Experiment #2

Drone Communication Systems for PPDR Stakeholders [Flybionic]

Overview and Objectives

Flybionic is a pioneering company that specializes in developing and distributing cellular-based communication systems for drones. Flybionic also offers a comprehensive service solution for fire departments and police forces. Lightweight drones with a takeoff weight of less than 400 grams are used for reconnaissance flights, to assess situations before emergency personnel arrive. Flybionic is dedicated to meeting diverse legislative requirements across various countries, while supporting PPDR stakeholders in their drone operations.

Therefore, Flybionic fits the requirements for the 'drone management' 5G scenario, emulating the evaluation criteria developed for the deployment of Network Applications resembling UC3. The target is to seamlessly integrate a Flybionic drone model into the 5G Berlin Testbed, and fuse it with the UC3 Network Application for full interoperability. Instead of the lightweight fixed-wing drone, a multicopter was used in this case, to test the 5G technology indoors with a flying drone.

5G plays a key role in this use case, by enabling the Flybionic drone model to not only use the designed Network Application, but also take advantage of native 5G functionalities (compared to LTE or other data transmission technologies for drone operation). As an example, increased data transmission capabilities enable operators to view streamed video from a drone in higher quality. Furthermore, reduced latency within a 5G network enhances reliability and reactivity for the drone operator.

The intended utilization of the UC3 Network Application has two main requirements: a video stream transmission in HD quality, and the generation of network performance indicator. For video stream creation, a Flybionic Model with a connected camera and a streaming protocol was chosen. Furthermore, the UC3 Network Application Key Performance Indicator program had to be integrated on the Flybionic drone.

Testbed Readiness

The deployment of the Flybionic drone, outlined in the next section, was straightforward, facilitated by the integrability of drone communication protocols within the UC3 Network Application. All subsequent connections with the Network Application were designed with interoperable interfaces on the application server. Bonding between the 5G network and the application server is reached via standard N6 interface for Data Networks. Hence, establishing a connection from the Flybionic drone to the 5G testbed was the first main working point.

Experiment Deployment

The deployment of the FlyBionic drone, visualized in Figure 1, was done in 2 different scheduled integration meetings. At the first appointment, connection to the 5G testbed was easily reached, but due to client-side routing errors a traffic interruption was regularly occurring, hindering any further integration of the Flybionic drone. After debugging and resetting routing priorities to standard gateways used in the 5G testbed, a stable connection was easily established at the second appointment and further integration could be started.

Firstly, the 5G connection was used to transmit a video stream from the Flybionic drone, due to the interoperability of Flybionic video framework and Network Application streaming framework of UC3, only small changes on network IP and ports were needed for a stable stream. Furthermore, the generation of the network performance indicators was realised, which resulted in the transmission of in-depth network performance information by the Flybionic

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drone. The presented performance indicators range from standard 5G cell information and Quality of Service parameters to actual transmitted data summaries.
Through connecting the drone with the 5G testbed and enabling client-side performance indicator generation, all client-side requirements were fulfilled and a full experimentation with the Network Application was possible.

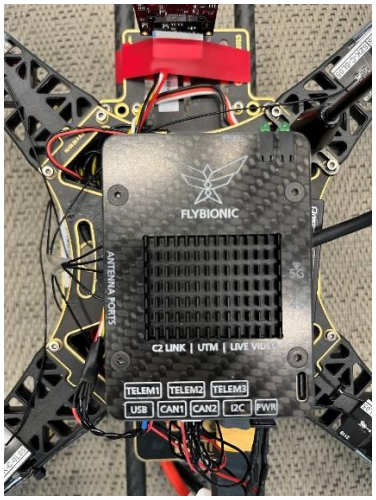

Figure 1: FlyBionic Drone

Figure 2: Drone ready

Experiment Execution and Results

The Flybionic drone was successfully connected to the 5G Berlin testbed and integrated with the UC3 Network Application. Consequently, only a fly experiment was missing for evaluation. Figure 2 shows the Flybionic drone ready for take-off. Figure 3 presents the fully operating Network Application with hosting a webpage for controlling all operations.

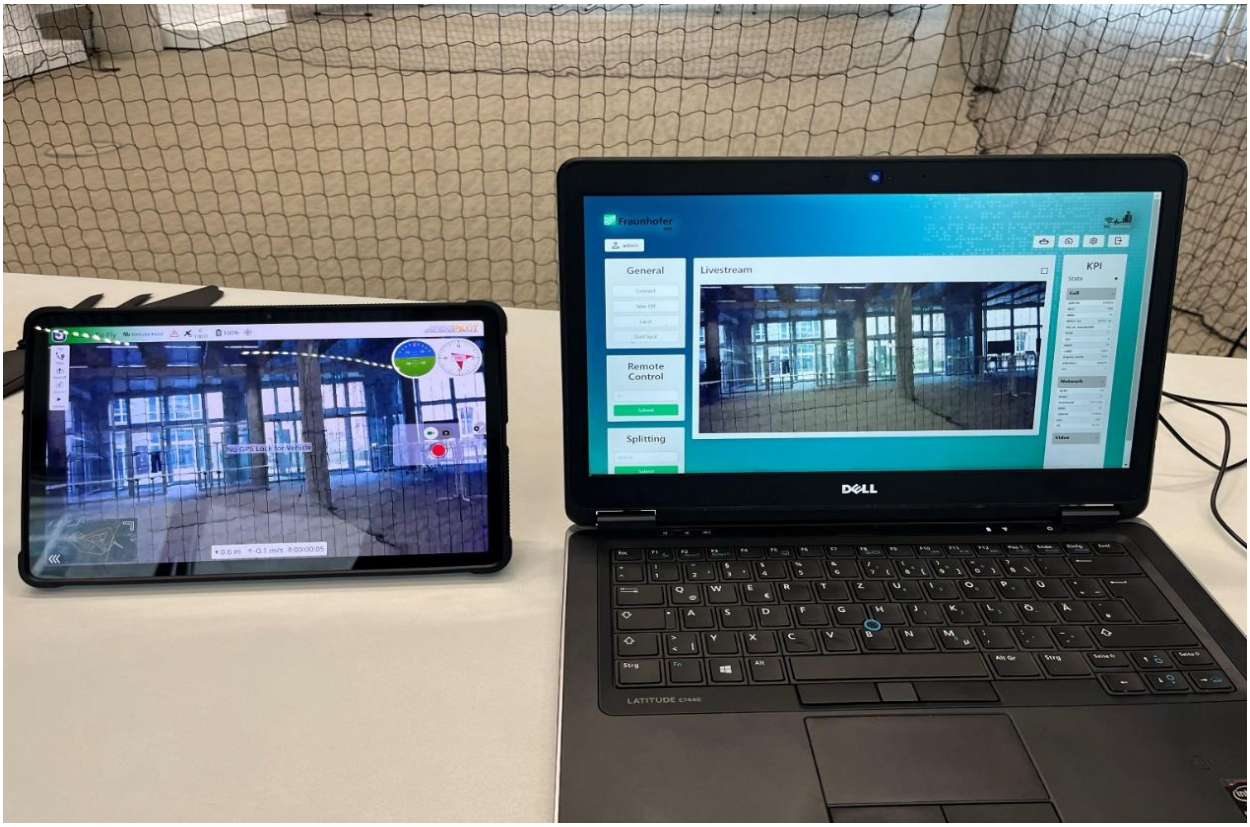

Figure 3: Working Network Application

Firstly, the drone control over the Flybionic model was given via 5G network towards the Network Application and from there, linked towards 5G-enabled tablet which was connected to the same testbed, enabling full 5G speed and latency advantages for drone operation. An open-source control software QGroundControl1 was implemented, aiding at in depth drone navigation. During the experiment execution, all required control and navigation data are served from the drone via the UC3 Network Application, with 5G to the control tablet. Furthermore, the video stream was visible and split to multiple users, including the tablet. Lastly, the required key performance indicators were fetched from the drone, transmitted via 5G towards the Network Application and then presented to the user via in-house developed UC3 WebGUI. **Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε.** shows the drone in full operation, while fuelling the Network Application with all needed information.

[1] QGroundControl is and intuitive and powerful Ground Control Station for the MAVLink protocol, Available Online: https://qgroundcontrol.com/.

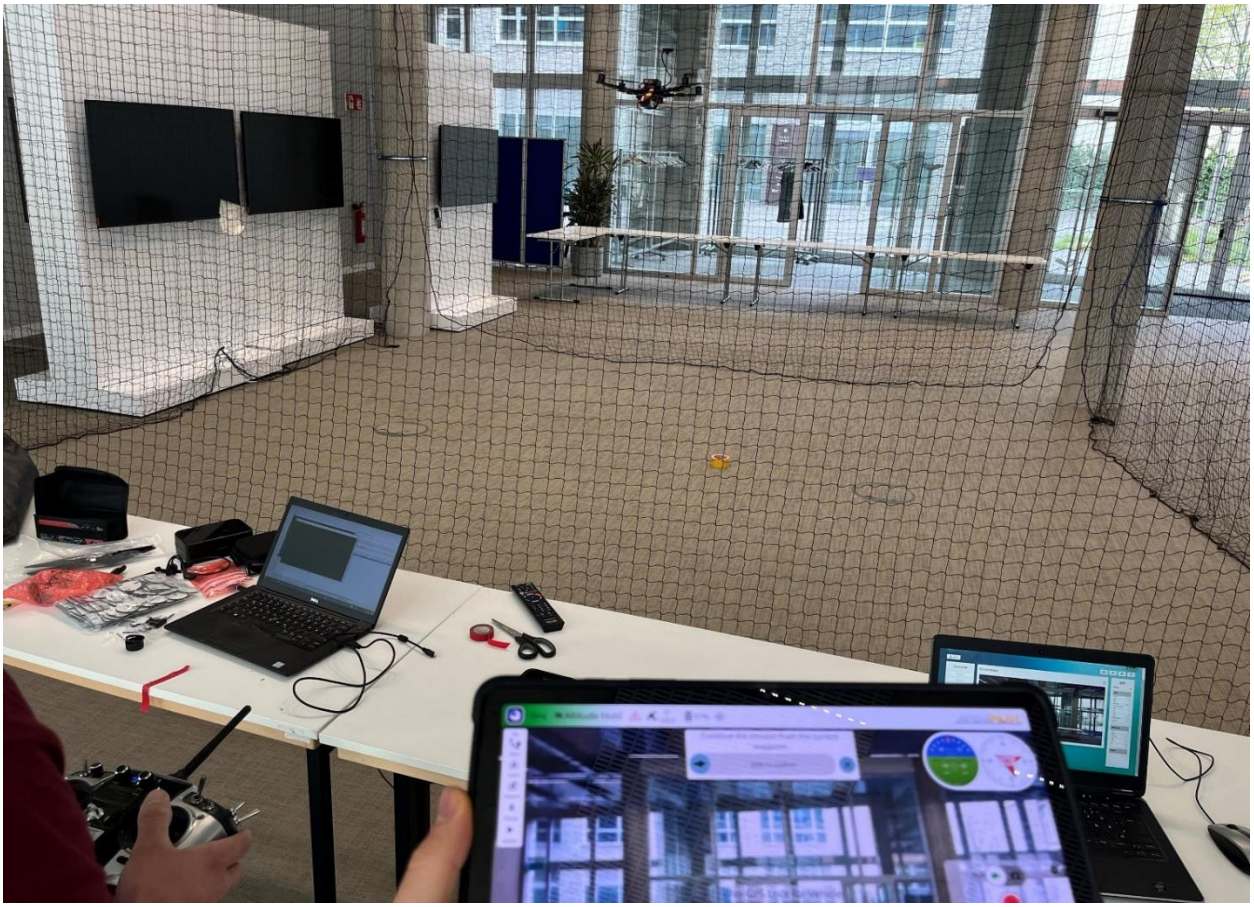

Figure 4: Flying Operation

Subsequently, the external Flybionic drone was integrated in the testbed and connected to the Network Application, resulting in a successful flying operation with all Network Application functions used.

Overall evaluation

The integration of the Flybionic drone in the 5G Berlin testbed, hosted by Fraunhofer HHI, was showcased during multiple integration meetings within April 2024. A special focus was placed on drone integration within the Network Application, with notable results in demonstrating the possible enhancements for all drone models. The fact that the Network Application utilises uniform and standard technologies for all communication interfaces within the current development of drones, enables a wide variety of possible integration methods for all drone models.

For both 5G-EPICENTRE and Flybionic, the integration of an external drone is an opportunity to assess and validate the deployment of individual developed drones and related services within a 5G network. Likewise, it highlights the importance of integrating 5G and the resulting performance enhancements for all drone UC stakeholders.

The most significant challenge was establishing a stable connection to the 5G testbed, as the used communication technology is the most variable setting in all drone operations. As the main lessons learned from this activity, one can identify:

- **Standardized interfaces are a basic requirement to ensure interoperability and seamless functionality and integration**.
- **Efficient 5G communication enables new performance levels for all drone stakeholders**, such as high-resolution video streaming and low latency aiding reliable drone control.

References

[1] Ghost Robotics , "Vision 60," [Online]. Available: https://www.ghostrobotics.io/vision-60. [Accessed June 2024].

[2] ROS, "ROS - Robot Operating System," [Online]. Available: https://www.ros.org/. [Accessed June 2024].