# 6G NeXt - Split Computing for Smart Drones


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***Abstract*—With the rising amount of UAV missions for logistics, agriculture, and other domains, control and anti-collision applications will gain importance. In this paper, we propose a UAV coordination system following a split computing paradigm. Furthermore, a proof-of-concept setup was built, showing promising results for future utilisation of the proposed system.**



***Index Terms*—6G, agile link adaptation, UAV, anti-collision system, quality of service, serverless, edge computing**


## I. Introduction

The utilisation of Unmanned Aerial Vehicles (UAVs) is propagating to new fields of operation such as logistics, agriculture, and natural disaster control. In Europe, the number of commercial UAVs is expected to reach 400 000 by 2050 [1]. This high amount of autonomous traffic will lead to an increasing risk of mid-air collisions, especially in dense air spaces such as airports, where UAVs are taking off and landing.

Research project *6G NeXt*[1] addresses this issue [2], [3]. Through a centralized anti-collision system that monitors the air traffic in a certain area, dangerous situations should be predicted and avoided. The high mobility and large coverage area of drones as well as latency constraints increase the overall complexity of the required system. Whereas fifth generation mobile networks provide a good starting point for the research activity, the requirements of the anti-collision application brings 5G to the limits, requiring further research on the next generation of mobile networks [4], [5].

## II. Smart Drones Anti-Collision System

In our paper, we propose an anti-collision system for UAVs, which relies on predicting the flight paths of all vehicles in a certain area. On the one hand, the prediction algorithm is greedy for processing power. Since high processing power means also heavy equipment, it is advantageous for a UAV to offload the prediction computations to a ground-based server in order to reduce the take-off weight. On the other hand,

[1]https://www.6gnext.de/

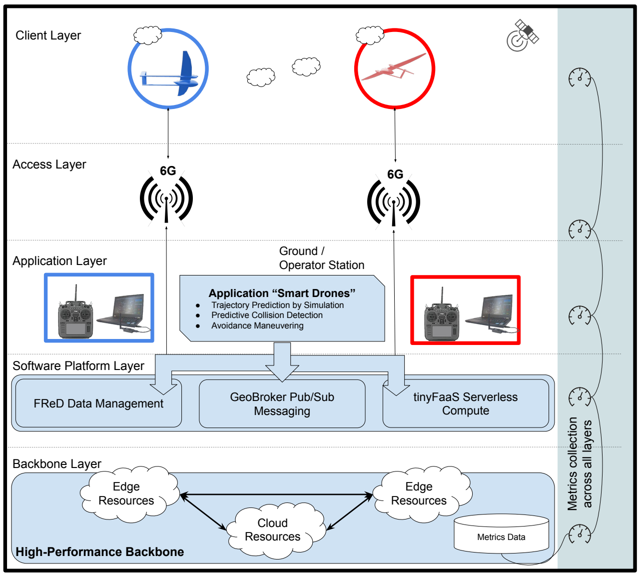
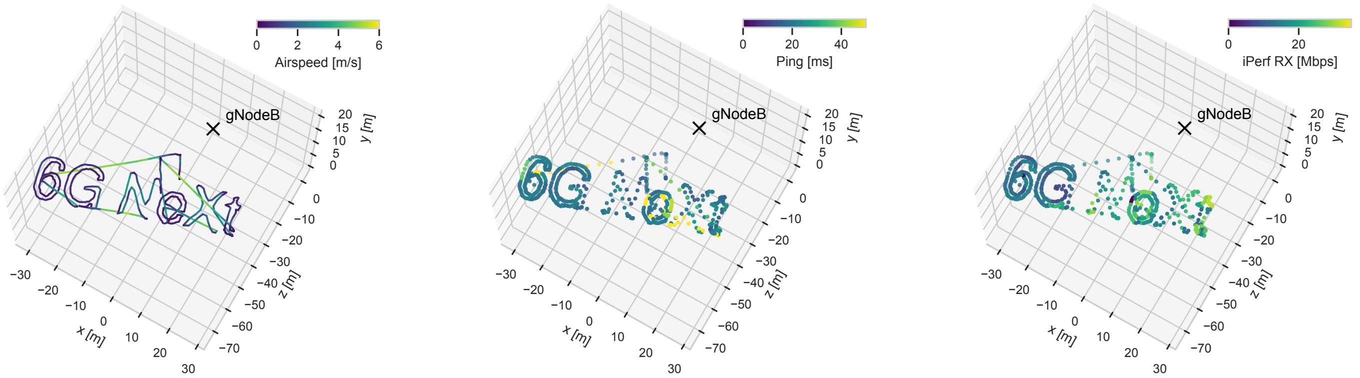



Figure 1. Architecture of a smart drones anti-collision system [3]

the UAVs need to coordinate their flight maneuvers with each other. Thus, a centralized processing entity would also increase the level of coordination between the UAVs. For these reasons, we propose to split the control application into client and server part, as illustrated in Fig. 1:

- **UAV Controller**: UAV-based flight controller, which requests the mission data from the Ground Station and reports the telemetry data (position, elevation, velocity, direction) back to it.
- **Ground Station**: ground-based simulation engine, which captures the flight data from UAVs, performs the anti-collision-prediction and commands the involved UAVs in case of harm probability.

The connection between UAVs and the ground station is provided by a 6G mobile network, which should be able to provide the low-latency, stable, and reliable link for each




(a) Flight path and airspeed (b) Network latency measurement (`ping`) (c) Network throughput (`iperf` receive)

Figure 2. Proof-of-concept measurement results

involved UAV. Note that the large flight range of UAVs may require several base stations for continuous coverage, while their high speed makes the management of network traffic between UAVs and the ground complex. To mitigate this issue, we propose to utilize a distributed serverless edge-cloud infrastructure [6]. Utilizing an additional geo-aware abstraction layer, the procedure of messaging as well as computational distribution can be mitigated.

## III. Proof of Concept

According to the architecture proposed in the previous section, we set up all required systems to perform multiple proof-of-concept flight tests at Rangsdorf model air field in Germany. Our UAV is a custom-designed quadcopter equipped with a *Cube Orange/+* flight controller and a *Raspberry Pi 4B* with 5G/6G connectivity through a *Quectel RM500* modem. For 5G/6G network connectivity, an OAI-based gNodeB setup for campus networks with an *NI Ettus USRP X410* was used. Our ground station software ran on a local edge server.

During the flight, the UAV mission was entirely controlled by the ground station over the 5G/6G network. Besides mission waypoints, the UAV was instructed to perform mobile network latency (`ping`) and throughput (`iperf` downlink and uplink) tests over the 5G/6G link. Results and telemetry parameters, such as location and airspeed, were collected, as we show in Fig. 2.

The degradation of throughput and latency correlates with the distance between the base station and UAV as well as its airspeed. However, there exist some points where the link degradation cannot be explained with an increased distance. These spots may get critical, especially if at this position the drone would be commanded by a ground station to perform an anti-collision maneuver. Understanding these effects is paramount to mitigate dangerous situations.

## IV. Conclusion & Future Work

In our paper, we described the idea of the integration of the future-oriented 6G network and advanced compute infrastructure to support a smart drone anti-collision system. We provide a brief overview of the required software and hardware components and how they interact with each other to provide the best performance to the overall system. Besides, we performed a proof-of-concept flight, during which a drone was successfully controlled solely via a stable 5G/6G link while performing network tests and reporting telemetry data.

The tests showed promising results on the quality of the wireless connection between the UAV controller and the ground station. Nevertheless, our measurements showed some spots with weak link condition, which should be further mitigated. Using channel state prediction, such spots might be indicated and the reliability of the link might be increased by proactively switching to a more robust link configuration scheme. This is a part of the future work.

Further, we plan to step beyond the proof of concept. Setting up a fully functional anti-collision system would provide the possibility to verify the requirements on latency and reliability of the communication link. Here, the anti-collision algorithms will be further adjusted to the link parameters to increase robustness to the link degradation, especially with higher speeds and a higher number of UAVs sharing the airspace.

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