Virtual feasibility tests of the 5G!Drones
Use-case: 4 - “Drone based 5G connectivity extension”

On June 30, 2020 5G!Drones partners NCSRD (located in Athens, Greece), CAFA Tech (located in Tallinn, Estonia) and Unmanned Life (located in Brussels, Belgium) conducted virtual feasibility tests. Due to COVID-19 travel restrictions the tests conducted remotely.

1. CAFA Tech Led Feasibility Tests

NCSRD and CAFA team set VPN connection between NCSRD (Demokritos) server where Drone Command and Control (C2) software UgCS worked and CAFA Tech drone operator in Tallinn. It has been tested with VPN and with Demokritos 5G network.
The main idea of having drone C2 server components in 5G Edge/MEC server is to manage and share resources among many drone operators in a common environment with very low latency.
NCSRD team installed TeamViewer application and sent access details to CAFA. 5G connections were between NCSRD 5G smartphones and NCSRD server. During the Test, all actions and commands have been sent via TeamViewer.

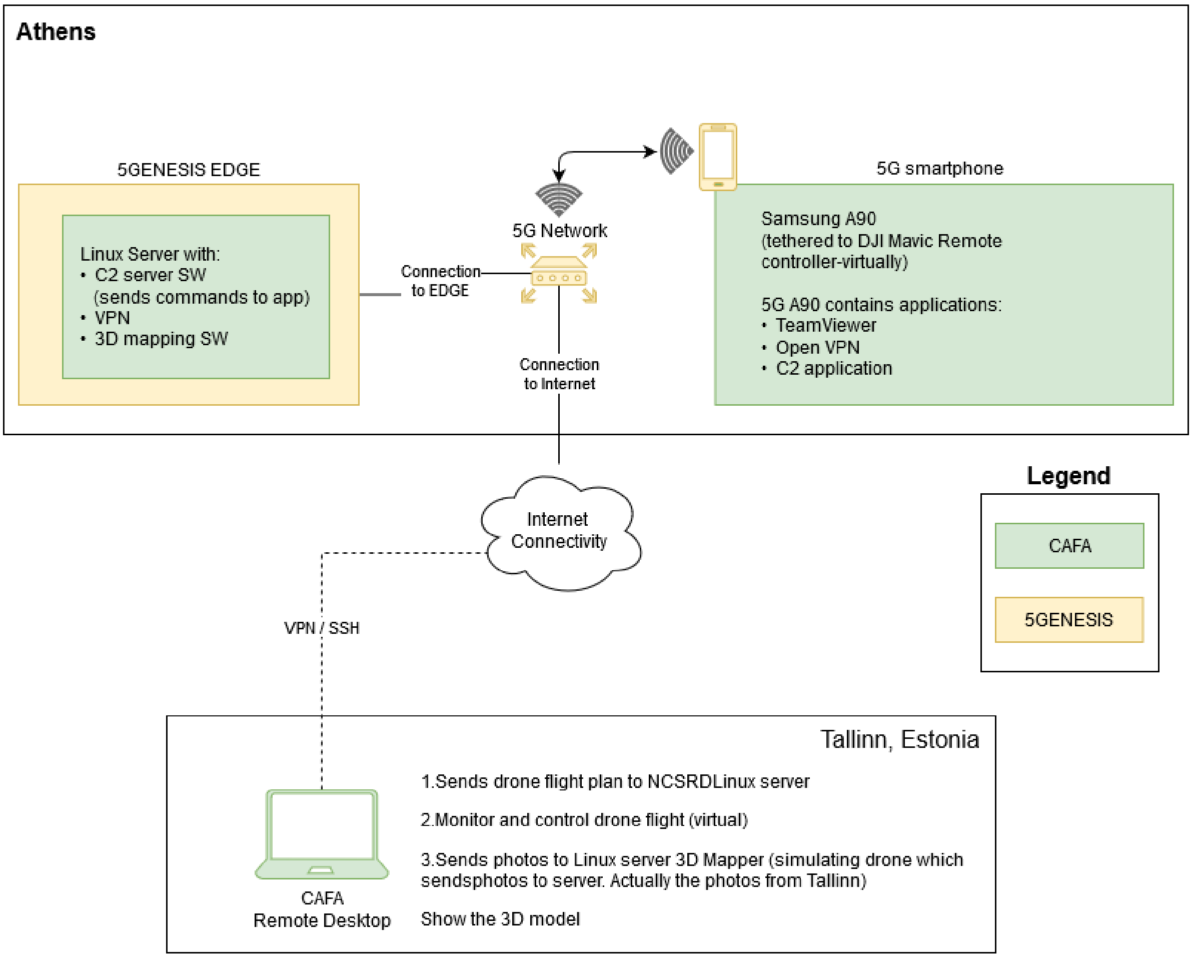

Figure 1 - Setup of CAFA Tech feasibility tests June 30, 2020

The UC4 scenario deals with the case of a mass event at the stadium of the Municipality of Egaleo (Athens). To provide an additional 5G communication resource, a drone carrying a 5G base station is used.

During feasibility tests CAFA Tech team created in NCSRD server the flight plan “STADIUM of Municipality of Egaleo” as shown below.

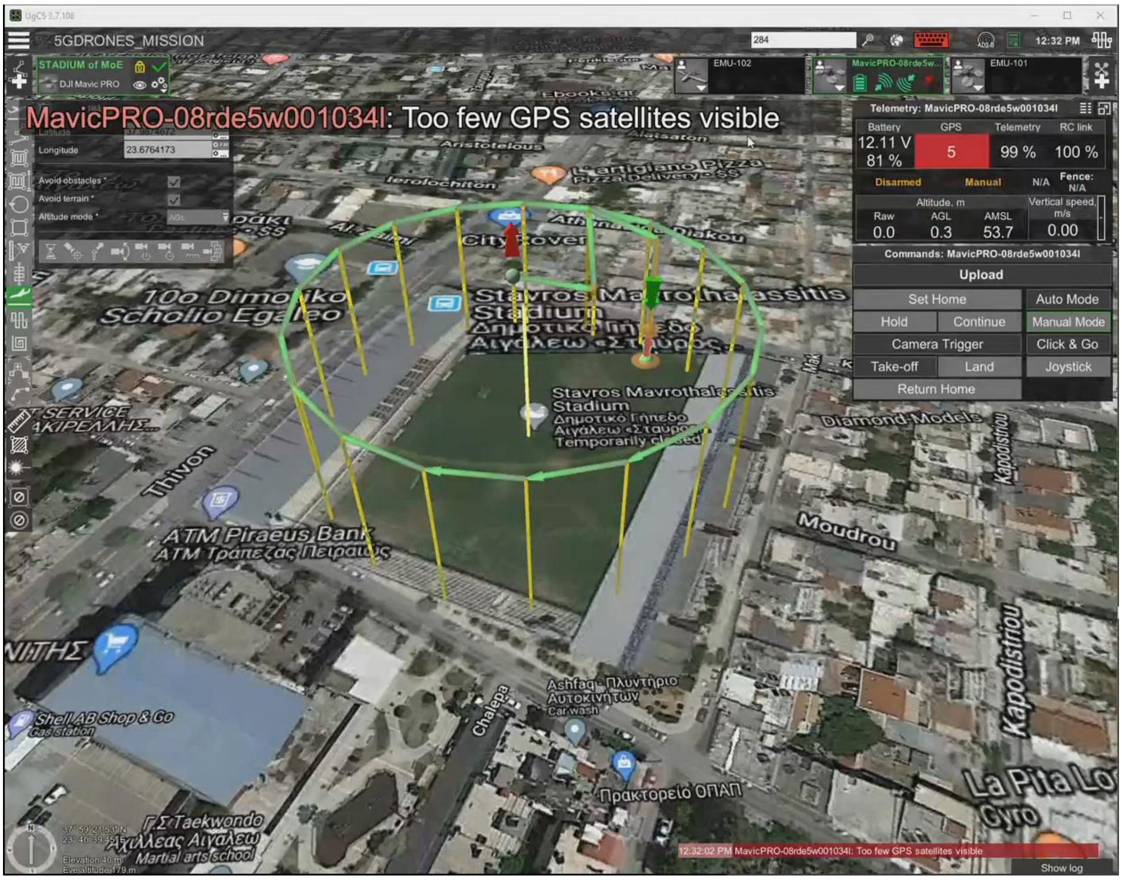

Figure 2 - Drone C2 software showing connected DJI Mavic Pro and flight plan for “STADIUM of MoE”

Then NCSRD server application sent this flight plan via 5G communication channel to NCSRD 5G smartphone which in turn can pass it on to the drone. The flight plan seen on smartphone shown in figure below. Connection was still active between UgCS server application (in NCSRD server) and 5G smartphone as shows green marker after word UCS.

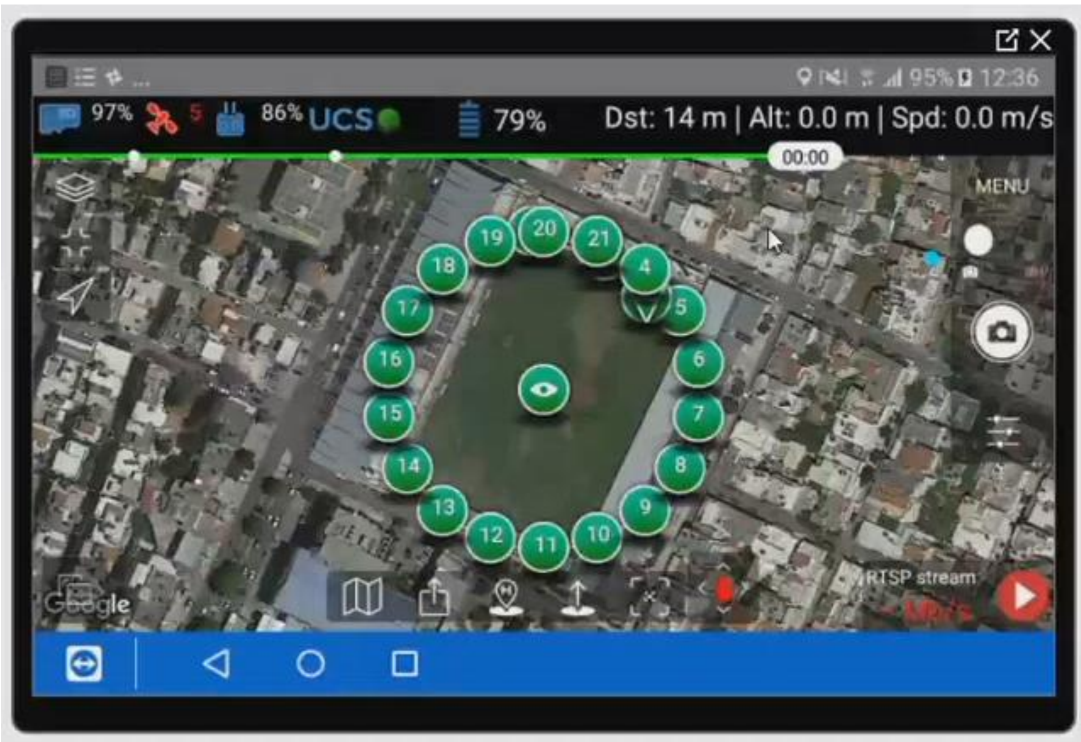

Figure 3 - Samsung smartphone screenshot with flight plan for "STADIUM of MoE”

As there was no drone in the NCSRD testbed, the drone flight was made in Tallinn, Estonia. To this end, a flight plan was created for the drone DJI Mavic using the UgCS application running on the NCSRD server. Then a real flight was made - this flight plan was sent to the CAFA Tech´s A3 smartphone connected to the drone remote control by the NCSRD server. The A3 smartphone transmitted it to the DJI Mavic drone via this drone remote.

June 30, 2020 at 12:35 PM EET, the DJI Mavic drone rose to a height of 4m as shown in Figure 4 below.

Figure 4 - Samsung A3 screenshot with real flight in Tallinn, June 30, 2020

2. Unmanned Life Led Feasibility Tests

Objective

As the other UAS operator for UC4SC1, Unmanned Life also performed a remote feasibility test of the solution.

The primary objective of this feasibility test was to evaluate the ability to communicate between ROS2/DDS nodes over the Athens network. The Unmanned Life platform leverages ROS2 as communication middleware between distributed nodes. ROS2, in turn, uses Data Distribution Service (DDS) as its underlying transport protocol, which is implemented by various vendors.

A secondary objective was to evaluate the performance of these messages at an application level. This is to say that data collected during these tests reflects the performance between two ROS2 endpoints rather than low-level network characteristics.

Execution

UMS and NCSRD coordinated directly to execute feasibility tests on June 30th, 2020. The full feasibility tests were preceded by two iterations of "smoke tests". These smoke tests were intended to validate that the feasibility test architecture would be compatible with the existing NCSRD network architecture.

UMS provided three Docker containers for the purposes of the feasibility test. These were hosted at the NCSRD facility as shown in Figure 5.

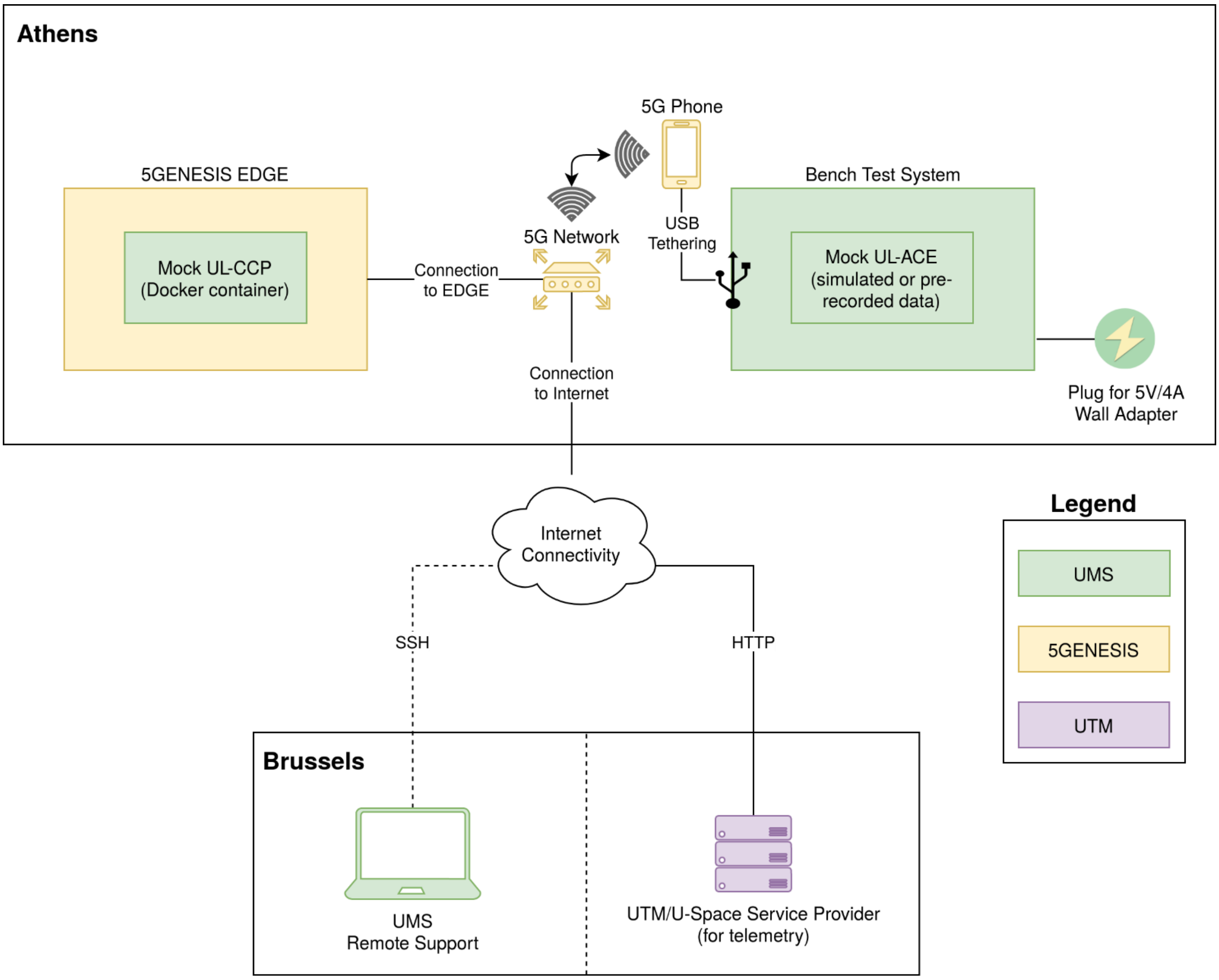

Figure 5 - Description of Unmanned Life feasibility tests June 30, 2020

The **Mock CCP**, hosted at the edge, emulated the Unmanned Life Central Command Platform (UL-CCP). The Mock CCP listens for image & GPS data from the Mock ACE and sends C2 commands.

The **Mock ACE**, hosted on the access side, emulated the Unmanned Life Autonomous Control Endpoint (UL-ACE). The Mock Ace listens for C2 commands and sends image & GPS data.

Finally, the **AFT Base** provided a management container that facilitated starting and stopping data collection as well as modifying test parameters such as publishing rate.

Results

In general, the results from these tests were encouraging for the initial feasibility tests and suggest that running the Unmanned Life platform at the NCSRD facility will be feasible.

Results for all the tests were roughly similar during "normal" operation. A representative example is shown in Figure 6**Error! Reference source not found.**. NavSatFix (GPS) messages typically come in between 80 – 100 ms, Image messages between 100 – 120 ms, and Twist (C2) messages in a much tighter range at 70 ms. Note again that these values do not reflect the true network latency but serve instead to provide a baseline that can be compared against during development.

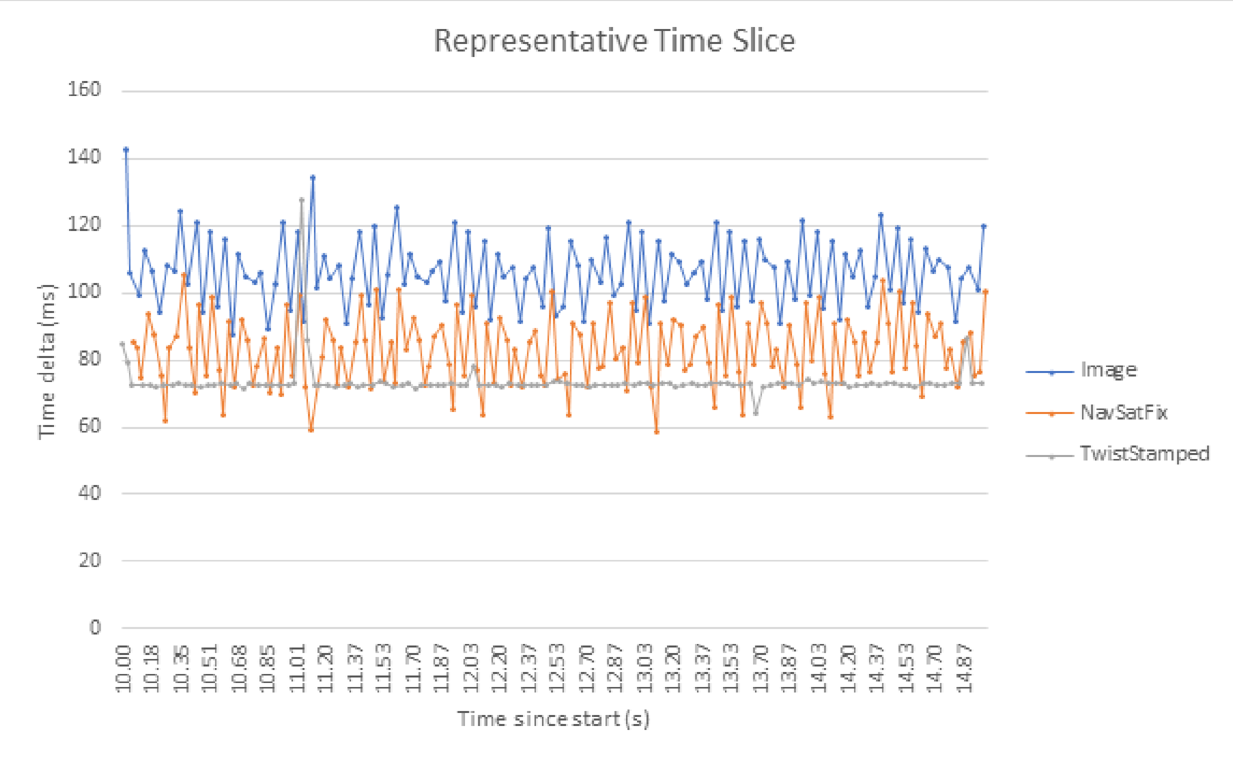

Figure 6 - Representative Time Slice

Conclusion

These results are positive in that ROS2 nodes were able to communicate correctly in the NCSRD facility. This is expected to support the Unmanned Life platform in future tests. These results provide valuable data that will help to tune the ROS2 quality-of-service settings for different streams of data in 5G!Drones trials.

To conclude, the Usecase4 virtual feasibility tests were very necessary because they provided the inputs that needed to be made from the server solutions to prepare for the physical tests. We thank the NCSRD team, whose infrastructure worked flawlessly.