DRONE INTEGRATION INTO AIRSPACE

A groundbreaking German project to identify and track drones could form the basis of Europe's unmanned traffic management system for unmanned aircraft

By Ralf Heidger, head of UTM development at DFS Deutsche Flugsicherung

In just a few years, drones, or unmanned aircraft systems (UAS), have developed into a true mass market. DFS Deutsche Flugsicherung, the German Air Navigation Service provider, estimates that there are about 500,000 drones in use in Germany alone. Drones already have multiple applications in industry, construction, agriculture and forestry management, but are particularly useful for the police, fire and rescue services.

Drones provide more benefits and will become commonplace when they can operate beyond the visual line of sight (BVLOS). However, drones also pose risks, especially for manned aviation. Unlike most commercial aircraft, drones do not actively transmit their location and are too small to be picked up by radar or the other sensors normally used in aviation. This is why DFS and the German telecommunications provider, Deutsche Telekom, joined forces in a research project named Connected Drones. The aim of the project was to use the mobile network to locate drones so that they can be integrated into airspace – safely and fairly.

In this way, the project turned the drone into a flying smart phone. Using a LTE modem and a sim card, the drone connects to the mobile network and transmits its exact 4D position and identification. This data is sent to DFS, tracked and fused in the Phoenix tracking system, combined with the data of manned aircraft, and displayed in the mobile and web displays of the UAS Traffic Management System (UTM).

Today's mobile networks are optimised for ground usage. Therefore, the project team started testing the mobile network intensively to prove it worked for the needs of UAS as well.

In May 2019, the two companies successfully transferred the Connected Drones project to a new business, Droniq, a joint venture between DFS and Telekom.

Functional layers of traffic management

UTM and air traffic management (ATM) can be distinguished from each other as regards the allocation to specific airspaces and the differences in the paradigm under which they operate. However, they have a common functional structure as depicted in the functional pyramid of command, control, and communication systems (C^3 systems). The functional layers are built on top of each other, beginning with registration, mapping and tracking. Above these, there are higher traffic management functions like mission planning, processing of environmental data, conflict detection and resolution, traffic flow prediction and eventually congestion management and user-specific HMIs as the uppermost layer.

Challenge for the aviation system

UAS represent a disruptive technological challenge for the aviation system and for ATM because they involve new flight technologies with a high potential for automation. In addition, the UAS market is growing fast, with a rate often in double digits. The expansion of applications and the increase in the number of units is happening in all directions, and numerous current aviation business models may change fundamentally, end up becoming obsolete or being replaced by new systems.

Very low-level airspace users

Most UAS will operate in very low-level airspace (VLL) in uncontrolled Class G airspace between 100m and 150m above ground, depending on the established rules and concept of operations. This airspace is used by various participants, for example, visual flight rules (VFR) pilots, helicopters of the emergency services and police as well as air sports. The danger of collisions poses a serious risk. "Keep well clear" and "see and avoid" under ICAO rules, which are already difficult and demanding to apply, are almost impossible because UAS are so small.

Integrating UAS

Controlled airspace (Class C, D and E) is primarily used by manned aircraft under instrument flight rules (IFR) and VFR. Nevertheless, it has been and will continue to be used for UAS missions, such as inspections of airports by UAS, military UAS operations, crossings of controlled airspaces for climbs to very high-level airspace or descents, as well as possible future UAS missions for freight and perhaps the transport of passengers. UAS operations are also expected above controlled airspace, such as meteorological station keeping, survey flights and long-term missions.

In the view of DFS, these UAS missions will need to be integrated into ATM systems,

Above: Flying drone with the LTE transponder and antennaes for example for ADS-B and FLARM attached (Image: Droniq)

Left: Functional pyramid of traffic management systems applied to UTM (Image: DFS)

including appropriate label display, mission processing and coordination with other aviation users. Enhancing ATM systems with drone flight plans and tracks will allow that integration. UAS already have to be equipped with a transponder for identification, surveillance and tracking in Class E airspace from 5000ft as well as in controlled airspace.

UTM as an end-to-end solution

The UTM by DFS offers services that are fundamental to the safe operation of UAS in airspace for all phases of flight. In the pre-flight phase, operators can register themselves in the UTM and plan their missions. They can also double-check them: Are there any no-fly zones or airspace restrictions? Are there any other registered flight movements? Do I need to obtain permission to conduct operations or a Specific Operations Risk Assessment?

If a permission from the responsible aeronautical authorities is needed, the UTM provides a workflow-based approval procedure between them and the operators. In addition, the UTM system continuously processes additional external data, in particular, meteorological data, chart data, geodata, obstacle data and NOTAM feeds, filtered for UAS. In the in-flight phase, operators can track their drone in real time and observe other aircraft, both manned and unmanned, in a combined air situation display, including those outside the visual line of sight of the pilot in the field. The UTM components in the post-flight phase help to assess and follow up on the flight, with logbook entries, incident management, battery management, for instance.

The need for a web-based, scalable cloud solution

Due to their operational characteristics, UAS are part of aviation, which traditionally has slow and considered innovation. However, technologically drones are more similar to the smartphone market – both are exposed to disruptive, fast-moving trends. The increasingly large number of UAS, operators and other stakeholders makes a web-based UTM solution more significant. As UAS pilots in the field will also be among the users who need situational awareness, mobile app human machine interfaces on smartphones or tablets must also be taken into account. This naturally leads to having a web-based, scalable cloud solution.

Safety and visibility in very low-level airspace

It is interesting to observe that the appearance of UAS in very low-level airspace increases the focus on the visibility of manned aircraft in this airspace. Manned aircraft in Class G airspace are not obliged to identify themselves, and ANSPs usually do not have an ATC mandate here.
For their own protection, a low-cost grassroots ATC based on ADS-B and traffic

Left: The ground based situational awareness system (GBSAS) receives the position data for example of other aircraft in the surrounding airspace (Image: Droniq)

Below: DFS and Deutsche Telekom trialed a drone flight out of sight together with the German life-saving society DLRG and watched the drone flight on the air situation display (image:DFS)

awareness and collision avoidance technology FLARM has developed among users over the past ten years. These technologies can now be used to complete the air situation display step by step. The UTM approach of DFS is therefore not just useful for UAS – it is also a means to increase safety and visibility in very low level airspace.

Central digital platform

The UTM system is available at Droniq as a first version that contains a live traffic display, registration and mission planning. UAS tracking functions via a device developed in-house with a modem and an integrated SIM card, and mobile or fixed ground sensors. The next step is to fully integrate the modem into the UAS.

In view of the potential risks of drones, there is a need for drone detection systems to secure sensitive areas such as airports. The multi-sensor data fusion tracker of the UTM means it is possible to incorporate any drone detection system and to separate between registered and rogue UAS. Functions such as mission clearance, conflict warning, integration of the command and control link and real-time data transfer via LTE are planned in the near future. DFS and Droniq's vision is to set up a central digital platform for UAS services in Germany, which could become a blueprint for Europe.

Change of the aviation system

Extensive discussions are taking place in the European Commission, in SESAR and with EASA about the future of UTM deployment architecture and the role of ANSPs and their relationship to the future third-party UTM service providers (USPs).

DFS foresees a national UTM in the hands of the ANSPs, at least for the core functions of registration, surveillance integration and tracking as well as for reference AIM data and meteorological information provision, where a single source of truth is needed. UTM covers a large range of topics and there is room for functions such as fleet management, and payload services for the competitive marketplace. The market is at the beginning of a long development path and our future will see a fundamentally changed aviation system. ❖