D4.3-UTM Box functional test report

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APPLICABLE DOCUMENTS		
Ref.	File Name	Description
AD 1	Grant Agreement-101082484-CERTIFLIGHT	Project Grant Agreement
AD 2	D2.6-CONOPS and System Requirements	CERTIFLIGHT System Requirements and Conops specification.
AD 3	D3.1 - UTM Box user manual	User Manual and Specification of the UTM Box
AD 4	D3.2 - CERTIFLIGHT platform user manual	User Manual and Specification of Certiflight platform
AD 5	TN2: MAIA UTM update IF/ICD report	Update of the SW Interface of MAIA UTM with Certiflight platform.
AD 6	TN3: D-FLIGHT UTM update IF/ICD report	Update of the SW Interface of D-FLIGHT with Certiflight platform.
AD 7	TN4: e-Conspicuity SW library documentation	Technical specification of e-Conspicuity SW library for UTM Box
AD 8	TN5: DKF and Spoofing detection SW library documentation	Technical specification SW library of GNSS Algorithms for Spoofing detection for Certiflight platform.
AD 9	TN6: UNIFLY UTM update IF/ICD report	Update of the SW Interface of Unifly UTM with Certiflight platform.

REFERENCE DOCUMENTS		
Ref.	File Name	Description
RD 1	https://lteitaly.it/	Map for 3G/4G/5G Mobile base station installations, with operational frequency bands and Telecom Operators
RD 2	https://simcom.ee/documents/SIM7060G/SIM7020%20Series_AT%20Command%20Manual_V1.03.pdf	SIM7020 Series_AT Command Manual_V1.02

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SUMMARY

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Abstract

This document represents the contractual deliverable D4.3-UTM Box functional test report

Status of the tests		
Test name	Status	Notes
TEST_UTMBOX.0010 Device configuration	Done	-
TEST_UTMBOX.0020 Security chain in device configuration	Done	-
TEST_UTMBOX.0030 Device Installation and Notification Features	Done	-
TEST_UTMBOX.0040 Device operative performance	Done	-
TEST_UTMBOX.0050 Device payload I/F function	Done	The tests were performed with a DJI PSDK license linked to one developer. It is suggested to test it also on another DJI M300 drone during E2E tests.
TEST_UTMBOX.0060 Device Gateway – USSPs Connectivity test	Done	The connection status (TCP/IP socket) is not implemented in the ICDs for D-Flight UTM and MAIA UTM. It is recommended to enhance both the D-Flight ICD and the Device Gateway ICD (used with MAIA UTM) with this feature to improve control over device connectivity.
TEST_UTMBOX.0070 Device Gateway - Transmission Rate Performance	Done	-
TEST_UTMBOX.0080 Simulation of Velocity Obstacle-based methods	Done	-
TEST_UTMBOX.0090 E-Conspicuity broadcasting functions verification	Done	-

1 Scope of the document

The scope of the document is to report the results of test case described in section 4 of the verification plan (D4.1). In particular, this technical note reports the results of test codes TEST_UTMBOX_00XX.

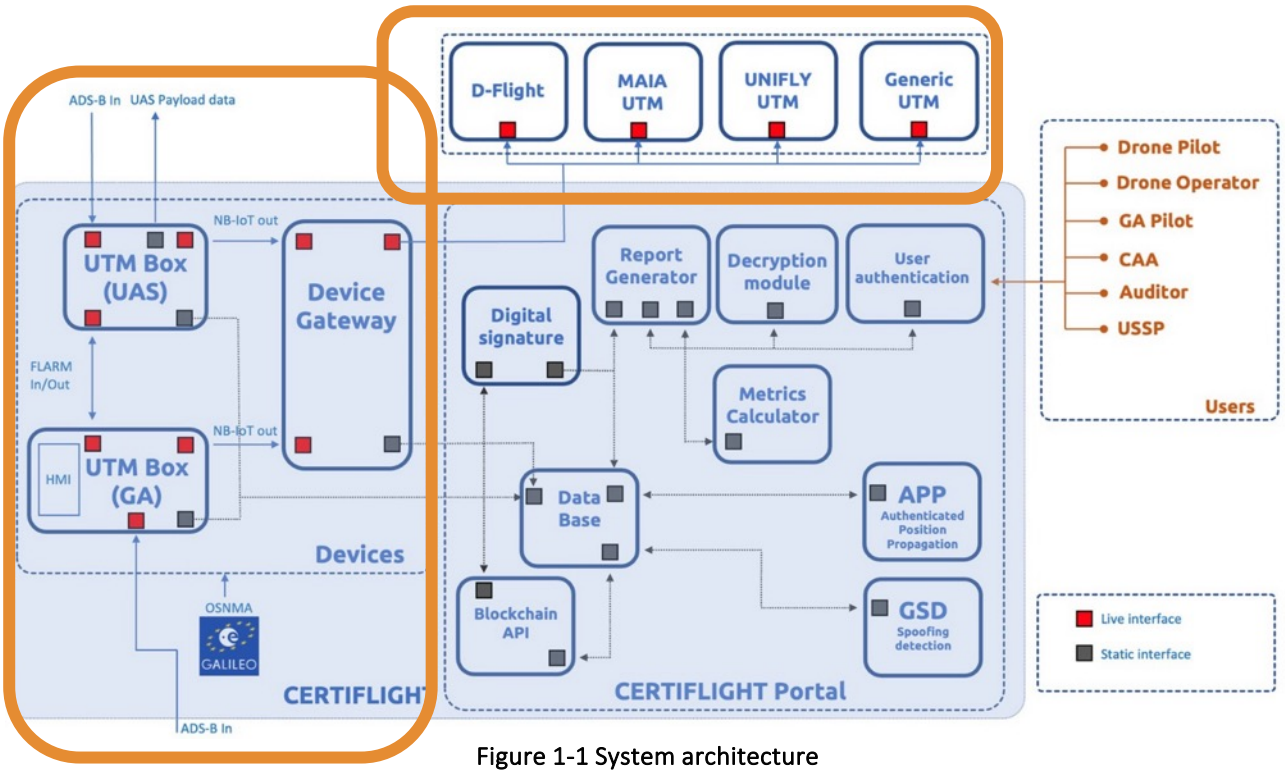

Figure 1-1 System architecture

To facilitate the reading, the Architecture of Certiflight is reproposed in the Figure 1-1, with a explanation of each block and the elicitation of the main I/Fs.

- **Devices:** The digital EGNSS/IoT UTM Box(s) installed on UASs and GA manned aircraft, equipped with an OSNMA Galileo/EGNOS enabled receiver, capable to guarantee the authenticity of their position information at the origin.
  - the **UTM Box** (UAS and GA) integrates GNSS and IMU sensors capable of providing information on the position, attitude, barometric and geometric altitude. Raw data of sensors are stored on board for post-processing. The chain of trust is enforced through anti-tampering mechanisms and cyphering algorithms.
  - The **Device Gateway** is the exchange node between Certiflight UTM Box and all the registered elements (CERTIFLIGHT Portal and other UTM/USSP providers). It implements tracking services relying on the authenticated information enhanced by security features, provided by the device.

- **Certiflight Portal:** It is the users' access point to Certiflight services. Each identified stakeholder may access with his/her profile for configuration, data ingestion, retrieving, visualization and reporting features. The collected data and the final report(s) allow the user to have all the certified information for in-flight and post-flight services.

- **UTM/USSP interfaces:** The UTMs/USSPs are connected to CERTIFLIGHT in two ways:
  - Through the Device Gateway for Tracking and Authenticated tracking services; in this case each UTM service provider has its own ICD I/F detailed in three specific technical notes.
  - Through direct access to Certiflight platform for post flight services retrieval. In this case, the UTM service provider logs-in as a user for retrieving the post flight Reports.

1.1 Acronyms

Acronyms	Description
AGL	Above Ground Level
BTS	Base Transceiver Station
CAR	Common Altitude Reference
DEM	Detailed Elevation Model
DTM	Detailed Terrain Model
EGNSS	European Global Navigation Satellite System
GA	General Aviation
GNSS	Global Navigation Satellite System
HOD	Hook on Device
NM	Nautical Miles
OSNMA	Open Service Navigation Message Authentication
UAS	Unmanned Aerial System
USSP	U-space Service Provider
UTM	Unmanned Traffic Management

Table 1-1 Acronyms list

2 Test Procedure

CERTIFLIGHT test procedures are built according to the following identification format: PROC_UTMBOX. <NNNNx>, where <NNNN> is the progressive number (E.g. PROC_UTMBOX.0010) and x identifies the substeps of each test. The structure of the test procedure is described in the table below.

PROC_UTMBOX.NNNNx. Procedure Title			
Step	**Activity description**	**Expected Result**	**Notes**
S_NN	<Step Title> Procedure description	Test explaining what it is expected for each step of the procedure	Notes for further explanation

Table 2-1 Example of test procedure

3 UTM Box Requirement Verification Matrix

The following table summarize the UTM requirements verified by Test (T).

ReqID	ReqTitle	ReqText	Type	Verification	Justification	Status of compliance	Close-out Status
Requirement Identification	Requirement title	Requirement text	General, functional, performance …	T, A	Comment to be fulfilled only in case of a requirement verified by A	<C>, <NC> or <PC> depending on the verification outcome	Requirement Identification
CFT-SYS-0060	UTM Box Interoperability	It shall be possible to configure the UTM Box to provide Tracking Data and authenticated Tracking Data to different USSPs, through pre-flight configuration.	general	T		C	

CFT-SYS-0130	Device Gateway and UTM Box Authentication	The Device Gateway shall handle authentication mechanisms during data retrieval by the UTM Box	functional	T		C	
CFT-SYS-0360	Feature for notification regarding the UTM Box power management	If on battery, UTM Box needs to notify the level of power remained for operation and/or condition the continuation of the flight. If dependent on the drone's power supply, UTM Box needs to have a standardized physical connection with the drones.	functional	T		C	
CFT-SYS-0370	Feature for notification regarding the UTM Box data management	The device shall notify when the internal data storage is about to be fully loaded.	functional	T		C	
CFT-SYS-0500	UTM Box 4G/5G Handover	The UTM BOX shall be able to handle 4G/5G Base Stations' handovers. The telemetry data during handover shall be received with a delay of maximum 10 seconds before the generation of a warning message.	Performance	T		C	
CFT-SYS-0510	UTM Box endurance (UAS)	The UTM BOX (UAS version) shall be able to transmit telemetry data via 4G/5G and store Raw data on Mass Memory for at least 3 hours without connection to Drone Power bus	Performance	T		C	
CFT-SYS-0520	UTM Box endurance (GA version)	The UTM BOX (GA version) shall be able to transmit telemetry data via 4G/5G and FLARM and store Raw data on Mass Memory for at least 8 hours without recharging the battery	Performance	T		C	

CFT-SYS-0530	UTM Box Transmission rate						
CFT-SYS-0650	UTM Box Factory key	The UTM Box shall have a unique factory secret key generated for re-association to other drones or other Factory reset and initialization.	security	T		C	
CFT-SYS-0660	UTM Box - Aircraft (UAS) pairing	The Device Gateway shall guarantee the pairing of an aircraft / drone with the UTM Box. The registration and pairing sequence shall be recorded in the blockchain node.	security	T		C	
CFT-SYS-0690	Accounts' data segmentation and non-interference	If a user tries to connect the UTM Box via another account, the pairing shall create a new and clean use case.	security	T		C	
CFT-SYS-0860	UTM Box IF to Drone data bus	The UTM BOX for UAS shall exhibit a suitable UART interface for reading data on the main drone data bus	Interface	T		C	
CFT-SYS-0870	UTM Box IF to Payload data	The UTM Box for UAS shall be capable to tag with epoch and position, calculated through the presence of OSNMA satellites in the PVT solution, the products generated by the UAS payload (RGB Photos, Thermal pictures,…). The Interface with the UAS payload data shall be done through the UAS data bus, SD Card or any other traceable mechanism.	Interface	T		PC	

CFT-SYS-0880	Authenticated Tracking service Transmission	The UTM Box shall be capable to transmit real time data of the authenticated tracking service to the selected USSP and CERTIFLIGHT Portal.	Interface	T		C	
CFT-SYS-0890	Authenticated Tracking service visualization on USSP	CERTIFLIGHT Poral shall guarantee the visualization of authenticated tracking in real time. The selected USSP shall be capable to visualize authenticated tracking in real time with different means comparing to traditional tracking on non-production platform (i.e. pre-production/Development)	Interface	T		C	
CFT-SYS-0910	UTM Box to USSP Interface: Connectivity	The integration between the UTM Box and the USSP shall be provided in the following way: - Unifly UTM shall be connected according to REST API protocol available for the Unifly UTM platform - MAIA UTM shall be connected according to JSON and MQTT protocol specification provided - D-Flgiht UTM shall be connected through API Bridge and ICD 2.0 available - A generic UTM shall be connected through "Pollicino" UTM Box tracking API	Interface	T		C	
CFT-SYS-0920	UTM Box to USSP Interface - Tracking device monitoring	The tracking monitoring of UTM Box devices shall be possible on each USSP platform independently. The configuration and Management of the UTM Box shall be possible through registration to the Device Gateway configuration.	Interface	T		C	

Table 3-1 UTM Box Requirement Verification Matrix

4 Test Report

CERTIFLIGHT test reports are built according to the following identification format: REP_UTMBOX.<NNNN>, where <NNNN> is the progressive number (E.g. REP_UTMBOX.0010).
Each test report presents one or more procedures and below of those are discussed the specific results.

4.1 REP_ UTMBOX.0010 Device configuration

This paragraph reports the tests of the options available to the user for the UTM box management and configuration after the registration in the Device Gateway.
The steps followed in this test are described in the table below

PROC_UTMBOX.0010 Device configuration			
Step	**Activity description**	**Expected Result**	**Notes**
S_01	**Sign Up** The user visits https://pollicino.topview.it:8443/ and creates a new account by entering: ✓ First name ✓ Last name ✓ Username ✓ Email ✓ Password Then the user chooses all three USSPs and clicks on sign up button	The user receives an email with the confirmation of registration	-
S_02	**Login** The operator accesses the platform using his credentials.	The user is successfully logged in	Username: Certiflight.test Password: Devicetest@
S_03	**First configuration of the device**	-	This step is part of the dedicated test TEST_UTMBOX.0020
S_04	**USSP selection** The user sets the device Network Remote ID parameters for each USSP	All USSPs are selectable, and the user can insert the data he wants to show on each of them	-
S_05	**Turn on the device** The user turns on the device and waits for green flashing light on the STATUS LED.	-	-

S_06	**Verify the data transmitted using the Device Gateway's map** The user verifies that the device location is properly visualized on the Map section of the Device Gateway and that the serial number of the UTM Box corresponds to the serial number on the bottom of the Physical device.	The position is correct, and the information of the device corresponds to the configuration. The Non authenticated position is flagged by a red icon. The Authenticated position is flagged by a blue icon.	-
S_07	**Verify the tracking on USSP**	The device location, the Authenticated and Non authenticated position are visualized on each USSP's interface, when selected by the Device Gateway USSP slider.	-

Table 4-1 Test procedure UTMBOX.0010

4.1.1 Test execution and results

Date	30th of July
Tester	Lorenzo Porricelli
Place	TopView premises
Hardware used	Device for UAS, PC
Notes	

The test starts with the registration of a new account on the device gateway.
Once in the homepage of Device gateway and clicked on "sign up" button, it starts the registration phase.
The fields of the registration form have been filled as follows

Field Name	Filling data
First Name	Certiflight
Last Name	Tester
Username	Certiflight.test
Email	lorenzo.porricelli@topview.it
Password	Devicetest@
Password confirmation	Devicetest@
Choose of USSP	All three the check box selected
I agree to the Privacy Policy	Check box selected

Table 4-2 Filling data in registration form of device gateway

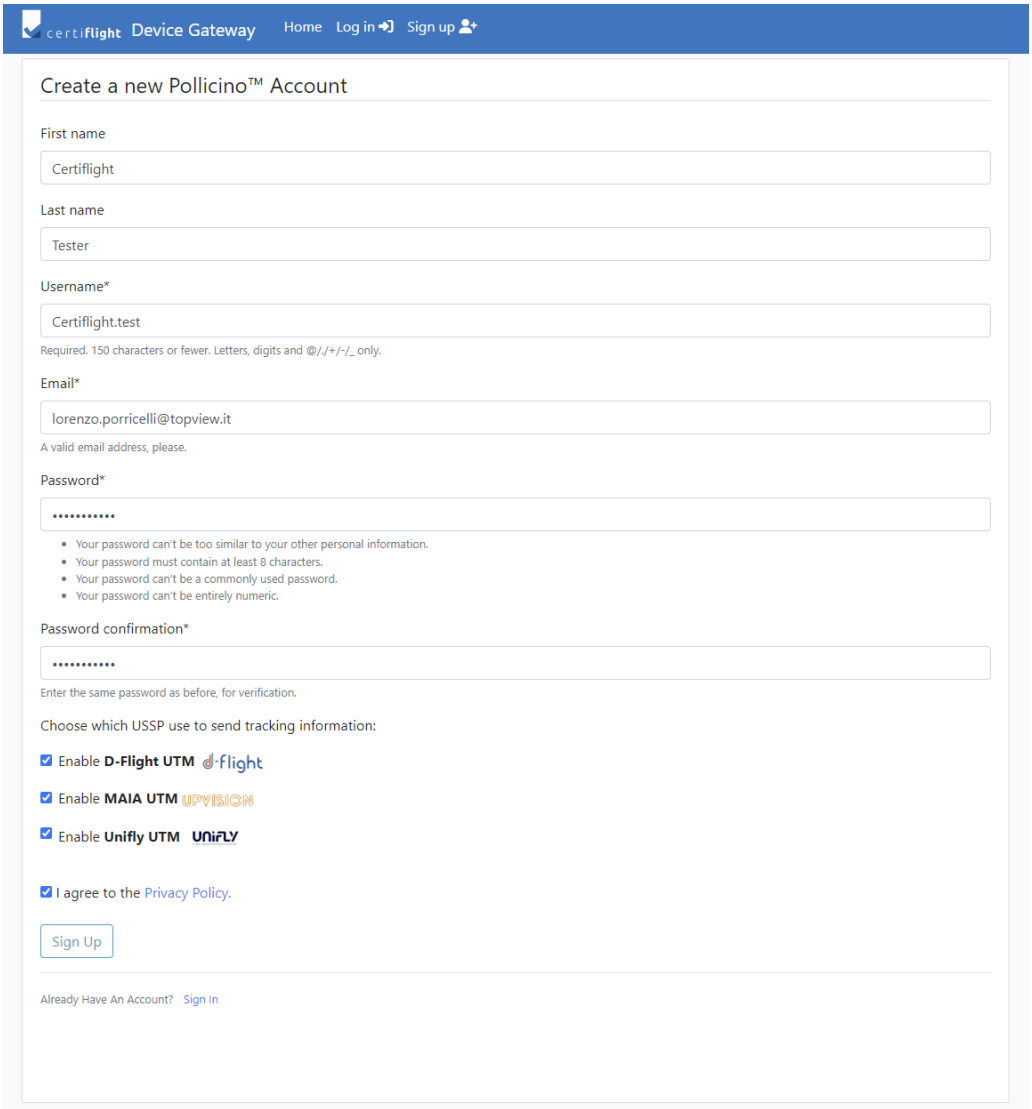

Figure 4-1 Device Gateway - Registration screen and selection of USSPs

After clicking sign-up button, we received an e-mail with a link to activate the account.

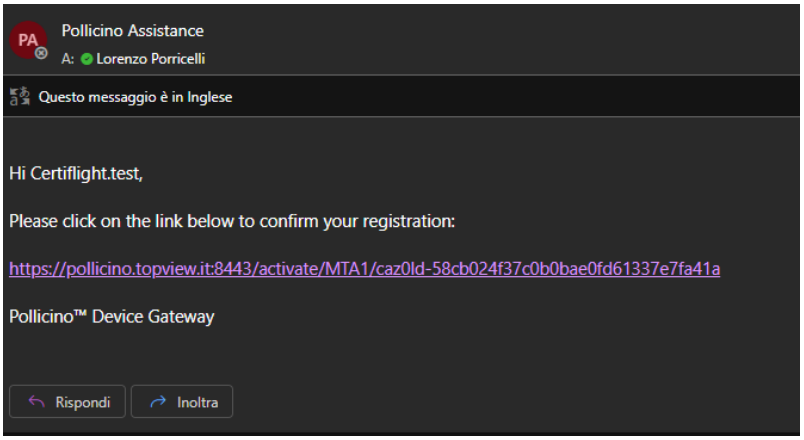

Figure 4-2 e-mail to activate the account

After the confirmation of the registration, we logged in the gateway and then click on device to register the new device.
The registration of the new device has been reported in a dedicated test case: UTMBOX.0020 Security chain in device configuration, which is in the following paragraph.
We turned on the device to verify that the information is properly visualized in the map section of the gateway.
As shown in Figure 4-3 the authenticated position is correctly visualized on the device gateway: the authenticated position is identified with a blue place holder

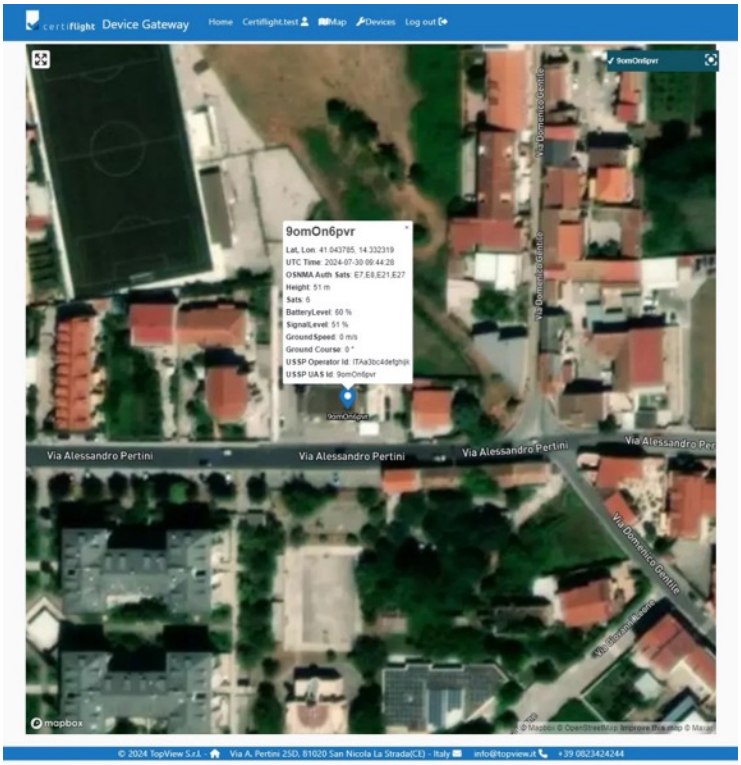

Figure 4-3 Visualization of authenticated position on device gateway

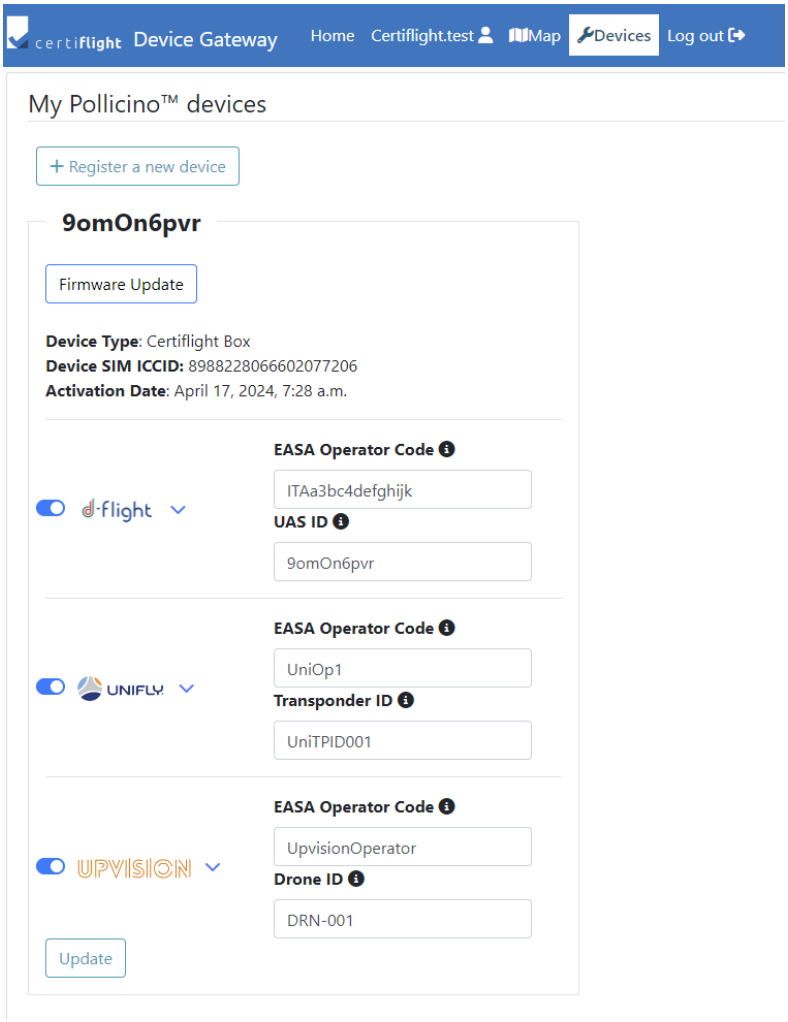

Figure 4-4 Configuration of the USSPs' parameters

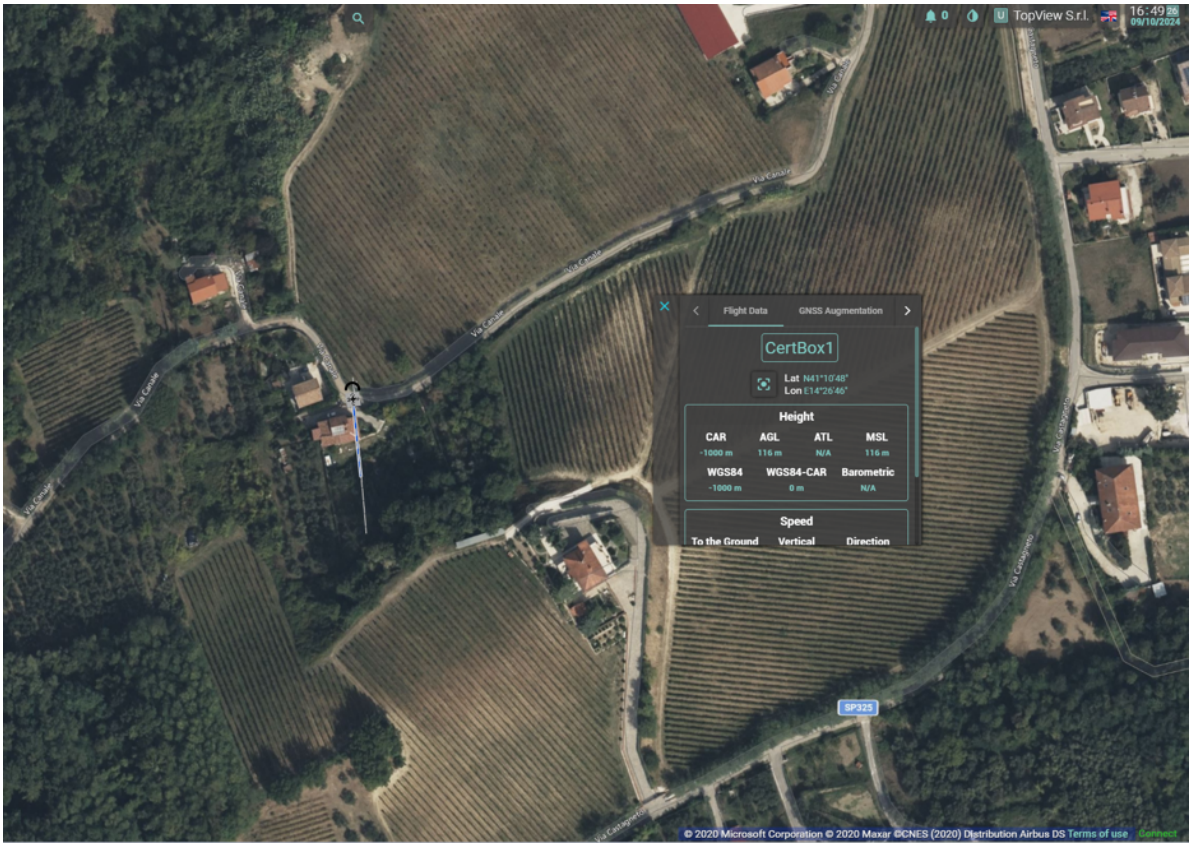

Figure 4-5 Authenticated position on d-flight

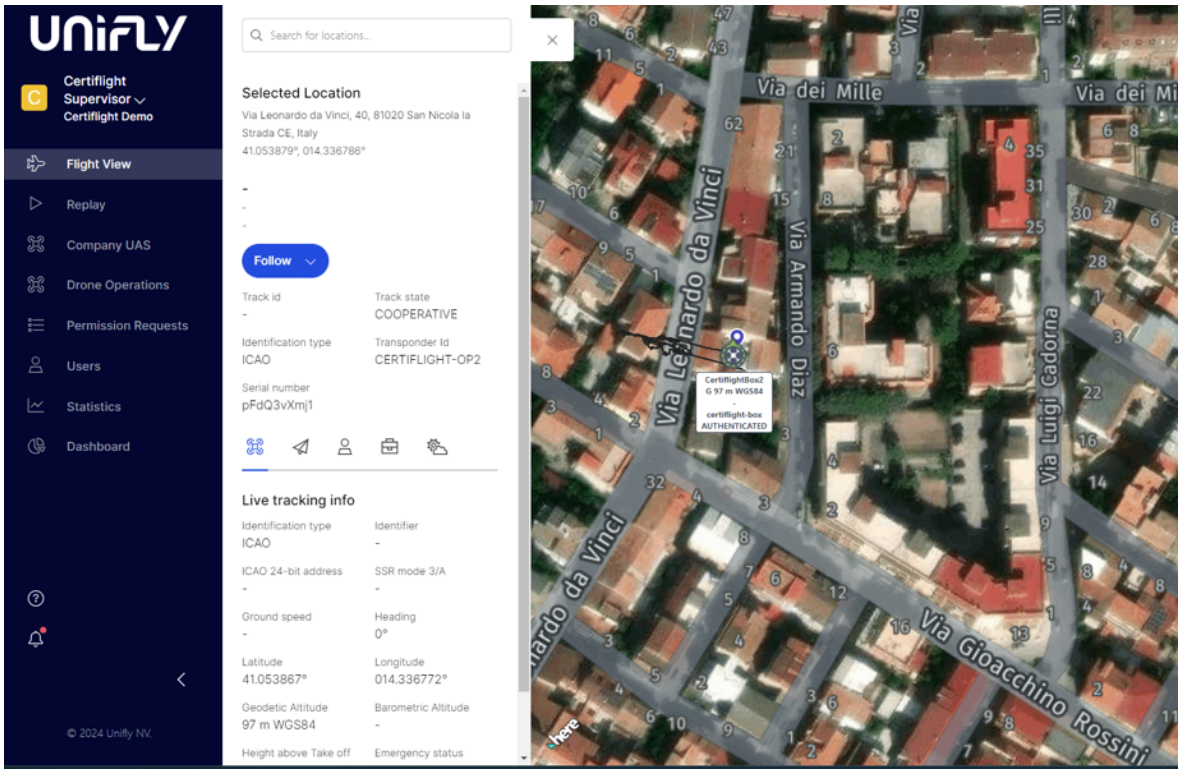

Figure 4-6 Authenticated position on Unifly UTM platform

Figure 4-7 Authenticated position on MAIA UTM platform

4.2 REP_UTMBOX.0020 Security chain in device configuration

This paragraph reports the test of the multiple security mechanisms during the device initialization and first configuration procedure.
This test has been performed following the steps in table below.

PROC_UTMBOX.0020 Security chain in device configuration			
Step	**Activity description**	**Expected Result**	**Notes**
S_01	**Login** The operator accesses the platform using his credentials.		The user has already an account for test Username: Certiflight.test Password: devicetest as described in test report 4.1 REP_ UTMBOX.0010 Device configuration
S_02	**First initialization of the device**	The device gateway recognizes the serial	

	The user follows the procedure as described in the section §5.1 of D3.1 – UTM Box User manual [AD 3].	number of the device as authentic and implements the binding mechanism for ensuring the first track of the security chain.	
S_03	**Confirmation message** The user receives a confirmation message on the Device Gateway "The device is now uniquely associated to your account"	The device gateway displays a confirmation message and a QR code to link the device with the Certiflight Portal	
S_04	**Scan QR Code of Certiflight Portal** The user scans the QR code or click on the link and sign-in to pair the device to his Certiflight account.	The user is redirected to the Certiflight Portal	

Table 4-3 Test procedure UTMBOX.0020

4.2.1 Test execution and results

Date	30th of July
Tester	Lorenzo Porricelli
Place	TopView premises
Hardware used	Device for UAS, PC
Notes	Results are in line with expectations

The test starts with the account login. To access we inserted the username and password registered during REP_ UTMBOX.0010 Device configuration:

- Username: Certiflight.test
- Password: Devicetest@

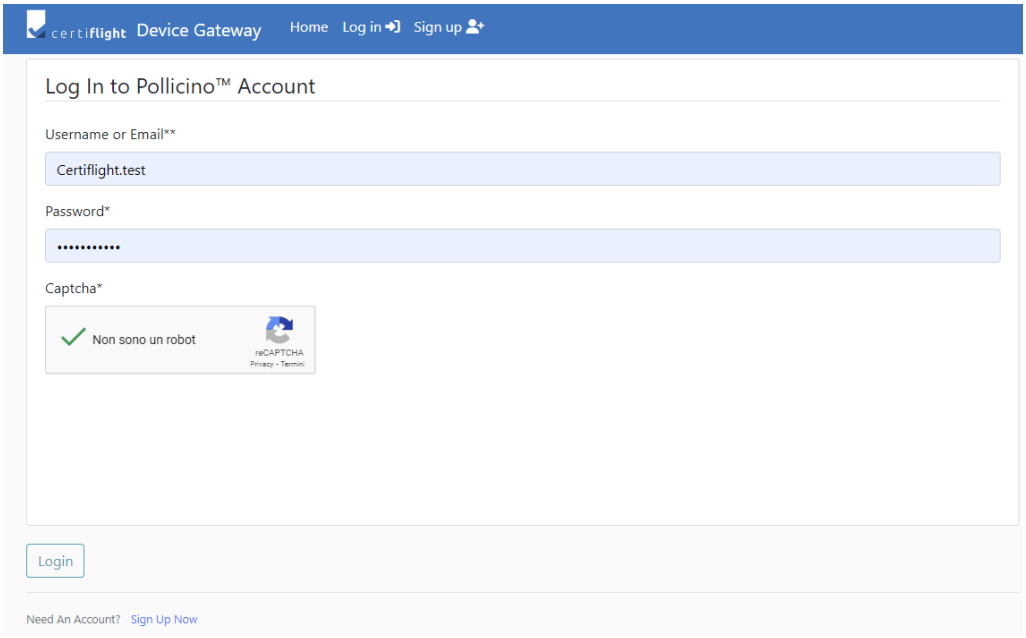

Figure 4-8 Device Gateway - Login screen

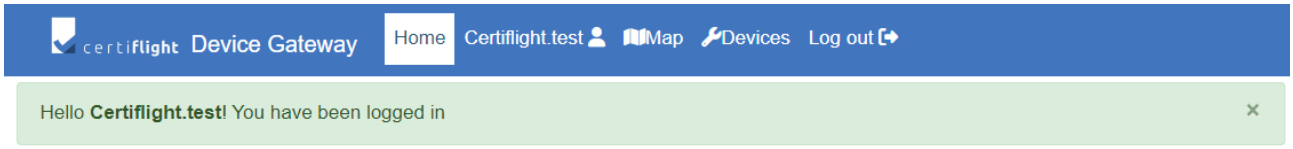

Figure 4-9 Welcome message after login

Once logged in the gateway, we clicked on “Devices” in the menu and then “Register a new device”.

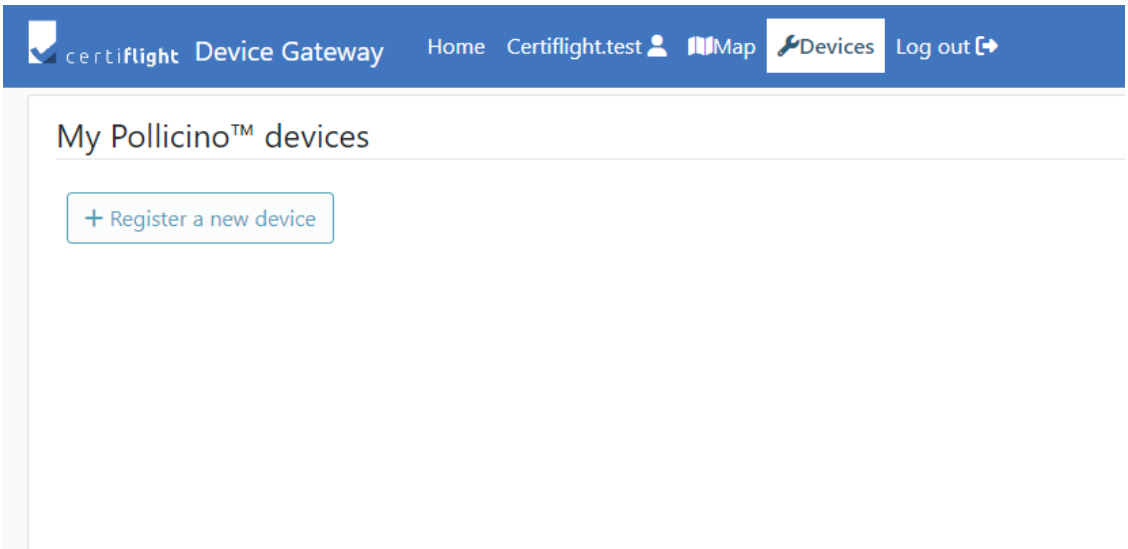

Figure 4-10 Device Gateway - Register new device button

In “register a new device to your account” screen, we selected “Certiflight Box” and then enter the serial number 9omOn6pvr.

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Figure 4-11 Serial number label on the device

This serial number is printed on the label in the back side of the device.
After typing this serial number and checked the matching with the label, we click on submit button

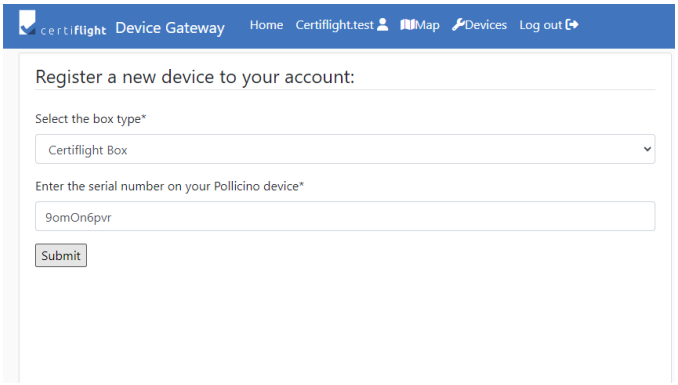

Figure 4-12 Serial number submission

In this phase the device gateway checks the validity of the serial number.
Our serial number has been correctly verified and the device gateway displayed a confirmation message and the link to access the Certiflight Portal.

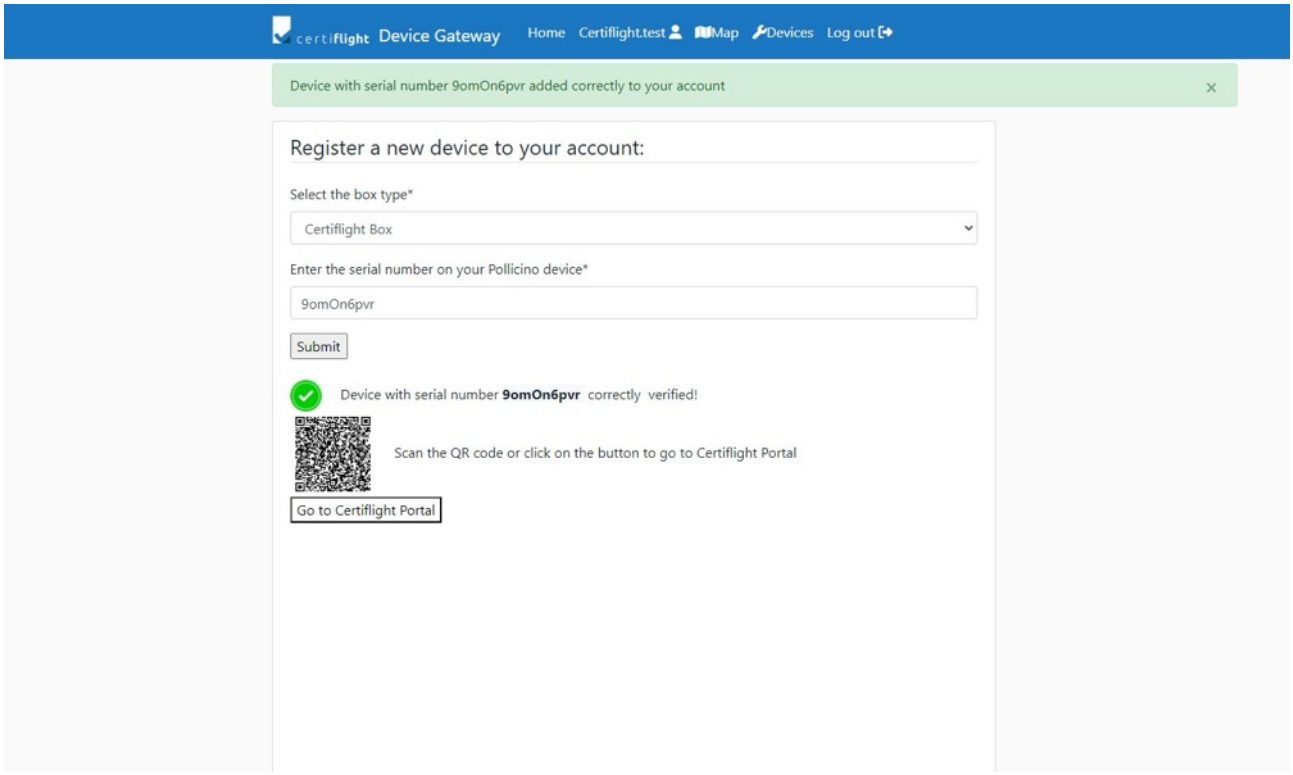

Figure 4-13 Confirmation of device verification

The verification of security chain has been successfully completed.

4.3 REP_UTMBOX.0030 Device Installation and Notification Features

This paragraph reports the test of the entire procedure of installation of the UTM BOX and proper functioning of the LED notification as explained in the user manual.
All the procedures below have been verified according to the User Manual for both device versions, respectively in the sections §3.3 and §4.2 of D3.1 – UTM Box User manual [AD 3].
The procedures and results of this test have been grouped in four specific subtests

1. Device for UAS – battery notifications
2. Device for UAS – Installation and battery charging via Drone
3. Device for UAS – Micro SD card check
4. Device for GA – Battery notification

4.3.1 REP_UTMBOX.0030a Device for UAS – battery notifications

This test has been performed following the steps described in the table below.

PROC_UTMBOX.0030a Device for UAS – battery notifications			
Step	**Activity description**	**Expected Result**	**Notes**
S_01	**Turn on the device**	The status led blinks in red colour	
S_02	**Wait until the battery reaches the 30% remaining**		For this test we used a device already used in

			other tests and not charged
S_03	**Check the battery using the LED** The user checks the battery status looking at the STATUS LED	The STATUS LED is visible and informs the user about battery charging status as explained in User Manual.	

Table 4-4 Test procedure UTMBOX.0030a

4.3.1.1 Test execution and results

Date	9th of July
Tester	Francesco Russo
Place	TopView premises
Hardware used	Device for UAS
Notes	Results are in line with expectations

Once turned on, the STATUS LED of the device behaves as expected: showing alternate green and red light when the battery reaches the 30% of remaining charging (Figure 4-14)

Figure 4-14 Low battery notification with STATUS LED red and green flashing

The test is completed, and results are in line with the expectations

4.3.2 REP_UTMBOX.0030b Device for UAS – Installation and battery charging via Drone

This test has been performed following the steps described in the table below.

PROC_UTMBOX.0030b Device for UAS – Installation and battery charging via Drone			
Step	**Activity description**	**Expected Result**	**Notes**
S_01	**Installation on the drone**	The Device is firmly installed on the drone and the LED	The DJI M300 is the target drone of this

	The user installs the device on the drone using the mounting adapter	indicators are visible when installed	test
S_02	**Connect the charging cable and turn on the drone** The user physically connects the Device to the drone by means of USB Type C cable, then turns the drone on	-	-
S_03	**Verify the charging from the drone** Verify that as soon as the drone has been turned the CHARGE LED of the device turns on	The CHARGE LED turns on when connected to the drone.	-

Table 4-5 Test procedure UTMBOX.0030b

4.3.2.1 Test execution and results

Date	9th of July
Tester	Francesco Russo
Place	TopView premises
Hardware used	Device for UAS, DJI M300
Notes	-

The test has been performed in the TopView premises with DJI Matrice 300.
The box has been mounted on the drone and connected with USB cable.
As soon as turned on the drone the CHARGE LED of the device turned on consequently, starting the charging from the power supply of the UAS.

Figure 4-15 The UTM installed on the drone while charging

4.3.3 REP_UTMBOX.0030c Device for UAS – Micro SD card check

This test has been performed following the steps described in the table below.

PROC_UTMBOX.0030c Device for UAS – Micro SD card check			
Step	**Activity description**	**Expected Result**	**Notes**
S_01	**Remove the Micro SD card from the slot** The user removes the Micro SD from the slot and put it aside	The Micro SD slot of the device is empty	-
S_02	**Check the STATUS LED** As soon as the Device is turned on the user can see the STATUS LED that notifies the SD error.	The Device detects the missing of the Micro SD card and notifies to the user through the STATUS LED turned on in solid RED colour for 6 seconds	-

S_03	**Insert a fully loaded Micro SD CARD** Using a PC the user uploads files up to the SD card until reaching less than 100 MB of remaining storage	The PC's file explorer displays that the remaining storage on the SD is lower than 100 MB	-
S_04	**Micro SD card fully loaded notification** As soon as the Device is turned on the user can see the STATUS LED that notifies the low SD storage remaining.	The Device detects the SD card and notifies the error by the STATUS LED turned on in solid PURPLE colour	Since a new colour has been assigned to this function the user manual will be updated accordingly

Table 4-6 Test procedure UTMBOX.0030c

4.3.3.1 Test execution and results

Date	9th of July
Tester	Francesco Russo
Place	TopView premises
Hardware used	Device for UAS, Windows PC, Micro SD card
Notes	-

This test has been performed on the desk with Device for UAS and a 32GB Micro SD Figure 4-16.

Figure 4-16 Device for UAS and micro-SD aside

Once turned on the device has correctly notified the missing SD card using the STATUS LED in a solid red colour Figure 4-17. The LED remains turned on for 6 seconds then the Device starts operating normally.

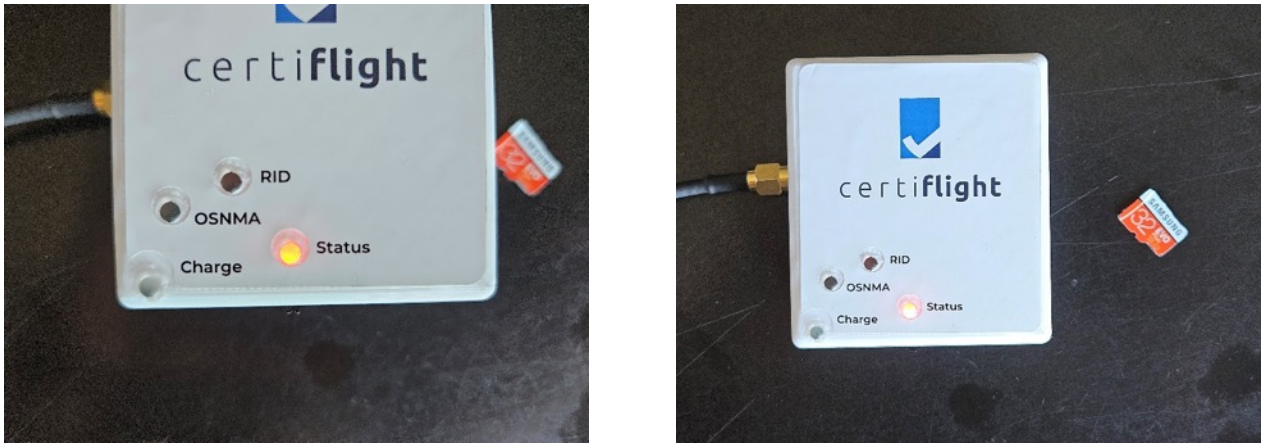

Figure 4-17 STATUS LED notifies missing micro-SD error (solid RED)

For the purpose of the test, we used an almost fully loaded SD card. Figure 4-18 shows the SD card with 84,6 MB of free storage remaining on a Windows PC.

Figure 4-18 The fully loaded micro-SD on Windows PC

Once inserted the Micro SD and turned on the device the STATUS LED notifies the error with a solid purple colour, as in Figure 4-19

Figure 4-19 STATUS LED notifies fully loaded micro-SD error (solid PURPLE)

The test has been passed successfully.

4.3.4 REP_UTMBOX.0030d Device for GA – Battery notification

This the test has been performed following the steps described in the table Table 4-7.

PROC_UTMBOX.0030d Device for GA – Battery notification			
Step	Activity description	Expected Result	Notes

S_01	**Turning on the Device** The user turns on the device		
S_02	**Battery check** The user checks the battery with icon on the display of the device	The battery icon is visible and follows the battery percentage detected by the system	

Table 4-7 Test procedure UTMBOX.0030d

4.3.4.1 Test execution and results

Date	17th of September 2024
Tester	Lorenzo Porricelli
Place	TopView premises
Hardware used	Device for G
Notes	-

```
2024-09-17 10:39:06,106 INFO Aerobits in line:
{"ver":1,"src":"21-0010057","ts":31146172,"gnss":{"fix":0,"acc":{"lat":3750.0,"lon":3750.0,"alt":3750.0}}}
2024-09-17 10:39:06,123 INFO Battery voltage: 16.6V
2024-09-17 10:39:06,124 INFO Battery level: 94.0%
2024-09-17 10:39:06,544 INFO Aerobits in line:
```

Figure 4-20 Device for GA Log with battery indicators

Figure 4-21 Device for GA Battery icon on screen

The device displays the battery percentage correctly. Test passed.

4.4 REP_UTMBOX.0040 Device operative performance

This paragraph reports the test of device battery and network performance.

4.4.1 REP_UTMBOX.0040a Cell handover test

The aim of this test is to highlight the management of the cell change by the Certiflight device during normal operation. The cell handover or handoff is a process in which data transmission is seamlessly transferred from one cell to another while the device remains connected to the network.
This test has been performed following the steps in table below.

PROC_UTMBOX.0040a Cell handover test			
Step	**Activity description**	**Expected Result**	**Notes**
S_01	**Fully charge the device** The user charges the device until the LED Charge is turns off		-
S_02	**Turn on the Devices** The user turns on the devices and checks the network identification is working in the map section of Device Gateway	The STATUS LED is flashing green and RID LED is flashing	-
S_03	**Check that the device is fully operational** To verify that the 2 UTM Boxes are operational and paired to the tester's account as per TEST_UTMBOX.0010.	The device is visible on device gateway and the battery level is 100%	-
S_04	**Execute the identified trajectory by car** The user drives there and back again, checking the behaviour of LEDs as per UTM Box User Manual, in particular in the places where the cell-handover handover is expected.	Automatic switch between cells without impact on user experience The device notifies possible network disconnection and reconnection	-
S_05	**Download the flight log**	The user obtains a .csv file	-
S_06	**Analysis of cell handovers**	All the "network handover Delays ">10 seconds of one flight log are signalled by a warning message in the device gateway. Seamless reconnection after handover < 10 seconds.	-

Table 4-8 Test procedure UTMBOX.0040a

4.4.1.1 Test execution and result

Date	12th of July
Tester	Mariano Iadaresta
Place	Caserta, Italy
Hardware used	Device for UAS, Windows PC, Micro SD card
Notes	Test in the car

For this test, the UTM box is equipped with a dedicated firmware version that enables saving a .CSV file with data collected from the embedded LTE modem. This information was saved with a frequency of 1Hz, and each sample was also associated with the epoch time, lat, lon and LTE signal strength [%] on a file called C_ID.CSV.
The data follows this format:

"epoch,lat,lon,sl,n,stat,tac,ci"

Field	Description	example
Epoch	Time expressed in epoch format	*1720812361*
lat	Latitude	*41.057064*
lat	Longitude	*14.341203*
sl	Network Signal level	*67*
n	Subscribe unsolicited result codes	*5*
Stat	Status of registration on the network 5 = registered	*5*
tac	Tracking area	*B7F4*
ci	Cell ID in Hexadecimal Format	*0136066F*

Table 4-9 Network log's fields in the Device for UAS

A sample of the data:

"1720812361,41.057064,14.341203,67,5,5,""B7F4"",""0136066F"

This test has been conducted in the car following the path in figure Figure 4-22 in the surroundings of TopView's premises.

Height or altitude data was not collected for this test, as the main purpose was to evaluate the resilience of the UTM Box to base station handovers. Moreover, given the urban scenario and the car-based setup (with low positional accuracy), such data would not have been significant. However, when connected to USSPs for tracking and authenticated tracking, height and/or altitude are transmitted according to the specific USSP interface. Barometric measurements above ground level (height) are transmitted for UAS local vertical reference and obstacle awareness, while 'geometric'

altitude is transmitted for a potential common altitude reference (i.e. other drones' traffic). USSPs are developing common altitude reference mechanisms (CAR) to convert height to altitude using DEM/DTM terrain information.

Figure 4-22 Planned path for cell handover test

The path has been planned to achieve at least three cell handovers. The target cell towers are all located in Caserta

	BTS name	Cell ID in hexadecimal numbers	Cell ID in decimal numbers	BTS eNodeB ID
1	Ex area Saint Gobain	0136066F 01360671	20317807 20317809	79366
2	Viale Sossietta Scialla	0136726F	20317553	79365
3	Via Benevento	01360571	20345455	79474

Table 4-10 BTS part of the test

To analyse the log, we first converted the CELL number from hexadecimal to decimal. Then by using the portal lteitaly.it we associated the CELL ID decimal numbers to a specific eNodeB ID which localizes the BTS on the map.

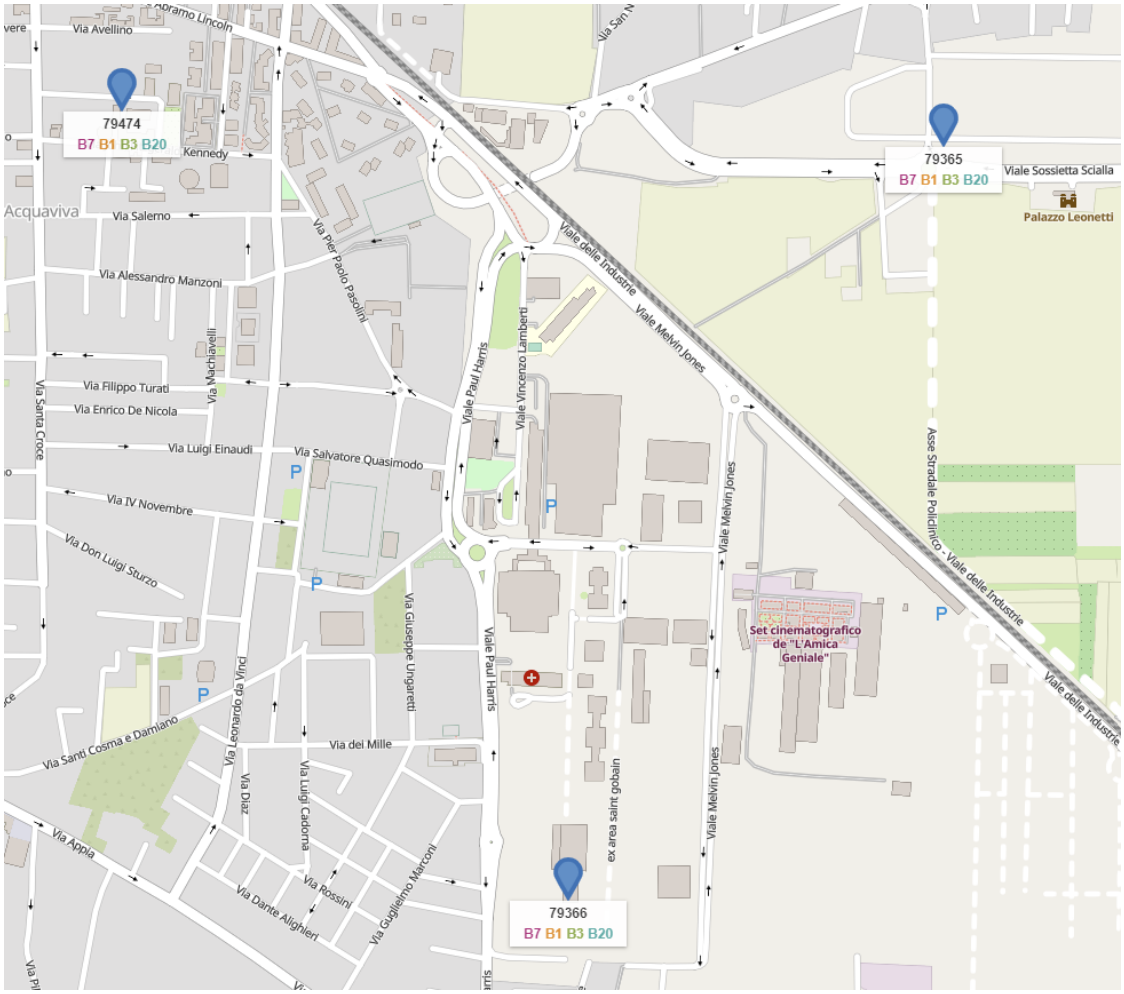

Figure 4-23 BTS location on LTE Italy with evidence of provided frequency bands (lteitaly.it)

The log analysis revealed eight cell handovers during the test, where the device maintained continuous connectivity by automatically switching between base stations.

Cell handover (epoch time)	Cell handover time (GMT)	Time to reconnect in seconds
1720812384	Friday 12 July 2024 19:26:24	1
1720812519	Friday 12 July 2024 19:28:39	1
1720812590	Friday 12 July 2024 19:29:50	1
1720812666	Friday 12 July 2024 19:31:06	1
1720812704	Friday 12 July 2024 19:31:44	1
1720812806	Friday 12 July 2024 19:33:26	2
1720813007	Friday 12 July 2024 19:36:47	1
1720813216	Friday 12 July 2024 19:40:16	2

Table 4-11 Time spent in cell handovers

In Figure 4-24 the switch between cell 01360571 and cell 0136726F (hexadecimal values) extracted from data logs.

```
1720812662,41.063148,14.341321, 54, 5,5,"B7F4","01360571",9,"00",0,0,"11100000","11100000
1720812663,41.063213,14.341230, 54, 5,5,"B7F4","01360571",9,"00",0,0,"11100000","11100000
1720812664,41.063274,14.341143, 54, 5,5,"B7F4","01360571",9,"00",0,0,"11100000","11100000
1720812665,41.063335,14.341058, 54, 5,5,"B7F4","01360571",9,"00",0,0,"11100000","11100000
1720812666,41.063389,14.340976, 54, 5,5,"B7F4","01360571",9,"00",0,0,"11100000","11100000
1720812667,41.063435,14.340909, 54, 5,5,"B7F4","0136726F",9,"00",0,0,"11100000","11100000
1720812668,41.063469,14.340859, 54, 5,5,"B7F4","0136726F",9,"00",0,0,"11100000","11100000
1720812669,41.063484,14.340817, 54, 5,5,"B7F4","0136726F",9,"00",0,0,"11100000","11100000
1720812670,41.063484,14.340776, 54, 5,5,"B7F4","0136726F",9,"00",0,0,"11100000","11100000
1720812671,41.063469,14.340737, 54, 5,5,"B7F4","0136726F",9,"00",0,0,"11100000","11100000
1720812672,41.063450,14.340698, 54, 5,5,"B7F4","0136726F",9,"00",0,0,"11100000","11100000
```

Figure 4-24 cell handover in the log highlighted in yellow

These two values converted to decimal are referred to cell ID 20345455 (eNodeB 79474) and 2031755 (eNodeB 79365).

Figure 4-25 BTS involved in cell handover of figure 4-15

Figure 4-26 The path of the test based on device's reported positions

Attached to test there's a file where the changes of CI are evident automatically managed by the modem and in an instant way as is evident from the relative epoch time (in seconds).
Also, we produced the KML (handover.kml) of the route taken with UTM Box by car.
For the verification of the Cell ID, please refer to the cellmapper.net or similar site where the BTS on which the telephone cells are mounted and encoded are reported.

Date	10th of September
Tester	Francesco Russo
Place	Castel Campagnano, Italy
Hardware used	Device for UAS, DJI M300
Notes	Inflight test

A second test has been conducted in Castel Campagnano, mounting the device on a DJI M300.
The flight plan has foreseen a grid path with increasing heights from 40 meters to 60 meters above the ground.

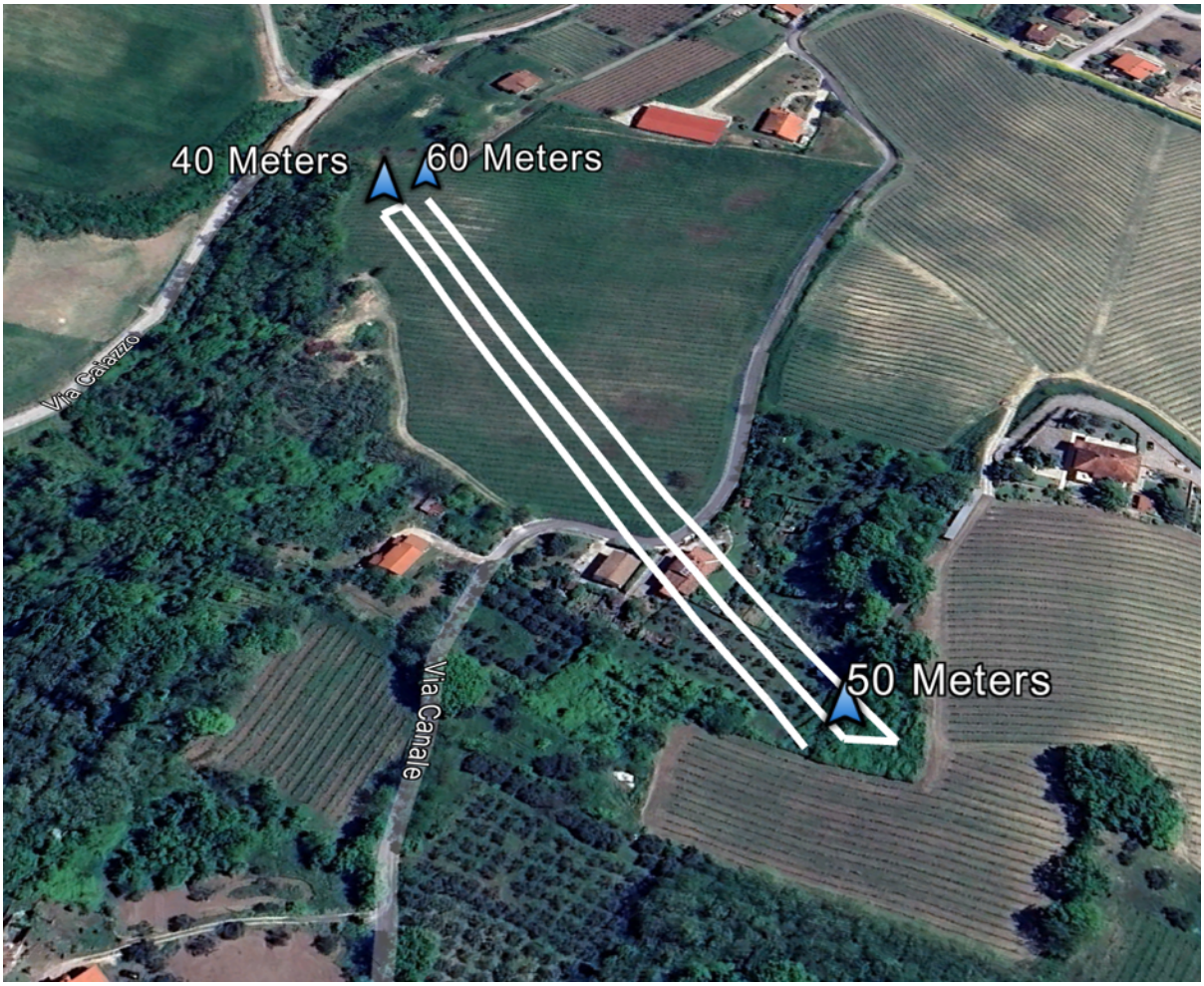

Figure 4-27 Flight path for handover test in Castel Campagnano

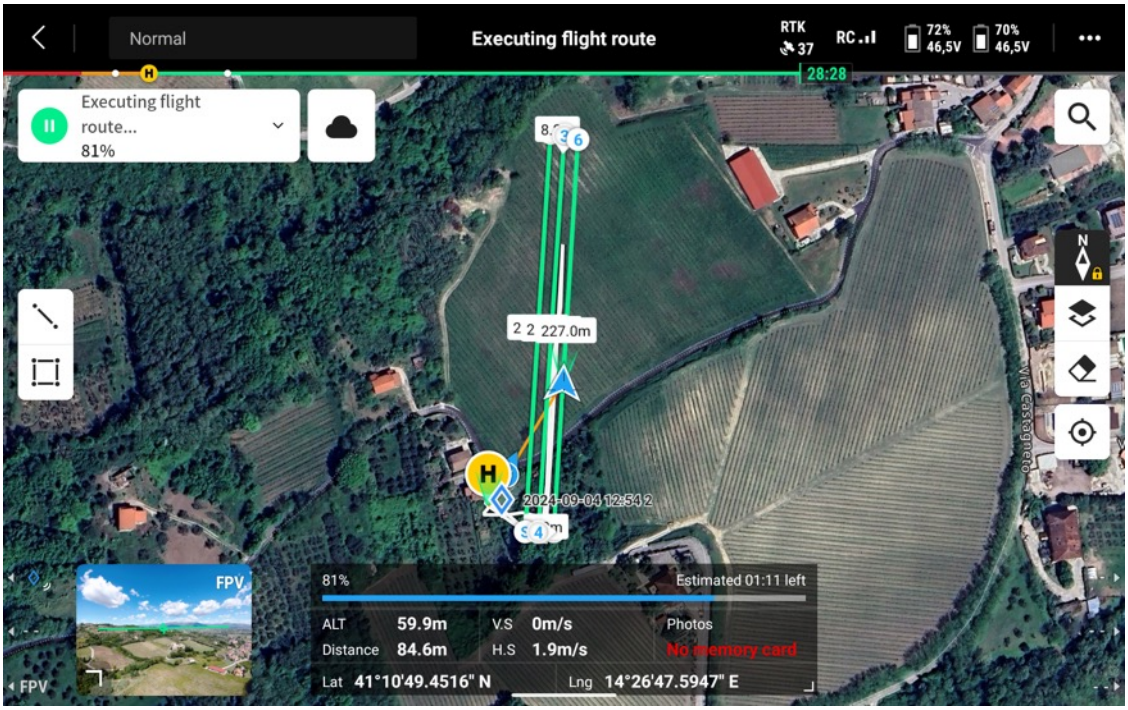

Figure 4-28 Flight route on DJI Pilot app

The Figure 4-29 shows the four cell towers involved in test.

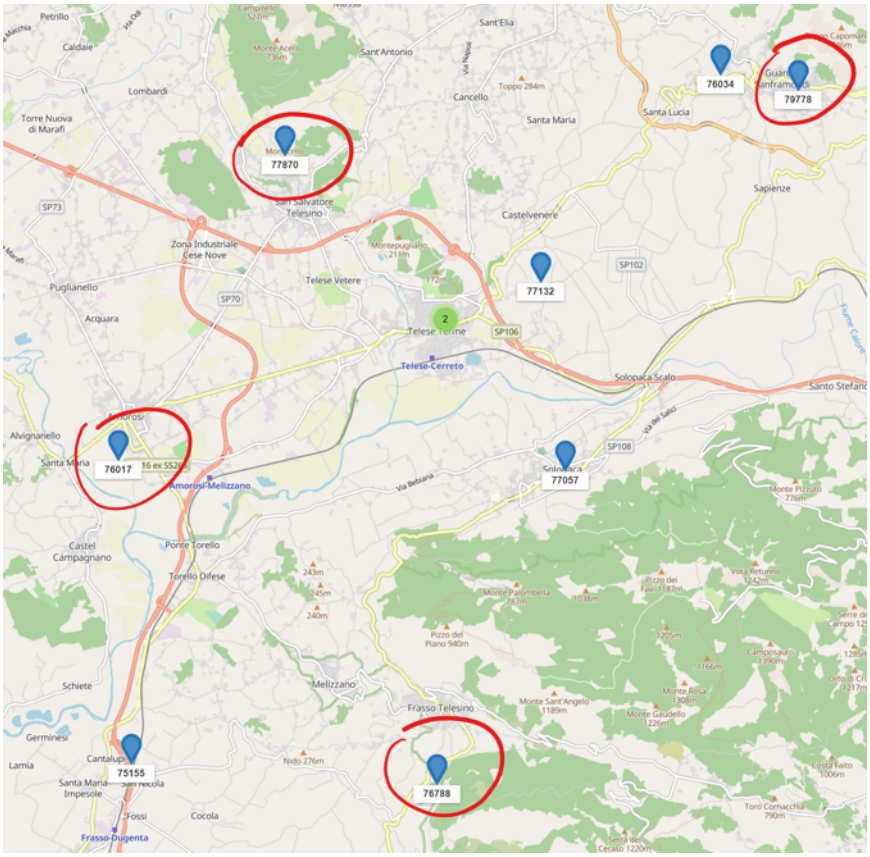

Figure 4-29 The four Cell Tower involved in the test

The furthest cell tower was in Guardia Sanframondi, 16 Km away from the drone position Figure 4-30.

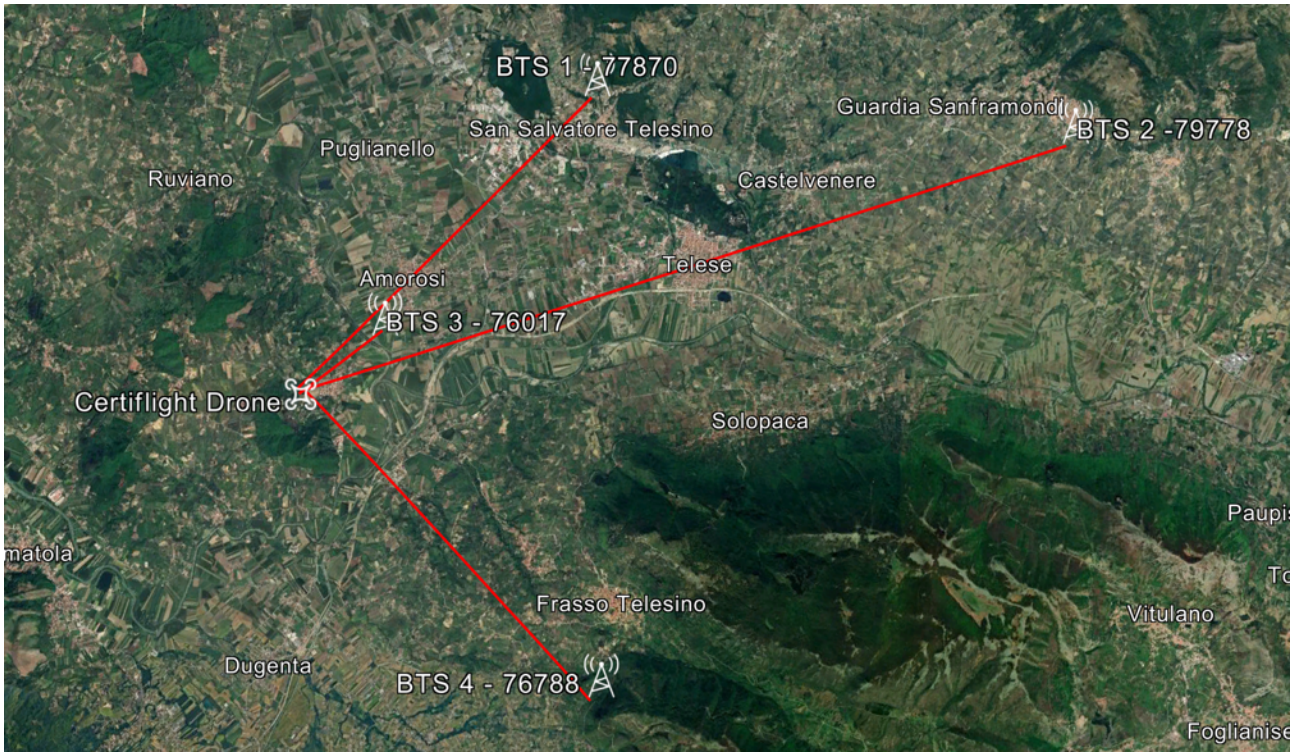

Figure 4-30 Distance between the drone and cell towers

The data analysis of the log showed a total of eight cell handovers Figure 4-31.

Epoch time	Date	Hour	Difference	lat	lon	Cell ID HEX	Handover counter	BTS eNodeB	BTS location
1725970576	10/09/2024	12:16:16		41.179749	14.446049	01302E70	0	77870	San Salvatore Telesino
1725970577	10/09/2024	12:16:17	00:00:01	41.179749	14.446049	0137A270	1	79778	Guardia Sanframonti
1725970780	10/09/2024	12:19:40		41.179192	14.445732	0137A270	0		
1725970781	10/09/2024	12:19:41	00:00:01	41.179199	14.445736	0128F171	1	76017	Amorosi
1725970911	10/09/2024	12:21:51		41.181480	14.446414	0128F171	0		
1725970912	10/09/2024	12:21:52	00:00:01	41.181499	14.446419	012BF470	1	76788	Frasso telesino
1725970958	10/09/2024	12:22:38		41.181240	14.446443	012BF470	0		
1725970959	10/09/2024	12:22:39	00:00:01	41.181221	14.446437	0128F171	1	76017	Amorosi
1725970994	10/09/2024	12:23:14		41.180607	14.446259	0128F171	0		
1725970995	10/09/2024	12:23:15	00:00:01	41.180588	14.446254	012BF470	1	76788	Frasso telesino
1725971055	10/09/2024	12:24:15		41.179527	14.445939	012BF470	0		
1725971057	10/09/2024	12:24:17	00:00:02	41.179508	14.445934	0128F171	1	76017	Amorosi
1725971323	10/09/2024	12:28:43		41.179745	14.446053	0128F171	0		
1725971324	10/09/2024	12:28:44	00:00:01	41.179749	14.446053	01302E70	1	77870	San Salvatore Telesino
1725971381	10/09/2024	12:29:41		41.179745	14.446059	01302E70	0		
1725971382	10/09/2024	12:29:42	00:00:01	41.179745	14.446059	0137A270	1	79778	Guardia Sanframonti
						Total Handovers	8		

Figure 4-31 Analysis of handover test

The Table 4-12 shows the handovers and the time to reconnect. On eight handovers just one took 2 seconds. This result is in line with the expectations.

Cell handover (epoch time)	Cell handover Date (GMT)	Cell handover time (GMT)	Time to reconnect in seconds
1725970577	10/09/2024	12:16:17	1

1725970781	10/09/2024	12:19:41	1
1725970912	10/09/2024	12:21:52	1
1725970959	10/09/2024	12:22:39	1
1725970995	10/09/2024	12:23:15	1
1725971057	10/09/2024	12:24:17	2
1725971324	10/09/2024	12:28:44	1
1725971382	10/09/2024	12:29:42	1

Table 4-12 Handovers and time to reconnect in seconds

4.4.2 REP_UTMBOX.0040b Device for UAS - battery life test

This test has been performed following the steps in table below.

PROC_UTMBOX.0040b Device for UAS - battery life test			
Step	**Activity description**	**Expected Result**	**Notes**
S_01	**Turn on the device**		
S_02	**Leave the device turned on until it's fully discharge**	The device logs the battery level parameters during the test	
S_03	**Analyse the log and calculate the average battery life**	Battery life must be no less than 3 hours	

Table 4-13 Test procedure UTMBOX.0040b

4.4.2.1 Test execution and results

Date	30th of July
Tester	Mariano Iadaresta
Place	TopView premises
Hardware used	Device for UAS, Windows PC
Notes	-

Using a multimeter tool we measured the voltage of the battery. Based on this we can estimate a battery life of about 5 hours. An additional test will be executed in order to further verify such estimation.

Time	Battery voltage
Initial measurement, battery fully charged	4,20 V
After 1 hour measurement	4,00 V

Table 4-14 Battery life measurements

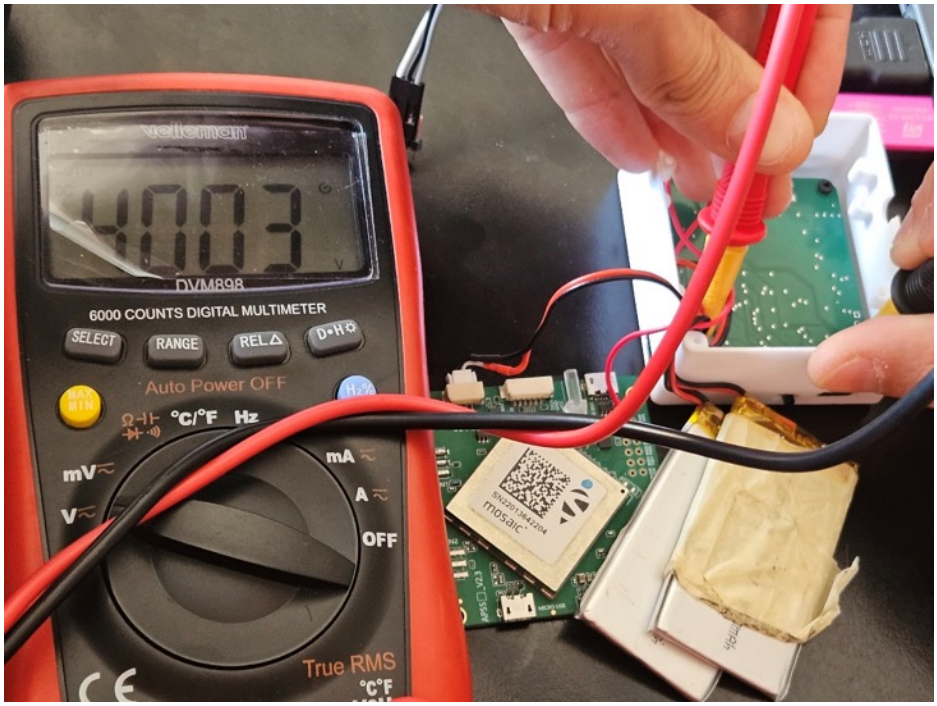

Figure 4-32 Volts of the device battery measured by the multimeter

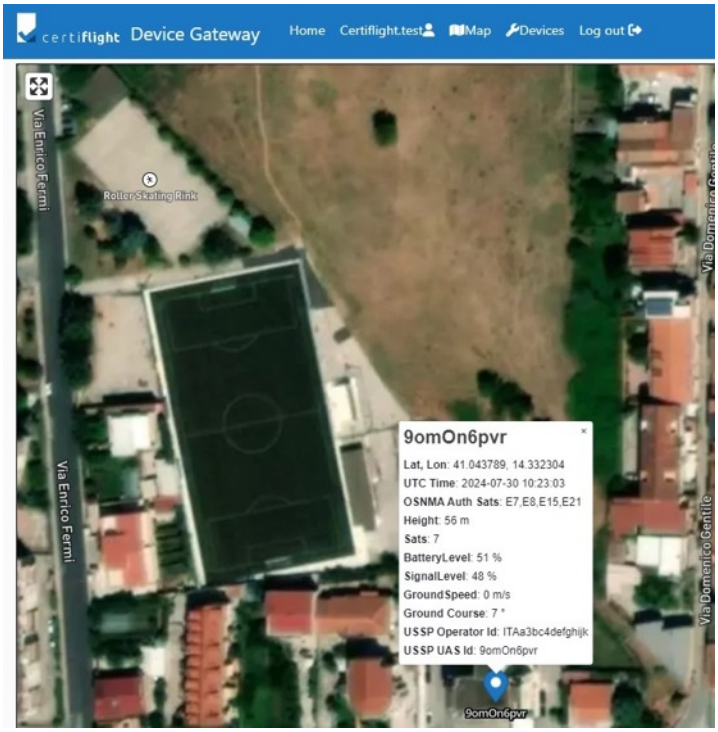

Figure 4-33 Battery level percentage as shown on the device gateway

The battery life measurements are above the expected results and the system requirement (at least 3 hours in continuous transmission).

4.4.3 REP_UTMBOX. 0040c Device for GA - battery life test

PROC_UTMBOX.0040c Device for GA - battery life test			
Step	Activity description	Expected Result	Notes
S_01	Turn on the device without charging	-	-
S_02	Leave the device turned on until it's fully discharge	-	-
S_03	Analyse the log and calculate the average battery life	Battery life must be no less than 8 hours	-

Table 4-15 Test procedure UTMBOX.0040c

4.4.3.1 Test execution and results

Date	29th of July
Tester	Mariano Iadaresta
Place	TopView premises
Hardware used	Device for GA, Windows PC
Notes	-

The current version of the device doesn't have a hardware controller capable of monitoring battery consumption. For the purpose of this test, we did an estimation based on voltage measurements starting from a fully charged battery by using a multimeter tool.

The device power consumption has been about 20% per 1 hour. As a result, the current estimation is 5 hours of battery life without damaging the battery.

Time	Battery voltage
Initial measurement, battery fully charged	16,80 V
After 1 hour measurement	16,29 V

Table 4-16 Voltage measurement

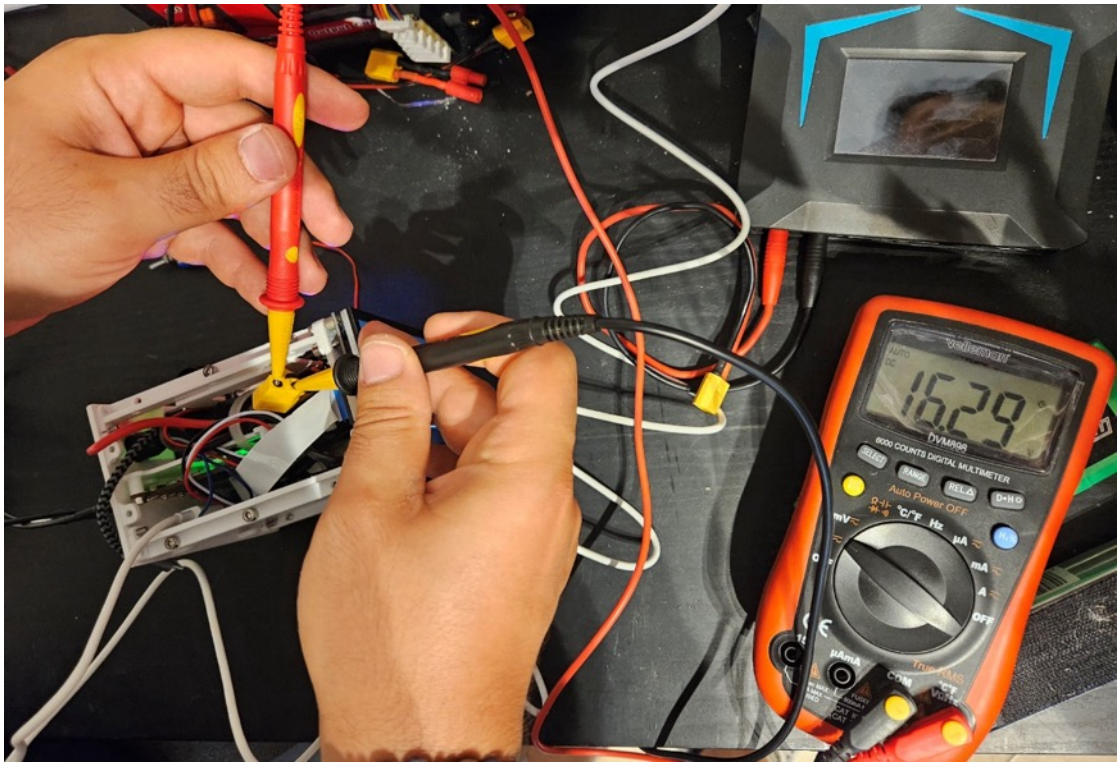

Figure 4-34 Voltage measurement of the battery

The device needs further optimizations to achieve the requirement of 8 hours or more battery life.

4.5 REP_ UTMBOX.0050 Device payload I/F function

This paragraph reports the test of payload I/F capabilities of the device.
This test has been performed following the steps in table below.

PROC_UTMBOX.0050 Device payload I/F function			
Step	**Activity description**	**Expected Result**	**Notes**
S_01	**Enter device in payload mode**	When in payload mode the STATUS LED flashes Blue and then Green	
S_02	**Install the device on the drone**		The target drone is the DJI M300
S_03	**Execute a flight (or bench test)**	when the Device is in Payload Mode and the UAS payload is capable to generate some products like RGB photos of thermal pictures.	Bench test executed.
S_04	**Execute some Thermal and RGB Shots manually**		

S_05	Switch off drone and UTM Box		
S_06	Verify on the UTM Box telemetry data through data logs	The event "picture shot" has been registered by the UTM Box telemetry and the event is tagged with epoch and position.	The tests were performed with a DJI PSDK license linked to one developer. It is suggested to test it also on another DJI M300 drone during E2E tests

Table 4-17 Test procedure UTMBOX.0050

4.5.1 Test execution and results

Date	30th of September
Tester	Mariano Iadaresta
Place	TopView premises
Hardware used	Device for UAS, Windows PC, STM32F4, DJI PSDK developer kit
Notes	Test done with DJI PSDK (one developer trial licence)

To test this feature, we used the DJI PSDK developer kit connected to e-port of the DJI M300 and the STM32F4 Discovery development board to programme in FreeRTOS.

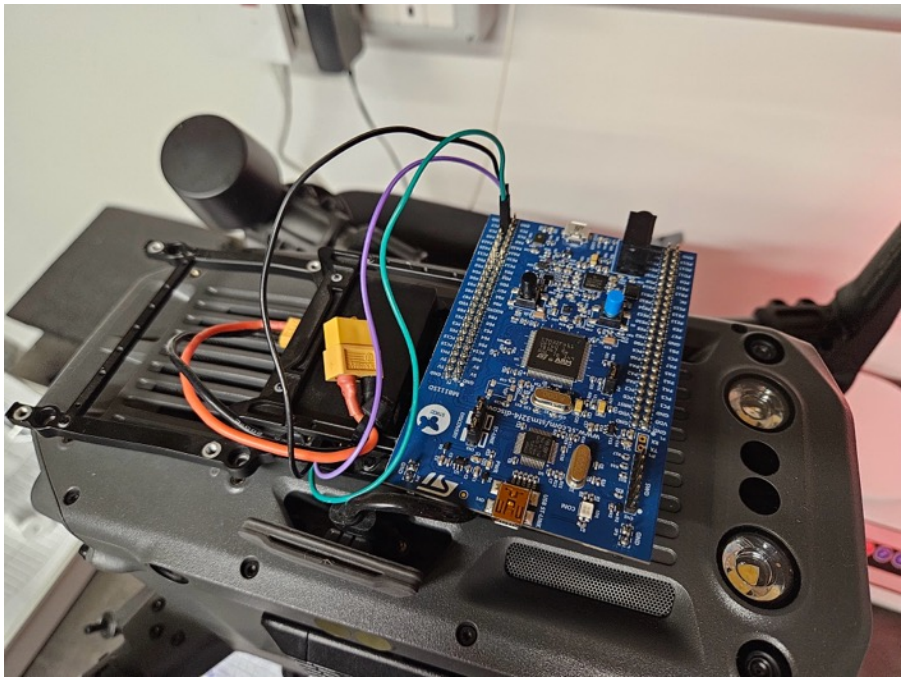

Figure 4-35 PSDK developer kit connected to STM32 on the DJI M300

The code for Payload interfacing is public available on GitHub. We used the sample provided by DJI to read the drone parameters.

Payload-SDK / samples / sample_c / platform / rtos_freertos / stm32f4_discovery / application / **application.c**

Code | Blame | 497 lines (440 loc) · 19.8 KB

```
393     #endif
394
395     #ifdef USING_UART_PORT_3
396             UART_GetBufferState(UART_NUM_3, &readBufferState, &writeBufferState);
397             USER_LOG_DEBUG("Uart3 read buffer state: countOfLostData %d, maxUsedCapacityOfBuffer %d.",
398                            readBufferState.countOfLostData, readBufferState.maxUsedCapacityOfBuffer);
399             USER_LOG_DEBUG("Uart3 write buffer state: countOfLostData %d, maxUsedCapacityOfBuffer %d.",
400                            writeBufferState.countOfLostData, writeBufferState.maxUsedCapacityOfBuffer);
401     #endif
402
403             // report system performance information.
404             // Attention: report system performance part is not intended for normal application runtime use but as a debug aid.
405             if (USER_UTIL_IS_WORK_TURN(runIndicateTaskStep++, RUN_INDICATE_TASK_FREQ_0D1HZ,
406                                        RUN_INDICATE_TASK_FREQ_1HZ)) {
407     #if (configUSE_TRACE_FACILITY == 1)
408                 currentTaskStatusArraySize = uxTaskGetNumberOfTasks();
409                 currentTaskStatusArray = osalHandler->Malloc(currentTaskStatusArraySize * sizeof(TaskStatus_t));
410                 if (currentTaskStatusArray == NULL) {
411                     continue;
412                 }
413
414                 currentTaskStatusArraySize = uxTaskGetSystemState(currentTaskStatusArray, currentTaskStatusArraySize, NULL);
415                 USER_LOG_DEBUG("task information:");
416                 USER_LOG_DEBUG("task name\trun time (%%)\tstack left (byte)\tnumber");
417                 for (i = 0; i < currentTaskStatusArraySize; i++) {
418                     cpuOccupyPercentage = 0;
419                     for (j = 0; j < lastTaskStatusArraySize; ++j) {
420                         if (currentTaskStatusArray[i].xTaskNumber == lastTaskStatusArray[j].xTaskNumber) {
421                             cpuOccupyPercentage =
422                                 (currentTaskStatusArray[i].ulRunTimeCounter - lastTaskStatusArray[j].ulRunTimeCounter) /
423                                 configTICK_RATE_HZ / RUN_INDICATE_TASK_FREQ_0D1HZ;
424                             break;
425                         }
426                     }
427                     USER_LOG_DEBUG("%-16s\t%u\t%u\t%u", currentTaskStatusArray[i].pcTaskName, cpuOccupyPercentage,
428                                    (unsigned int) currentTaskStatusArray[i].usStackHighWaterMark * sizeof(StackType_t),
429                                    (unsigned int) currentTaskStatusArray[i].xTaskNumber);
430                 }
431                 osalHandler->Free(lastTaskStatusArray);
432                 lastTaskStatusArray = currentTaskStatusArray;
433                 lastTaskStatusArraySize = currentTaskStatusArraySize;
434     #endif
435             }
436             USER_LOG_INFO("Used heap size: %d/%d.\r\n", configTOTAL_HEAP_SIZE - xPortGetFreeHeapSize(),
437                           configTOTAL_HEAP_SIZE);
438         }
```

Figure 4-36 Sample of PSDK code on GitHub

```c
#include "dji_payload_sdk.h"
#include <stdio.h>
#include <time.h>

// Funzione per loggare eventi
void logEvent(const char* event) {
    FILE* logFile = fopen("event_log.txt", "a");
    if (logFile == NULL) {
        printf("Errore nell'apertura del file di log.\n");
        return;
    }

    // Ottieni l'ora corrente
    time_t now;
    time(&now);
    char* timeStr = ctime(&now);
    timeStr[strlen(timeStr) - 1] = '\0'; // Rimuovi il carattere di nuova linea

    // Scrivi l'evento nel file di log
    fprintf(logFile, "[%s] %s\n", timeStr, event);
    fclose(logFile);
}

// Callback per lo scatto di foto
void onPhotoCapture() {
    logEvent("Foto scattata");
}

int main() {
    // Inizializza il DJI Payload SDK
    DjiErrorCode errorCode = DjiPayloadSdk_Init();
    if (errorCode != DJI_ERROR_CODE_SUCCESS) {
        printf("Errore nell'inizializzazione del DJI Payload SDK: %d\n", errorCode);
        return -1;
    }

    // Registra la callback per lo scatto di foto
    DjiPayloadSdk_RegisterPhotoCaptureCallback(onPhotoCapture);

    // Loop principale
    while (1) {
        // Esegui altre operazioni
    }

    // Termina il DJI Payload SDK
    DjiPayloadSdk_Deinit();
    return 0;
}
```

Figure 4-37 Current function used to read event from PDSK

4.6 REP_ UTMBOX.0060 Device Gateway – USSPs Connectivity test

This paragraph reports the test of the integration between the UTM Box and the USSP according to the interface explained in:

- D3.3 TN2: MAIA UTM update IF/ICD report [AD 5]
- D3.4 TN3: D-FLIGHT UTM update IF/ICD report [AD 6]
- D3.7 TN6: UNIFLY UTM update IF/ICD report [AD 9]

This test has been performed following the steps in table below.

PROC_UTMBOX.0060 Device Gateway – USSPs Connectivity test			
Step	**Activity description**	**Expected Result**	**Notes**
S_01	**Login**		-
S_02	**Check that all USSPs all selected and configured in devices section**		-
S_03	**Turn on the device**		-
S_04	**Verify connectivity errors**	The device gateway receives a connectivity	-

		confirmation from the USSPs with no issues for both authenticated and non-authenticated tracking information. No data injection issues are reported.	

Table 4-18 Test procedure UTMBOX.0060

4.6.1 Test execution and results

Date	30th of July
Tester	Graziano Gagliarde
Place	TopView premises
Hardware used	Device for UAS, Device gateway, Windows PC
Notes	-

The test has been successfully passed. The device gateway has been successfully connected to the USSPs, and no data issues are reported.
The Unifly platform features a dedicated API request response (Figure 4-38 and Figure 4-39)

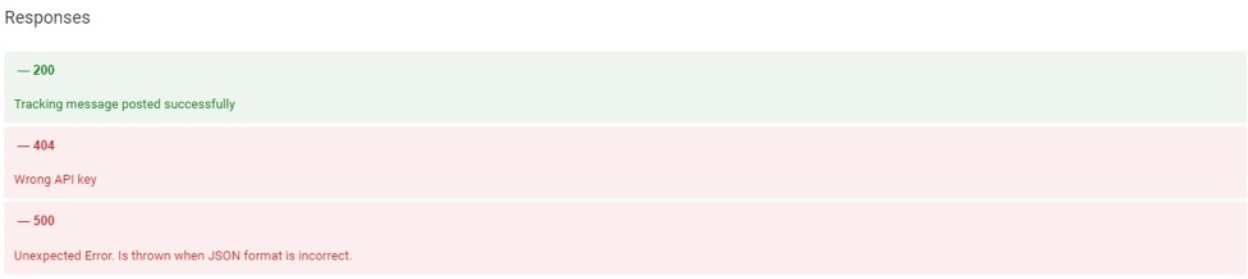

Figure 4-38 Types of API responses from Unifly's platform

Figure 4-39 API Request response from Unifly's platform

4.7 REP_UTMBOX.0070 Device Gateway - Transmission Rate Performance

This paragraph reports the test of device transmission rate performance and notify any temporary transmission outage
This test has been performed following the steps in table below.

PROC_UTMBOX.0070 Device Gateway - Transmission Rate Performance			
Step	**Activity description**	**Expected Result**	**Notes**
S_01	**Execute one or more flight sessions** The drone has the device on board	During the flights the device transmits the position information to the device gateway	-
S_02	**Verify messages with delay > 1s** Download the logs to compare timestamps and epoch information. how many tracking and authenticated tracking messages (data packets) were sent with a delay of more than 1s;	100% of messages with delay over 1 s are flagged by the Device Gateway	-
S_03	**To measure if any packet is sent with a rate of over than 5 seconds (i.e. every 6 seconds);**		-
S_04	**Report how many delayed messages result flagged according to the req. CFT-SYS-0530.**		-

Table 4-19 Test procedure UTMBOX.0070

4.7.1 Test execution and results

Date	26th of September 2024
Tester	Graziano Gagliarde
Place	TopView premises
Hardware used	Device for UAS, Device gateway, Windows PC
Notes	-

For the purpose of this test the device has been placed on the balcony of the office and left turned on for 30 minutes.

Figure 4-40 Device used in the transmission rate test

The gateway recognizes the delayed data by comparing in each message the epoch time of device with the timestamp of the server.
If the message has a delay of more than one second, the field “is_delayed” has a value “1” and “delay_seconds” records the number of seconds of delay.

fw_version	lat	lon	geoid	agl	ns	bl	sl	gs	gc	utctime	epoch	epoch_raw	timestamp	is_delayed	delay_seconds
CRT_v1.0.0	41.074.783	14.313.836	0	0.0	5	68	64	1	163		########	1,727E+09	2024-09-26 15:17:22.825	0	NULL
CRT_v1.0.0	41.073.475	14.314.616	0	0.0	5	68	64	1	164		########	1,727E+09	2024-09-26 15:17:23.604	0	NULL
CRT_v1.0.0	41.073.151	14.314.808	0	0.0	5	68	64	1	158		########	1,727E+09	2024-09-26 15:17:24.564	0	NULL
CRT_v1.0.0	41.072.929	14.314.941	0	0.0	5	68	64	1	158		########	1,727E+09	2024-09-26 15:17:25.847	0	NULL
CRT_v1.0.0	41.074.020	14.314.291	0	0.0	5	68	64	1	163		########	1,727E+09	2024-09-26 15:17:26.812	0	NULL
CRT_v1.0.0	41.075.394	14.313.472	0	0.0	5	68	64	1	159		########	1,727E+09	2024-09-26 15:17:27.825	0	NULL
CRT_v1.0.0	41.076.290	14.312.938	0	0.0	5	68	64	1	166		########	1,727E+09	2024-09-26 15:17:29.379	0	NULL
CRT_v1.0.0	41.076.935	14.312.554	0	0.0	5	68	64	1	163		########	1,727E+09	2024-09-26 15:17:30.322	0	NULL
CRT_v1.0.0	41.076.927	14.312.559	0	0.0	5	68	64	1	166		########	1,727E+09	2024-09-26 15:17:31.284	0	NULL
CRT_v1.0.0	41.076.897	14.312.578	0	0.0	5	68	64	1	168		########	1,727E+09	2024-09-26 15:17:32.588	0	NULL
CRT_v1.0.0	41.076.557	14.312.780	0	0.0	5	68	64	1	162		########	1,727E+09	2024-09-26 15:17:33.582	0	NULL
CRT_v1.0.0	41.076.382	14.312.883	0	0.0	5	68	64	1	164		########	1,727E+09	2024-09-26 15:17:34.482	0	NULL
CRT_v1.0.0	41.076.305	14.312.927	0	0.0	5	68	64	1	160		########	1,727E+09	2024-09-26 15:17:35.762	0	NULL
CRT_v1.0.0	41.076.099	14.313.050	0	0.0	5	68	64	1	159		########	1,727E+09	2024-09-26 15:17:36.791	0	NULL
CRT_v1.0.0	41.076.035	14.313.085	0	0.0	5	68	64	1	158		########	1,727E+09	2024-09-26 15:17:38.066	0	NULL
CRT_v1.0.0	41.076.065	14.313.067	0	0.0	5	68	64	1	160		########	1,727E+09	2024-09-26 15:17:39.297	0	NULL

All the delays have been recognized correctly and no one was over 5 seconds.

Transmission rate recorded	
Total transmission time in minutes	30 minutes
Percentage of time with no delays	95,51 %
Number of delays recorded	74
Max delay recorded in seconds	2

Table 4-20 Transmission rate test results

4.8 REP_UTMBOX.0080 Simulation of Velocity Obstacle-based methods

This paragraph reports the test of Velocity Obstacle-based algorithm, verifying the correct implementation in the device for GA.
This test has been performed following the steps in table below.

PROC_UTMBOX.0080 Simulation of Velocity Obstacle-based methods			
Step	**Activity description**	**Expected Result**	**Notes**
S_01	**Sending of simulated traffic** The Device Gateway generates a simulated traffic and transmits it to the UTM Box GA via 4G/5G network.	The device receives the simulated data successfully	-
S_02	**Display the traffic and the warning message** Once received the simulated tracks The device displays the traffic and suggested heading and speed to avoid conflict	The Velocity-obstacle method algorithm detects potential traffic interference and generates a warning message The warning messages are also collected on the log file of the device	-
S_03	**Verify the heading and speed displayed in the warning messages**	The message generated from the algorithm includes advise for heading and speed (one or both) and it is provided at least 15 seconds before the potential traffic interference	

Table 4-21 Test procedure UTMBOX.0080

4.8.1 Test execution and results

Date	16th of July 2024
Tester	Francesco Russo

Place	TopView premises
Hardware used	Device for GA, Windows PC
Notes	-

In this test the device for GA has been placed statically on the desk to receive the simulated data from the device gateway and to be monitored by the tester.
The simulated track course from the gateway aimed to intersect the course of the device for GA.
For this test, we configured a simulated route to help activate the algorithm on the device.

Figure 4-41 Paths of the devices: red for simulated track, light blu for Device for GA

As shown in figure Figure 4-42, the device for GA received correctly the data from the device gateway, and in particular:

- INFO Device Gateway connected, which confirms the successfully connection between the device and the gateway
- INFO Device Gateway input line, which appears in the log when a position in the surrounding has been received. This line appears every 1 second to update the position of the detected aircraft.

```
2024-07-16 14:58:42,077 INFO Starting log session.
2024-07-16 14:58:42,149 INFO ADSB/FLARM receiver connected
2024-07-16 14:58:42,150 INFO Device gateway connected
2024-07-16 14:58:42,214 INFO ADSB/FLARM receiver in line:
2024-07-16 14:58:42,247 INFO Device gateway input line:
{"sim":"89123456000074654111","fw":"POL7020_v1.3.4","lat":"41.04369905878949","lon":"14.3282404749732 51","geoid":"30","agl":"0.0","ns":"14","bl":"92","sl":"51","gs":"10.0","gc":"90.2","epoch":"1721134720"}
2024-07-16 14:58:42,325 INFO ADSB/FLARM receiver in line:
{"ver":1,"src":"21-0010057","ts":46722000,"adsb":[{"icao":"ADFD72","sigStr":-80,"sigQ":5,"lat":40.99204,"lon":14.51700,"baroAlt":5225,"geoAlt":5725,"track":237.65,"hVelo":213.1,"vVelo":-128,"ident":"NAVY50
2024-07-16 14:58:42,326 INFO ADSB appended.
{'ID': 'ADFD72', 'LAT': 40.99204, 'LON': 14.517, 'ALT': 1744.98, 'DIR': 237.65, 'GS': 109.61863999999998, 'VS': -0.65024}
2024-07-16 14:58:42,450 INFO ADSB/FLARM receiver in line:
```

Figure 4-42 Connection to device gateway and reception of surrounding flights

The presence of the simulated track trigged the Velocity Obstacle algorithm correctly.
As show in figure, the log gives details of both “Vertical conflict and “Horizontal conflict”.

```
2024-07-16 15:28:20,491 INFO Fix
2024-07-16 15:28:20,495 INFO Visible ADSB aircrafts: 0
2024-07-16 15:28:20,500 INFO Visible drones: 1
2024-07-16 15:28:20,599 INFO Vertical conflict.
Aircraft={'ID': '891222', 'LAT': 41.05047119, 'LON': 14.34908742, 'ALT': 30.0, 'DIR': 228.1, 'GS': 47.83, 'EPOCH': 1721136496, 'VS': 0.0}
2024-07-16 15:28:20,606 INFO Horizontal conflict.
```

Figure 4-43 Warning message in the flight log of the device

As shown in the device’s log, the input parameters are the follows:

- my data= {'LAT': 41.043899, ' LON': 14.335628, 'ALT': 30, 'DIR':90, 'GS': 14.0, 'VS': 0.0}
- Aircraft = {'ID': '891222', Aircraft= 47.83, ' LAT': 41.05047119, 'LON': 14.34908742, 'ALT': 30.0, 'DIR': 228.1, 'EPOCH': 1721136496, 'VS': 0.0}

The algorithm’s returns these output results:

- Time to conflict = 23.0267395210316654 s
- Speed_band= [11,72608695652173, 16,27391304347826]
- Dir_band= [98.72, 80.28]

```
My data= {'LAT': 41.043899, 'LON': 14.335628, 'ALT': 30, 'DIR': 90, 'GS': 14.0, 'VS': 0.0}
Aircraft= {'ID': '891222', 'LAT': 41.05047119, 'LON': 14.34908742, 'ALT': 30.0, 'DIR': 228.1, 'GS': 47.83, 'EPOCH': 1721136496, 'VS': 0.0}
Time to conflict= 23.0267395210316654 s
2024-07-16 15:28:20,645 INFO Speed/Heading bands:
speed_band= [11,72608695652173, 16,27391304347826]
dir_band= [98.72, 80.28]
```

Figure 4-44 Input parameters and output of the algorithm in the flight log of the device

As regards the HMI, using the on algorithm data output (Figure 4-44) the device for GA displayed the information to avoid collision (Figure 4-45)

Figure 4-45 Warning message displayed on the device

This test is passed since the device respected the criteria in terms of:

- Reception of surrounding traffic
- Triggering of the VB algorithm and visualization of suggested heading and speed
- Alert the user at least 15 seconds before the collision (Time to collision > 15 seconds)

However further simulation will be done to confirm the capability of the device in the handling of the algorithm in different conditions. At the same time, we will optimize the visualization of this data, to make them clearer to final user considering also to provide the suggested indications in the proper measurement units (i.e. knots instead of m/s).

4.9 REP_ UTMBOX.0090 E-Conspicuity broadcasting functions verification

This paragraph details the test of e-conspicuity broadcasting functions, with a focus on the device's FLARM transmission and reception for General Aviation (GA). This test has been performed following the steps in table below.

PROC_UTMBOX.0090 E-Conspicuity broadcasting functions verification			
Step	**Activity description**	**Expected Result**	**Notes**
S_01	**Identification of a suitable area for testing** The chosen area for test is the operative headquarter of TopView in Castel Campagnano	The area has no relevant constrains for the test execution	

	The premises have an ADS-B/FLARM antenna installed on the roof. That area is suitable because of: • no ground obstacles (i.e. trees, slopes and buildings) • Open Category Class G airspace where drones are allowed to fly up to at least at 50 meters and up to 120 meters.		
S_02	**Flight planning** We planned a mission to move the drone 100 metres horizontally from the antenna installed on the roof of our headquarter.	Reach at least 1Km in both transmission and reception	
S_03	**Install the UTM Box for GA on a suitable drone.** The drone is capable to transport the device, with enough space for a clean installation of the FLARM / ADS-B and GNSS Antennas.	The mounting adapter is correctly installed on the drone with no influence on operative performance	
S_04	**Fly with a second drone equipped with the ADS-B/FLARM Device** This drone will be flown 50 meters on the zenith of the VHF Ground station	The device on board transmits FLARM signals.	

Table 4-22 Test procedure UTMBOX.0090

4.9.1 Test execution and results

Date	29th of July 2024
Tester	Francesco Russo
Place	San Nicola la Strada
Hardware used	Device for GA, Aerobits HOD, Aerobits ADS-B FLARM Antenna, Windows PC
Notes	-

To test the FLARM features of the device for GA, we used a FLARM transceiver for UAS provided by Aerobits.
This test has been executed with this device on-board in a car, driving in the surroundings of TopView's premises.

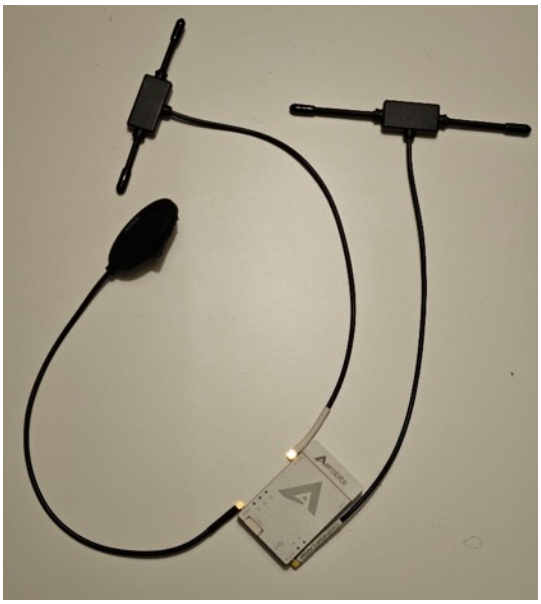

Figure 4-46 Aerobits HOD FLARM transceiver

Once on sight the device for GA detected the Aerobits HOD many times.
The furthest detection was only 281 meters for this preliminary test as shown in parameter “Flarm distances list” in Figure 4-47. I must be noted that the two devices were not in line of sight and the test was performed in a very congested electromagnetic environment (Urban). Better performances in term distance are showed the in rural environment for line-of-sight operations as documented in the following sections.

{"ver":1,"src":"21-0010057","ts":56612272,"adsb":[{"icao":"471F86","sigStr":-86,"sigQ":2,"lat":41.10132,"lon":16.11334,"baroAlt":
2024-07-29 17:43:35,377 INFO ADSB updated. ID = 471F86
2024-07-29 17:43:36,315 INFO Fix
2024-07-29 17:43:36,320 INFO Visible ADSB aircrafts: 0
2024-07-29 17:43:36,322 INFO Flarm distances list= [281.003792534933]
2024-07-29 17:43:36,326 INFO Visible Flarm aircrafts: 1
2024-07-29 17:43:36,341 INFO Vertical conflict.
Aircraft={'ID': '300247', 'LAT': 41.04362, 'LON': 14.32898, 'ALT': 77, 'DIR': 90, 'GS': 7, 'VS': 0.0, 'TS': 1722267815.1870582}

Figure 4-47 Log from Device for GA

Figure 4-48 FLARM devices on the map

The second preliminary test aimed to verify the maximum achievable transmission distance installing the device for GA in the car.
The signal has been received by the ground antenna on a distance of 987 meters (Figure 4-49), the devices' altitude was slightly higher than the office one.

Figure 4-49The distance of devices from ground antenna

Date	4th of September 2024
Tester	Francesco Russo
Place	TopView premises in Castel Campagnano

Hardware used	Device for GA, Aerobits HOD, Aerobits ADS-B FLARM Antenna, Windows PC
Notes	-

We performed two in-flight tests to verify the maximum reachable distance in both transmission and reception of FLARM signal.
To test the FLARM capabilities, we mounted the device for GA on a DJI M300, using a dedicated 3D printed adapter.

Figure 4-50 The device for GA installed on DJI M300

For the same purpose we installed the FLARM/ADS-B Antenna on the roof of our premises to check the signal received using the software provided by the manufacturer.

Figure 4-51 Aerobits FLARM on-ground station

We gradually flew away from the ground antenna, reaching a distance of about 1 Km, without any significant signal issues.

Figure 4-52 The software provided with the ground antenna showed a distance of 1 km.

For the FLARM reception test we used a second drone: DJI M200 with Aerobits HOD Flarm transceiver on-board.
This second drone has been lifted and left in hovering right above our premises, aiming to transmit the signal to the first drone with Device for GA on-board.

Figure 4-53 The second drone DJI M200 with FLARM transceiver

Figure 4-54 The drones used for FLARM reception test

Figure 4-55 The CR algorithm detects another drone in the surroundings

The log of the device shows a result of 1085 meters in the message “flarm distance list”. Approximately the same result was shown on the software.

Figure 4-56 Device log with flarm distance

Figure 4-57 The Device for GA showed on the FLARM Antenna software

Even if the minimum distance required was already achieved, we performed a second test.
This time we took off the drone in a place 2km far from the ground antenna and in line of sight.
The results of first test were doubled with a transmission and reception distance of more than 2 km.

```
2024-09-10 16:06:31,218 INFO Aerobits in line:
{"ver":1,"src":"21-0010057","ts":51539700,"gnss":{"fix":1,"lat":41.19732,"lon":14.43861,"altWgs84":353.6,"altMsl":312.5,"track":353.9,"hVelo":30.5,"vVelo":-0.18,"gndSpeed":[-3.3,30.3],
2024-09-10 16:06:31,590 INFO Attempting to connect to device gateway...
2024-09-10 16:06:32,713 INFO Fix
2024-09-10 16:06:32,718 INFO Flarm distances list= [2084.285669704679]
2024-09-10 16:06:32,719 INFO Flarm relative directions list= [162.3056834040293]
2024-09-10 16:06:32,721 INFO Visible Flarm aircrafts: 1
```

Figure 4-58 Maximum distance of received signal on the log of the Device for GA

Figure 4-59 Maximum transmission distance shown on the ground antenna software