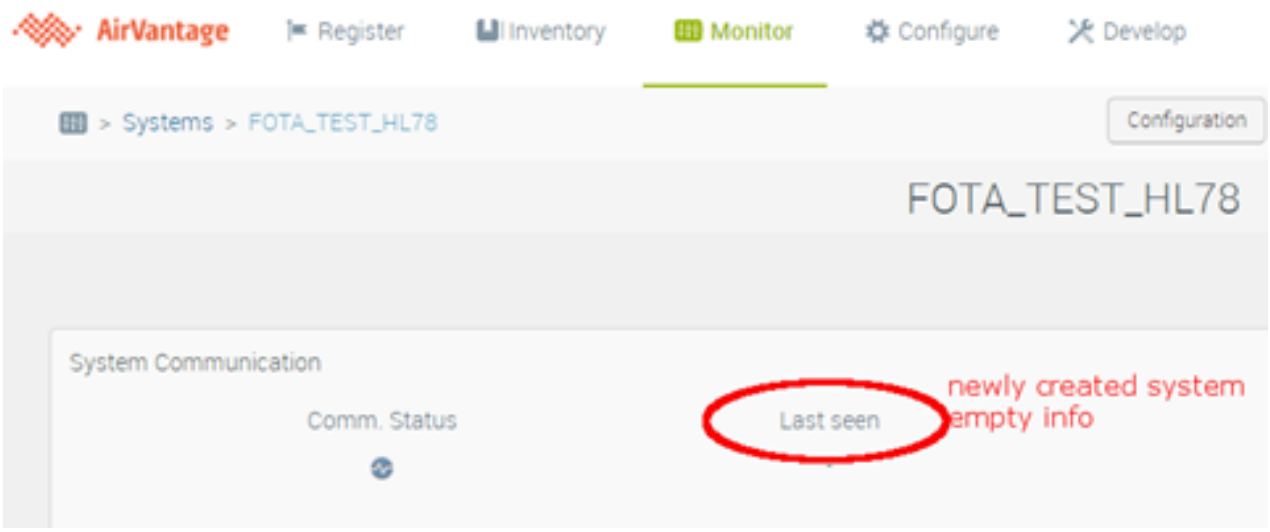



*Figure 5: New System has Never Connected to AirVantage*

### 4.5.2 Connect the Module to AirVantage

Trigger a DM session (refer to section Host Processor Initiated DM Session).

- Set the APN
- Check APN (AT+WDSS?)
- Activate two user agreements (AT+WDSC=1,1 and AT+WDSC=2,1)
- Check user agreements setting (AT+WDSC?)
- Initiate a DM session (AT+WDSS=1,1)

In this example, the module attempts to connect with the DM server with several retries. Upon failure, it connects to the bootstrap server to update credentials (+WDSI: 23,0), then successfully connects to the DM server (+WDSI: 23,1).

Note that the connection remains open until we explicitly close it with AT+WDSS=1,0. +WDSI: 8 indicates that the connection is closed.

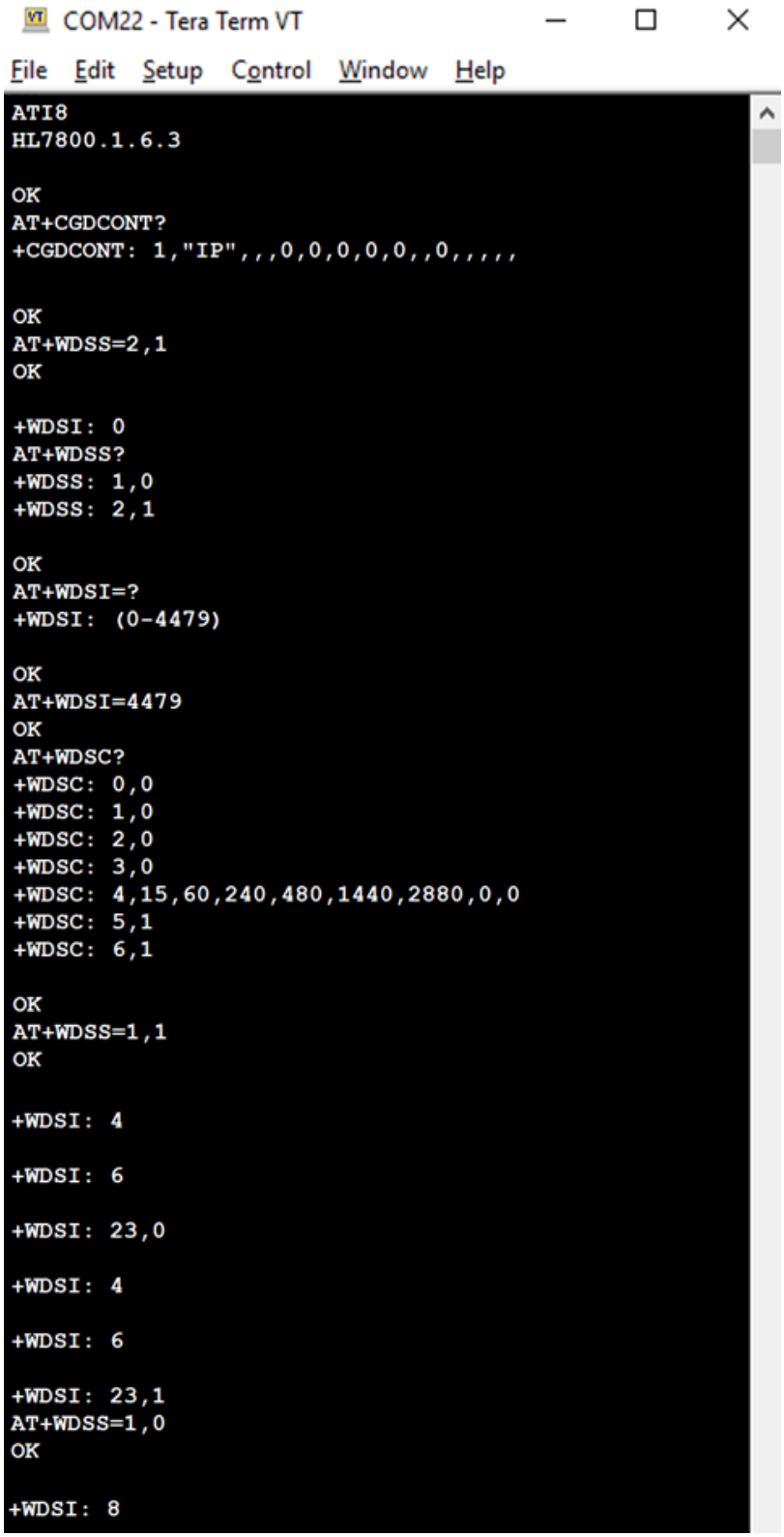



*Figure 6: Connect Module to AirVantage*

### 4.5.3 View Device Data in AirVantage

Return to the AirVantage portal and refresh the page. We can now see that the “Last seen” field indicates a connection from the module.

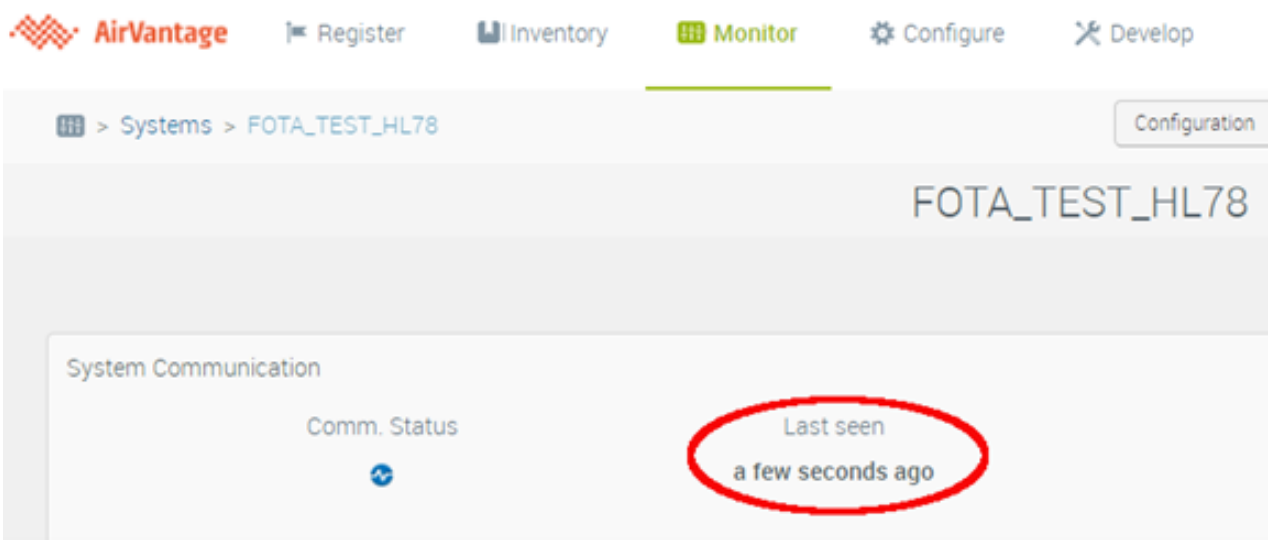



*Figure 7: “Last Seen” Indicates a Connection from the Module*

This connection can be visualized in the AirVantage “Timeline” widget – the module has performed a Registration with AirVantage.


*Figure 8: Module has Performed a Registration*

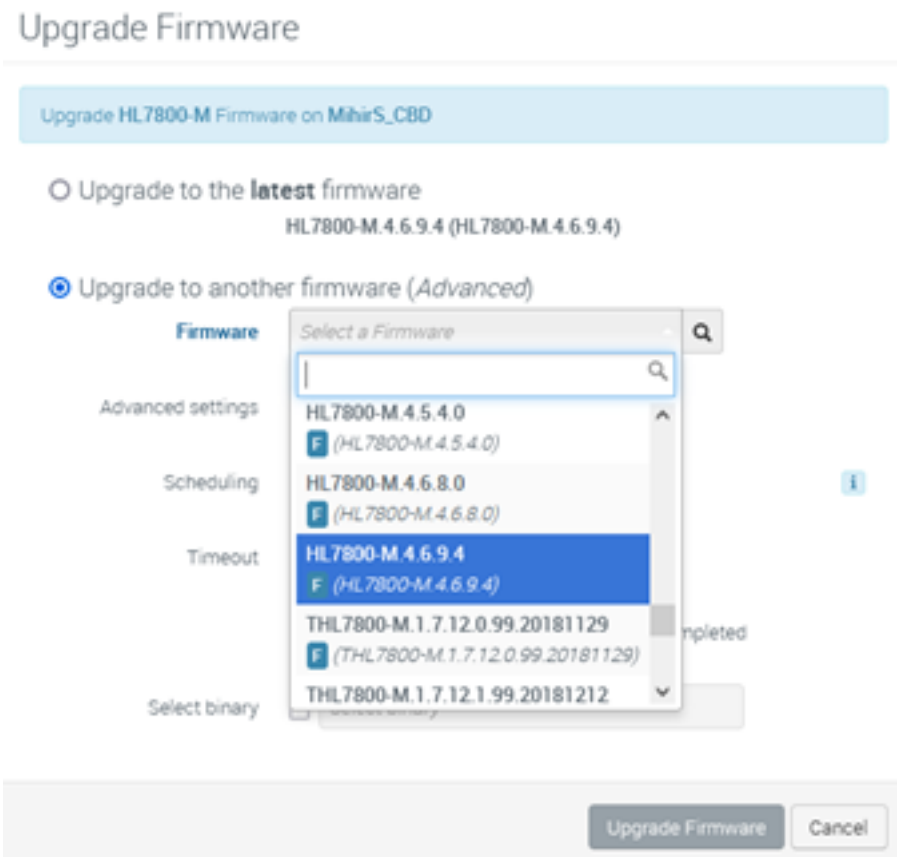
# 5 Create FOTA Operation on AirVantage

Create a FOTA operation on AirVantage by following these steps:

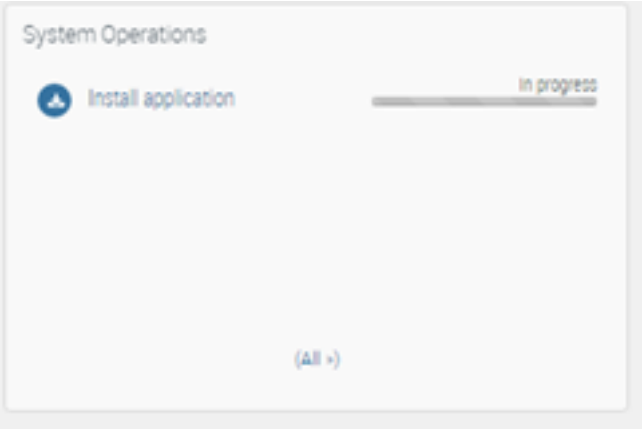
1. Login to AirVantage.
2. If you don’t have an account, sign up for a free trial here.
3. Go to Monitor/Systems or Upgrade/Systems (if UFOTA account) view and select your device.
4. Note that the current firmware version of your device in the “System Info” widget. This information shall have been updated during the last DM session (refer to Testing).

5. Click “Update Firmware”.


6. Select the target firmware version for the FOTA operation. Note that only compatible packages are listed.




7. The FOTA operation, also referenced generically as “Install Application”, is now in “In progress” state.




# 6 Firmware Update OTA

When a FOTA operation is created on AirVantage (refer to Create FOTA Operation on AirVantage), the module will start the firmware download and installation procedure as soon as it opens a DM session with AirVantage.

Note that the newly created FOTA operation cannot start immediately for the following reasons; refer to Restore Downstream Communication for additional information:

- The device has not opened a DM session.
- The device has opened a DM session, but there was no network traffic beyond a timeout period (operator specific). This inactivity is causing the NAT to be released, therefore AirVantage can no longer send the FOTA command to the device. In this case, the FOTA operation is queued in AirVantage and the module will start the FOTA operation at the next device connection (new DM session).

Download request (+WDSI: 2) and Installation request (+WDSI: 3) indications are used to catch events. User agreement AT commands (AT+WDSR) are used to accept or delay requests. Refer to User Agreements for details.

Ongoing download process might be suspended for various reasons such as network loss, module power off, module reset or DM session close. However, the download process will be resumed by the module; refer to Suspending and Resuming Download for details.

Upon FOTA completion of software install process (success +WDSI: 16 or failure +WDSI: 15), the module will report the status to AirVantage whenever it gains network connectivity. If it fails to connect to AirVantage (e.g. due to network loss), status reporting will be repeated once connected to the network.

The following sub-sections describe two FOTA use cases – with and without User Agreements.

## 6.1 Without User Agreement

User agreements are deactivated by default.

DM session initiation is the same as Host Processor Initiated DM Session, but user agreements are deactivated.

Note that for simplicity, this depicted flow assumes that credentials are valid; connection to the bootstrap server is not required.

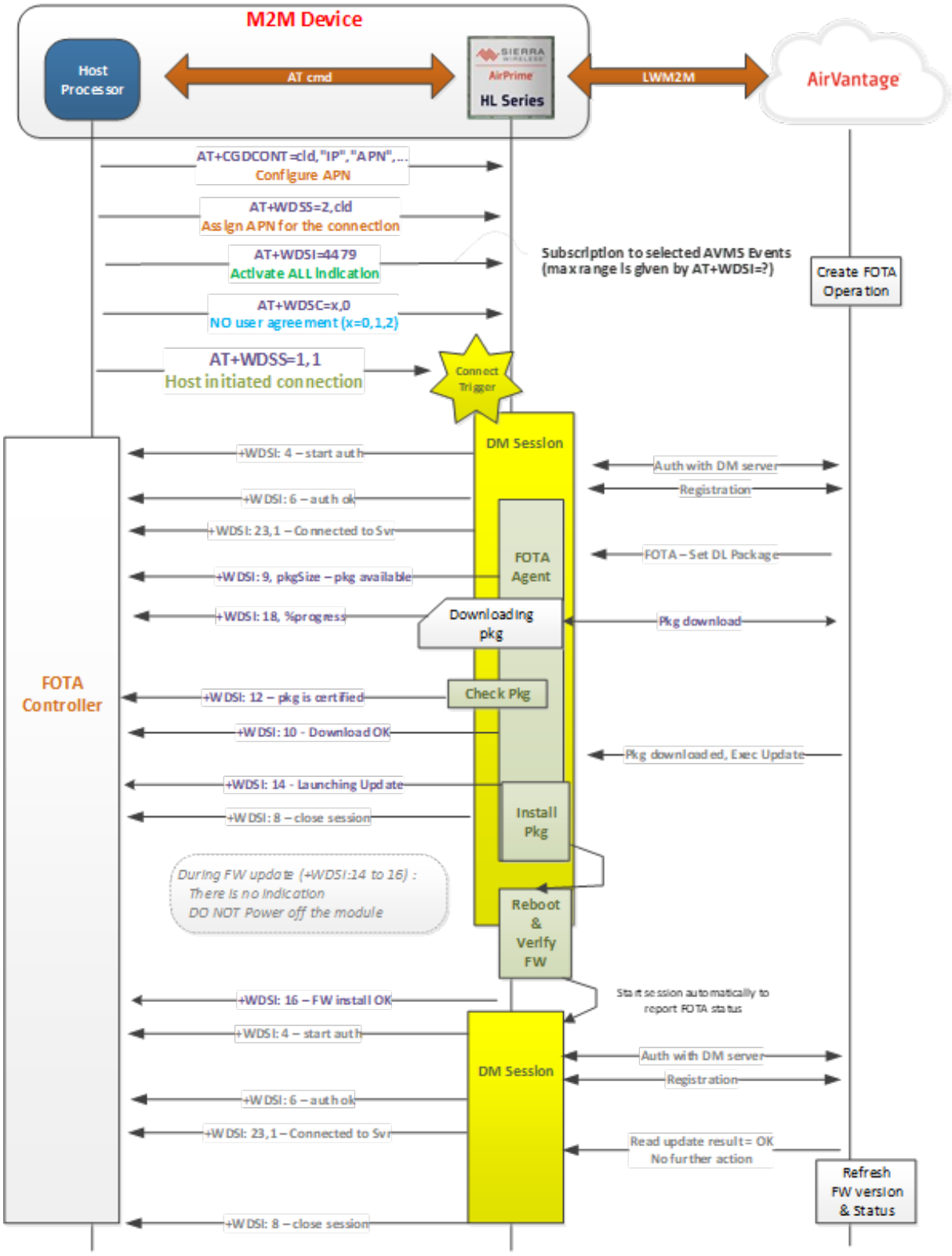



*Figure 9: No User Agreement FOTA – Host processor Initiated DM Session*

## 6.2 With User Agreement

Even though the device is busy fulfilling services, it can decide on the action to take when FOTA requests arises by activating user agreements. These commands (as listed in User Agreements) allow the host processor to accept or delay the FOTA request (download and install).

The following AT commands can be used to activate user agreements:

AT+WDSC=1,1 — Activate firmware download agreement

AT+WDSC=2,2 — Activate firmware installation agreement

Refer to Figure 10 for details. Note that for simplicity, this depicted flow assumes that credentials are valid; connection to the bootstrap server is not required.

A request can be postponed by specifying a delay period in minutes. Upon expiration of the delay, the module will send the same request again. It can either be postponed again or accepted. Refer to Figure 11 for details.

When user agreement is required for package download and install, the module will keep waiting for a response (AT+WDSR). If there is no response, then the same user agreement request (+WDSI) will be sent again every 30 minutes.

When the user agreement for connection is enabled, the module will send a request to the host processor asking for connection to the server. In this event, the host processor application can trigger a connection (AT+WDSS=1,1) immediately or later.

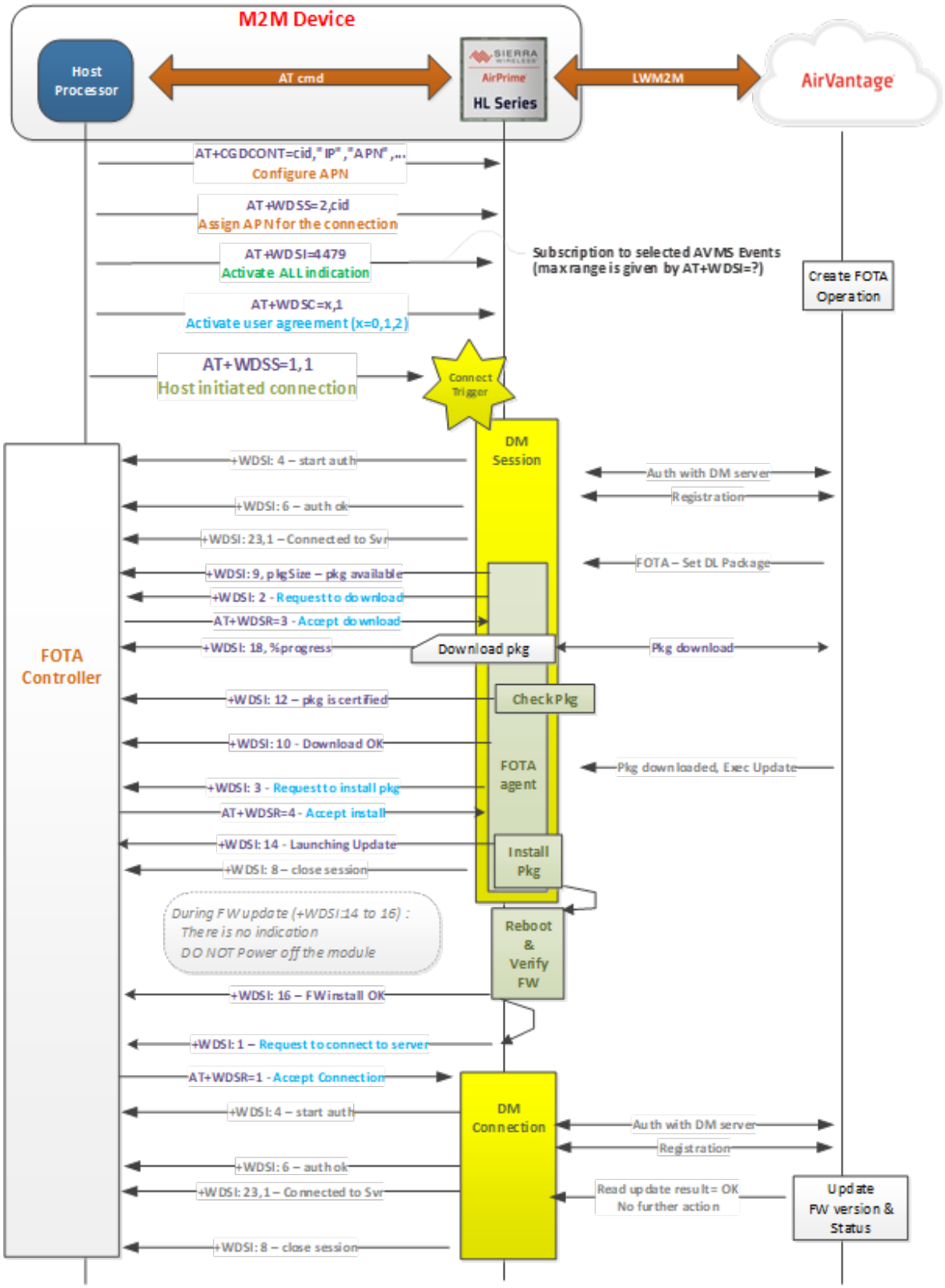



*Figure 10: FOTA Flow Controlled by User Agreement*

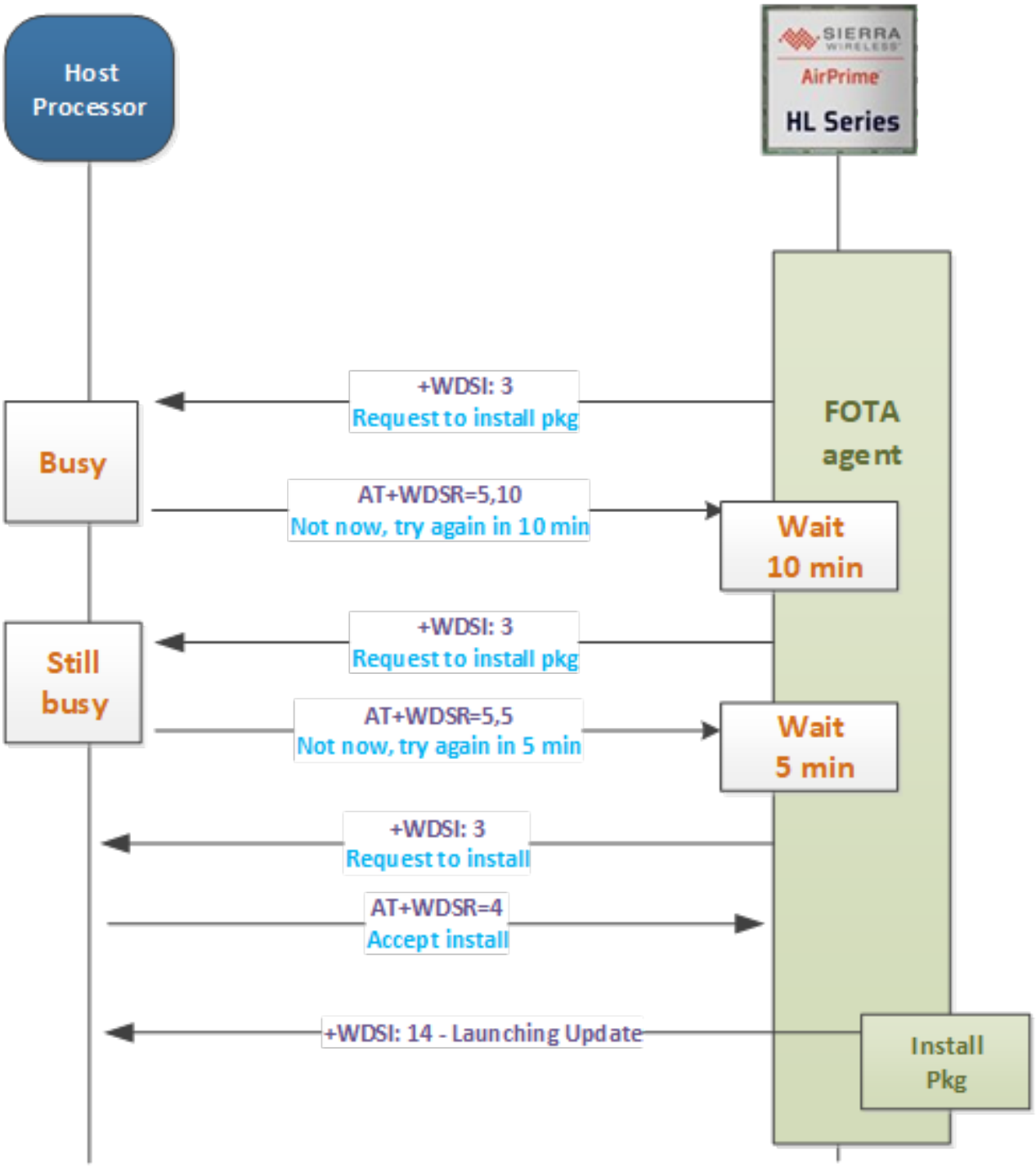



*Figure 11: Delaying a Request*

## 6.3 Firmware Package Security

Firmware packages are signed with a private key. Before starting the firmware installation, the module checks the validity of the download package. This verification makes use of an embedded RSA 2048-bits public key.

## 6.4 Update and Timing

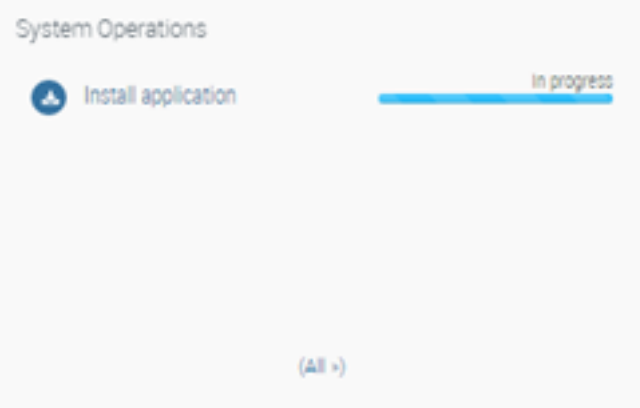
Upon receiving +WDSI: 14, which indicates the beginning of the Firmware Update, your application will not power off the module and will wait for the end of this process: +WDSI: 15 (failure) or +WDSI: 16 (success). Firmware update duration depends on the type of package (delta package or full package), the package size and the complexity of the difference between the two images (delta package). For the latter case, the image difference could be mainly incremental or differential. In general, update duration ranges from 1 to 8 minutes. Should you need to setup a watchdog, a timer of 15 minutes should provide a safe margin.

## 6.5 Testing

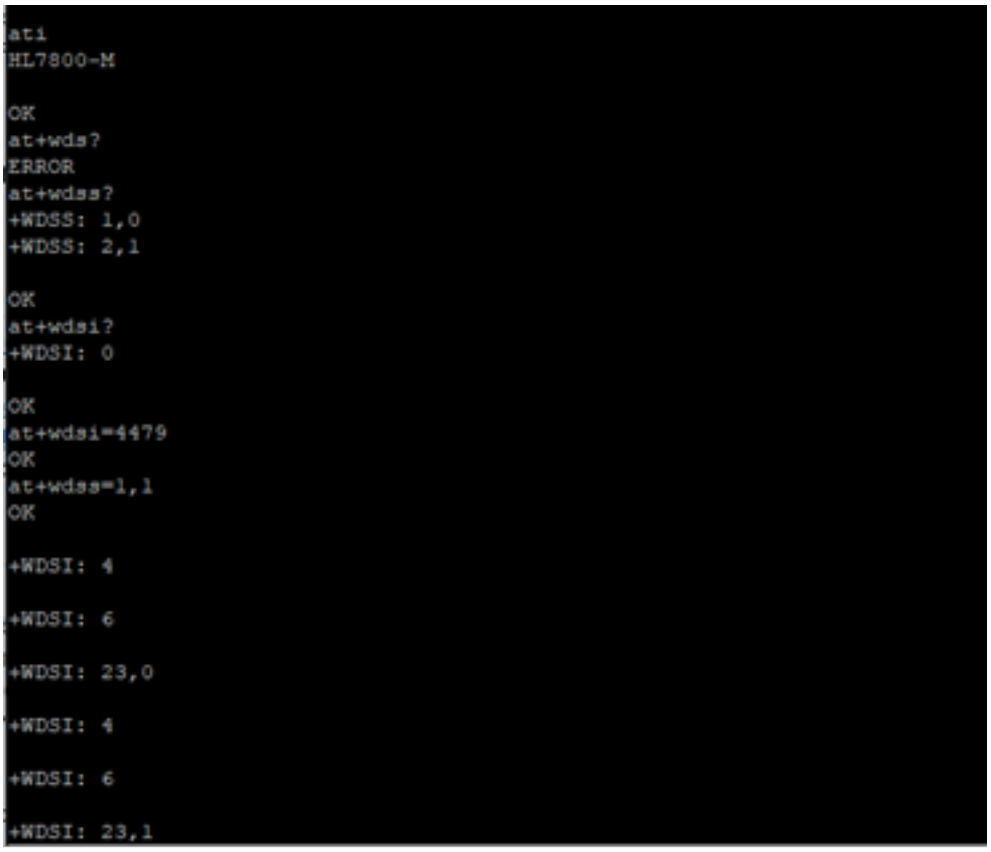
As an example, a FOTA operation has been created on AirVantage in Create FOTA Operation on AirVantage.

To trigger this on the device side:

- Send AT+CGMR to get the current firmware version. Before FOTA, version is BHL7800.1.6.3.0.20180803.
- Check APN settings.
- Check indication settings; all indications are activated.
- In this example, user agreement for “download” is deactivated, but activated for “install”.
- Start DM session.
- +WDSI: 9,1464 indicates that a package is available for download and the package size is 1464 bytes.
- +WDSI: 18 indicates the download progress.
- On the AirVantage portal, the “Install application” is now in progress.




- +WDSI: 18,100 indicates the download operation is reaching 100%.
- +WDSI: 12 indicates that package has been verified (authentication and integrity checks).
- +WDSI: 10 indicates that package has been successfully downloaded and stored in flash.




- The module reboots.
- Upon reboot, +WDSI: 16 indicates that the module has successfully started with the new firmware.
- SIM PIN is entered after the reboot to allow the module to reconnect to the network.
- Per indications +WDSI: 4, +WDSI: 6 and +WDSI: 23,1, the module connects to AirVantage to report the FOTA result and then close the connection (+WDSI: 8).
- AT+CGMR will confirm the new firmware being THL7800.1.6.3.0.99.20180803.

```
ati
HL7800-M

OK
ati3
HL7800-M.4.6.8.0

OK
at+cmgr
ERROR
at+wdss?
+WDSS: 1,0
+WDSS: 2,1

OK
at+wdsc?
+WDSC: 0,0
+WDSC: 1,0
+WDSC: 2,0
+WDSC: 3,0
+WDSC: 4,15,60,240,480,1440,2880
+WDSC: 5,0
+WDSC: 6,0

OK
at+wdss=1,1
OK
at
+WDSI: 4
+wdsi?
+WDSI: 4479

OK

+WDSI: 6

+WDSI: 23,1
at+wdss=1,0
OK

+WDSI: 8
```

- On the AirVantage portal, the FOTA operation now reflects a successful outcome.


The following figure shows a test with user agreement activated.

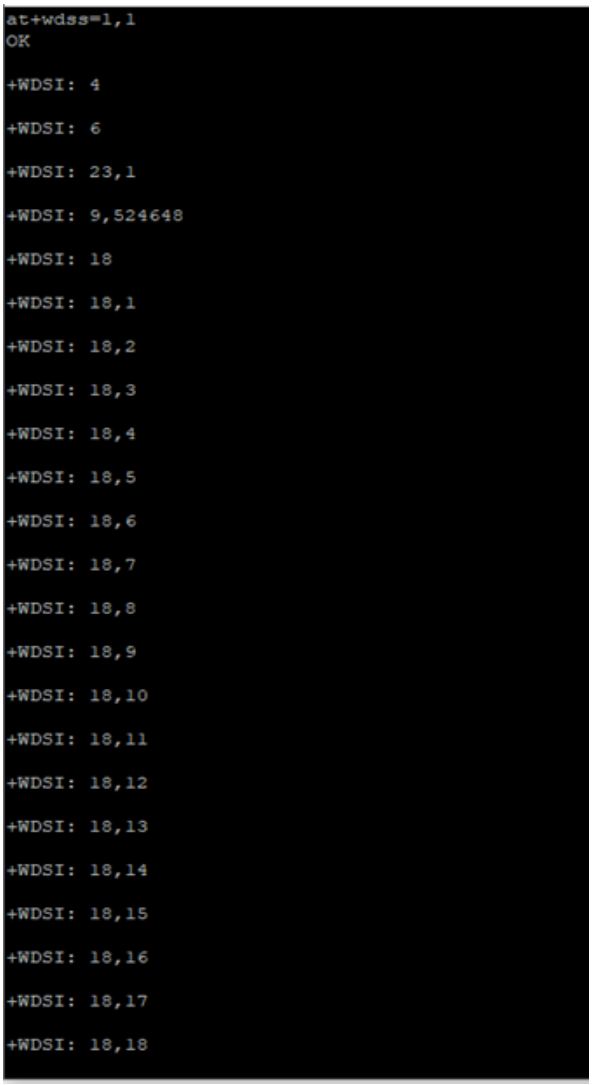



*Figure 12: Test with User Agreement Activated*

Note the following:
- +WDSI: 2 indicates that the module is requesting user agreement to download the firmware package.
- AT+WDSR=3 grants the download.
- +WDSI: 3 is requesting user agreement to install the firmware package.
- AT+WDSR=4 is entered to accept the package installation.
- The module reboots when installation is complete. +WDSI: 16 indicates that the module has successfully started with the new firmware.

# 7 Local Firmware Update

This section describes how to update the firmware locally without connecting to a remote DM server.

The Firmware package (DWL file extension) must be available in the host. It could either be a delta package or full package.

AT+WDSD is used to perform this update locally as follows:
- Specify the size of the firmware to be downloaded by the module using AT+WDSD=<dwl_file_size>.
- At this point, the module is waiting to receive data from the host. +CME ERROR: 3 will occur if data transfer is not started within 5 minutes.
- Send the firmware package file to the module using 1K-XMODEM file transfer protocol. TeraTerm can be used to perform this file transfer. The file transfer must be initiated within 5 minutes.
- Upon completion of the file transfer, the module will request a user agreement (+WDSI: 3) to install the firmware. To accept the installation, send AT+WDSR=4.
- +WDSI: 12 indicates that the downloaded package is valid.
- +WDSI: 14 indicates that the update is about to be launched.
- +WDSI: 15 indicates that the downloaded package cannot be applied due to version mismatching.
- If there is no firmware mismatch, +WDSI: 16 will indicate the completion of the update. New firmware version can be checked with AT+CGMR.

# 8 Suspending and Resuming Download

An ongoing download operation can be suspended then resumed as follows if the user agreement for package download is activated. Otherwise, a new connection is immediately initiated in order to resume download.

+WDSI: 18, 5

+WDSI: 18, 6

AT+WDSS=1,0// stop the bearer; package download is suspended if user agreement for package // download is activated

OK

…

…

// Download is automatically resumed if user agreement for package download is NOT activated. Otherwise, resume // package download using the following command:

AT+WDSS=1,1 // resume package download

OK

+WDSI: 18, 7

+WDSI: 18, 8

Note that if user agreement for package download has been activated, indications +WDSI: 9 and +WDSI: 2 will be returned when DM is restarted. In this event, AT+WDSR=3 is required to resume the download.

## 8.1 Device Reset During Package Download

When a device reset happens during package download, if user agreement for package download is activated, some notifications are returned at device startup (+WDSI: 9,<remaining_bytes> and +WDSI: 2).

The user can then resume the download by sending AT+WDSR=3. The download will be resumed at offset linked to flash storage before the reset.

## 8.2 Power Off During Package Download

When a power off (AT+CFUN=0) is sent to the device during package download, the connection to the server is stopped and the package download is suspended (some notifications are returned at device startup such as +WDSI: 9,<remaining_bytes> and +WDSI: 2). The user can resume package download when the device is registered again on the network.

## 8.3 Network Lost During Package Download

When a network lost happens during a package download:

- The package download can be automatically resumed if the device can register on the network again before a specific timeout.
- The connection to the server is stopped (+WDSI: 8 notification) if the network lost lasts more than the specific timeout. Then, if user agreement for package download is activated, some notifications are returned at device startup (+WDSI: 9,<remaining_bytes> and +WDSI: 2).

## 8.4 Power Cut

When a power cut happens during a package download, if user agreement for package download is activated, some notifications are returned at device startup (+WDSI: 9,<remaining_bytes> and +WDSI: 2).

## 8.5 Summary

The table below summarizes the download resume behaviors if the firmware package download process has been initiated and the download process is suspended (due to network loss, power off, reboot or intentional disconnection +WDSS=1,0).

**Table 12: Download Suspension and Resumption Summary**

| Download User Agreement | Behavior when Device is Reconnected to AirVantage (e.g. upon reboot, resume connection) | Resuming Download |
|---|---|---|
| Disabled (+WDSC: 1,0) | Download is resumed. No notification returned.<br>User cannot stop the download process (except network loss, stop session, reboot) | Download is automatically restarted to continue downloading the remaining bytes (from where it stopped). However, if the package size is small (e.g. less than 1500bytes), the download will restart from the beginning (as the previously downloaded bytes were not large enough to store into flash). |
| Enabled (+WDSC: 1,1) | User receives pending notifications:<br>+WDSI: 9,<remaining_bytes><br>+WDSI: 2<br>User can defer the download process. | AT+WDSR=3 should be entered to resume download. The starting point of the download has the same condition as mentioned in the row above. |

# 9 Error Cases

This section lists the most common errors.

- The device is connected to a DM server (+WDSI: 23,1) but the module does not receive FOTA commands created on AirVantage. This is due to the NAT being released by the mobile operator; AirVantage can no longer send commands to the device as the external IP address and port of the module is no longer valid (address translation being dropped). Downstream communication is therefore broken. However, the connection remains active and the module is still able to send data to AirVantage. The inactivity period for the network to release the NAT is operator-dependent and can vary. Both the module and the AirVantage server are not aware of the NAT being released by the network. To reestablish downstream communication, the host processor can have the module perform a LwM2M registration again. This can be achieved by closing the current session (AT+WDSS=1,0) and restarting a new session (AT+WDSS=1,1). Sending upstream data will have the network renew the NAT for the device, and AirVantage will update the new external IP address and port of the device.
- DM connection error (AT+WDSS=1,1):
  - +CME ERROR: 650, APN is not defined, or there is a pending operation (e.g. +WDSI: 2 or +WDSI: 3) that is waiting for a user agreement to be entered (AT+WDSR).
  - +CME ERROR: 133, Invalid APN
  - +CME ERROR: 148, Activation error
  - +WDSI: 7, connection error with DM server; try AT+WDSS=1,1 again
- Firmware update error:
  - +WDSI: 15, firmware update failed
  - This failure occurs when trying to upgrade with a delta of mismatched firmware.

# 10 Power Cut

Ongoing FOTA operation (e.g. FW package download or FW upgrade) will be resumed in case of power off/on. +WDSI indications will be available after reset; pending user agreement will also be resumed.

# 11 Document History

| Revision Number | Release Date | Changes |
|---|---|---|
| 1.0 | September 05, 2018 | Creation |
| 1.1 | September 18, 2018 | Updated:<br>▪ Table 1: Device Services Indications<br>▪ Firmware Update OTA<br>▪ Suspending and Resuming Download |
| 2.0 | July 10, 2019 | Added key rotation use cases in 7.4 Connection Flows and AT Commands |
| | | Updated:<br>▪ Table 1: Device Services Indications<br>▪ Firmware Update OTA |
| 2.1 | July 15, 2019 | Updated Suspending and Resuming Download |
| 3.0 | January 21, 2022 | Updated Suspending and Resuming Download |
| 4.0 | June 2024 | Updated PDP Context |
| 5.0 | October 2024 | Typographical edits<br>Updated 6 Firmware Update OTA |

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