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SHARING THE SKY

DLR is conducting research to ensure safety in rapidly changing airspace

By Dagi Geister

A freight drone delivers a consignment of goods to the front garden of a detached house. Up above, autonomous air taxis fly commuters to their workplaces in the city. Small unmanned aircraft hover over road junctions in the inner city, detecting traffic volumes and disruptions before feeding the information into a central traffic control system. Although the scene might sound as if taken from a science-fiction film, this futuristic scenario is already becoming a reality – at least partly. In Singapore, drones transport work materials to ships as part of the 'Skyways' project, while in cities like Dubai, Vienna and Ingolstadt preparations are now under way to carry people by air taxi. Yet regardless of what is technologically and economically feasible, one key issue remains to be resolved. How can the safety of air transport users and people on the ground be ensured in an airspace simultaneously occupied by manned and unmanned aircraft?

The integration of Unmanned Aerial Systems (UAS) into the airspace system is becoming increasingly significant. The media often report on dangerous encounters between drones and manned aircraft or helicopters. Several such incidents have also occurred at airports. As a result, Germany's Federal Government made its first attempts to regulate the system in 2017, initiating laws such as the Drone Regulations (Section 21a/21b of the German aviation regulations, LuftVO). These prohibit drones from flying in sensitive zones – near airports or locations where police and fire brigades are on the scene. Yet these measures are limited and do not cover the normal requirements of a growing aviation sector. In particular, operators of small and medium-sized unmanned aircraft (>25 kilograms) are very interested in flying permits. Scenarios range from hobby use to a variety of commercial applications (infrastructure monitoring, parcel delivery, agricultural support), as well as official deployment (civil defence, rescue operations). At present, however, there is neither a fully defined legal framework nor an established infrastructure to enable and safely manage the widespread use of UAS in general airspace.

Today's UAS are used for a variety of missions and applications. To meet the various requirements they vary in size – from quadcopters to medium-sized unmanned helicopters and larger, fixed-wing aircraft – and performance (manoeuvrability and collision avoidance ability), as well as technical characteristics (sensor systems and degree of autonomy). The challenge is to safely plan and monitor the flight movements of UAS with such different characteristics within airspace that includes other air traffic users, such as helicopters, gliders and skydivers.

Looking further into the future, the urgent need for intelligent rules becomes even clearer. According to a study by the SESAR (Single European Sky ATM Research) Joint Undertaking published in November 2016: "By 2050, it is estimated that there will be some 7 million consumer leisure drones in operation across Europe, including a fleet of 400,000 drones offering important services across the agricultural, energy, e-commerce, transport as well as public sectors." Drone fleets for parcel services and infrastructure monitoring will play a major role in this regard, but interest in air taxis is also growing. This requires special safety measures.

As such, the integration of UAS into airspace requires a comprehensive solution. In the long term, it must ensure safe and efficient operation – even for the widest range of air-traffic participants and when traffic volumes are high. Depending on the airspace category and drone's mission area, the airspace under consideration will define specific requirements for those involved. Flight rules and minimum separations must be observed, and aircraft must be equipped with transponders depending on the airspace category. Flight in urban areas requires the consideration of various other aspects. Complex obstacle scenarios place high demands on detection systems and UAS flight capabilities, and there are additional risk factors – such as crowds, critical infrastructure, areas with high probabilities of signal loss, or downdrafts – for which flight restrictions or even no-flight zones may have to be imposed.

Data protection is another key concern. The cameras on UAS acquire data that could be misused –a potential problem that could be detrimental to their acceptance by the general population. Noise, emissions and environmental factors also play an important role. All of these aspects must be considered and used to devise a viable concept that accommodates safety, cost-effectiveness, technical feasibility and societal concerns.

REQUIREMENTS OF AN AIR TRAFFIC MANAGEMENT SYSTEM INCORPORATING UNMANNED AIRCRAFT

The tasks of classic air traffic management (ATM) also apply in unmanned traffic management (UTM). This covers the optimal use of the available airspace (airspace management, ASM), air traffic flow management (ATFM) and operational air traffic services (ATS). As such, UTM should enable safe and efficient UAS operation in lower airspace (below 500 feet) in the medium term and in controlled airspace in the long term. This will require services such as:

- airspace organisation and management, including geo-awareness (notification of prohibited or restricted airspace areas),
- the planning and approval of UAS flights,
- dynamic capacity control,
- route planning and route changes,
- contingency management,
- separation, conflict and emergency management,
- weather and wind restrictions, and
- terrain and obstacle mapping.

DLR expertise for future air traffic management

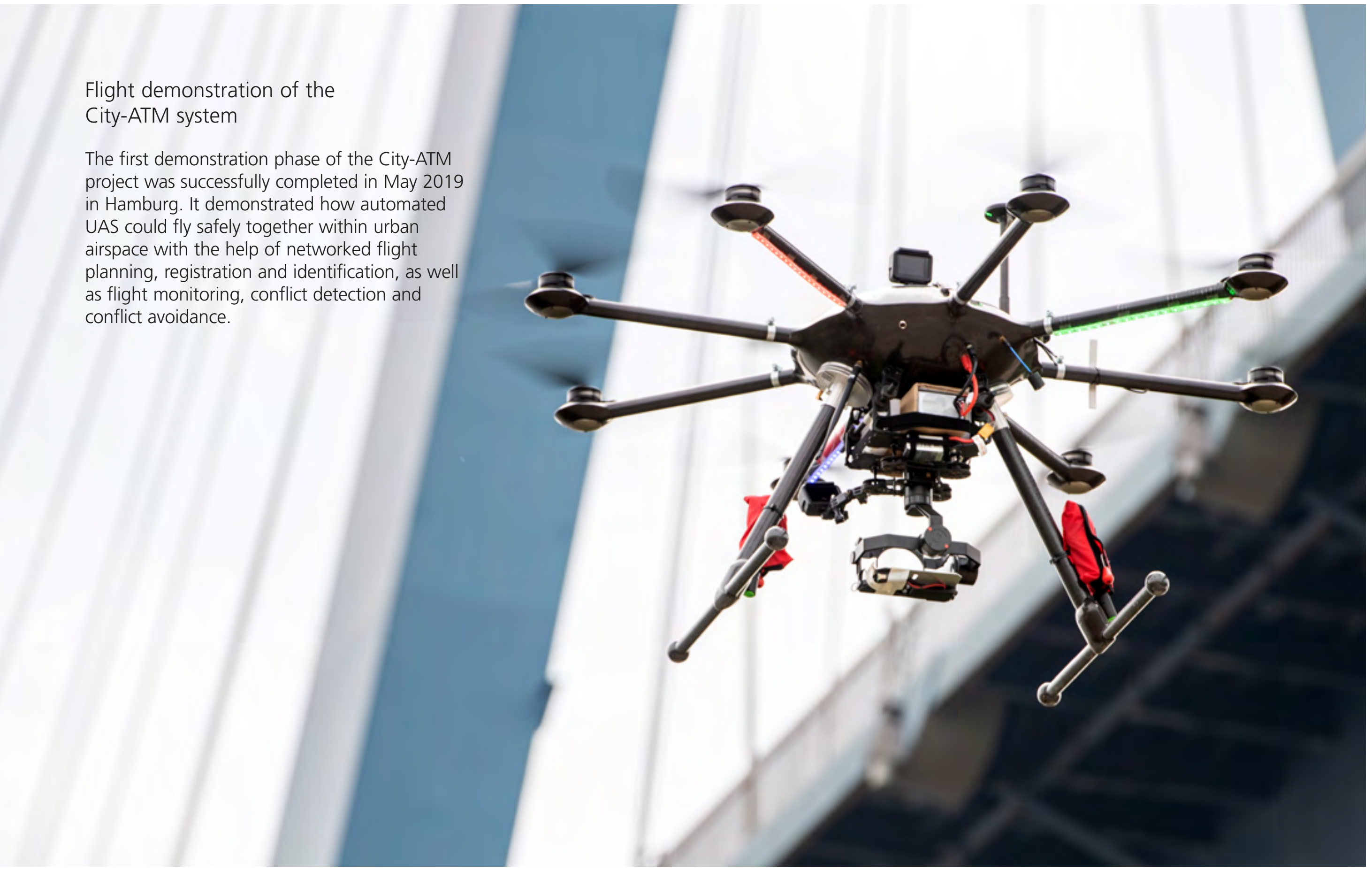
The DLR Institute of Flight Guidance has been conducting research into concepts and technologies to integrate UAS into airspace for many years. In early 2018, it presented a concept for a flexible, Europe-wide airspace management system, referred to as U-space. This opens up airspace to UAS with both low and high levels of technology. At the same time, it provides incentives for UAS manufacturers and operators to invest in the new technology, but does not prevent minimally equipped and lower-performance airspace users from entering U-space. The concept is based on efficient airspace segmentation and models for UAS performance. Airspace characteristics – population density, land use, geofences, availability of U-space services, and the occurrence of traffic operating under visual flight rules – are used to divide up the airspace into cells with similar use requirements.

According to the DLR concept, the lower the overall performance capability of the airspace participant, the greater the safety distance and the bigger the airspace area required for its exclusive use. This means that an airspace area could be used simultaneously either by a few low-performance aircraft or by several high-performance aircraft. The resulting airspace management would offer a great deal of freedom when traffic volumes are low, but little freedom when they are high. This would allow the U-space to be organised safely and efficiently. Conflict-free routes and missions could be strategically planned and monitored – even in dense traffic scenarios.

As part of its national City-ATM project (Demonstration of Traffic Management in Urban Airspace), DLR is working on a concept for the management of urban airspace. It should enable the safe and efficient integration of new air traffic participants, such as UAS and air taxis. This includes defining and verifying operational and technical concepts for airspace management and providing information. Traffic flow management, monitoring traffic for possible conflicts and developing basic concepts for a communications, navigation and surveillance infrastructure must also be considered. A simulation and demonstration platform for an urban air traffic management system is being devised on this basis. This assists with identifying and realising unmanned aircraft configurations that can operate safely in these environmental conditions and in accordance with the new regulations. DLR researchers are hoping that the project will bring together many stakeholders – including UAS manufacturers, urban traffic management system providers, aviation authorities and drone operators – in order to develop a comprehensive solution for the integration of (partially) automated aircraft into the airspace.

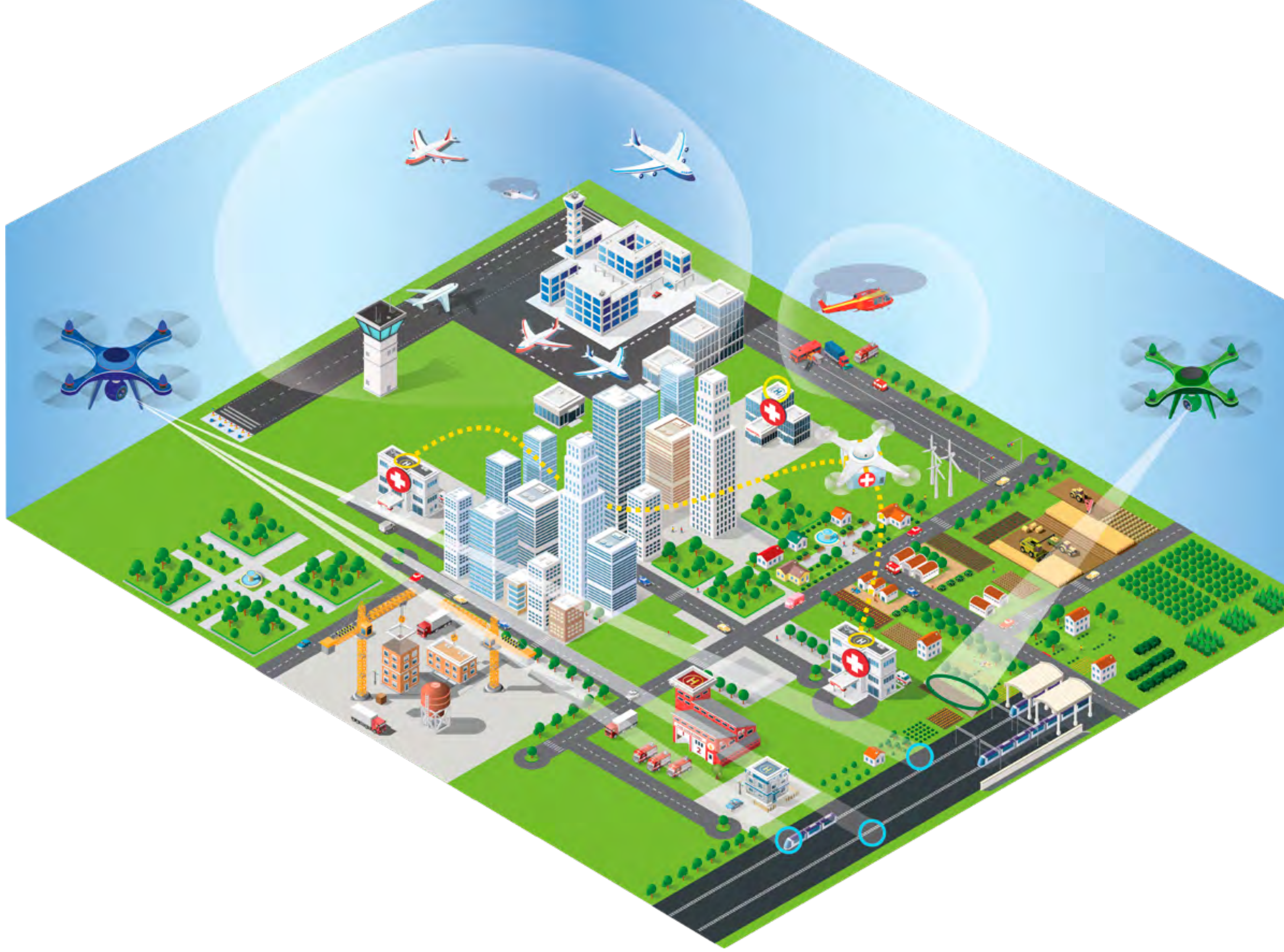
The three-year City-ATM project was launched on 1 January 2018. It is based on the European SESAR U-space programme. Ultimately, City-ATM is intended to demonstrate a comprehensive solution for a future U-space.

Dagi Geister heads the research group for unmanned aerial systems (UAS) at the DLR Institute of Flight Guidance in Braunschweig. She addresses research questions concerning the integration of UAS and air taxis into airspace, and is involved in numerous European committees and initiatives for the design of U-space and Urban Air Mobility.



Flight demonstration of the City-ATM system

The first demonstration phase of the City-ATM project was successfully completed in May 2019 in Hamburg. It demonstrated how automated UAS could fly safely together within urban airspace with the help of networked flight planning, registration and identification, as well as flight monitoring, conflict detection and conflict avoidance.



Design of manned and unmanned airspace use (SESAR U-space Blueprint)

REGULATIONS FOR U-SPACE

On 11 June 2019, the European Union Aviation Safety Agency (EASA) published new regulations (DELEGATED REGULATION (EU) 2019/945) aimed at harmonising the rules for drone flights throughout Europe. These are to be enacted as national law by June 2020. In particular, they will replace the current rules for the operation of drones under Sections 21a and 21b of the German aviation regulations (LuftVO). The major changes enacted by these new regulations have a particular bearing on the subdivision of UAS missions into the categories of OPEN, SPECIFIC and CERTIFIED. In the OPEN category, UAS can fly without authorisation in EU airspace areas designated for that purpose under strict operational restrictions. In contrast, the SPECIFIC and CERTIFIED categories have operational and technical requirements due to their respective mission risks, which generally require approval by a competent authority. In addition, all UAS must bear a CE mark following a transitional period of two years.

Other regulations relate to the future use of U-space – the airspace allowed for drone flights (up to 500 feet above the ground). These rules will cover the structuring of the airspace, the different airspace categories and the types of drone flight permitted within them under various conditions. They will also provide for basic services (information and capabilities) to safely and efficiently manage large numbers of UAS within airspace.

An initial draft of the U-space regulations is available and should be presented by EASA in the fourth quarter of 2019. It is important to note that the fundamental idea of U-space in the long term envisages the integration of manned and unmanned air traffic. As such, this will eventually affect the airspace currently reserved for manned air traffic. The design of future airspace and the associated impact on air traffic must therefore be carefully considered now.