



U-space

Blueprint

The demand for drone services is steadily increasing, with the potential to generate significant economic growth and societal benefits¹, as recognised in the 2015 EU Aviation Strategy², and more recently in the 2016 SESAR Drones Outlook Study and Warsaw Declaration on drones³. In order to realise this potential, the declaration calls for “urgent action on the airspace dimension, in particular the development of the concept of U-space”. Ultimately, U-space will enable complex drone operations with a high degree of automation to take place in all types of operational environments, including urban areas. U-space must be flexible enough to encourage innovation, support the development of new businesses and facilitate the overall growth of the European drone services market while properly addressing, at EU level, safety and security issues, respecting the privacy of citizens, and minimising the environmental impact. This blueprint outlines the proposed vision for U-space and how it could be rolled out. Rather than providing a definitive solution, this blueprint provides the basis to better define the way drones will operate in Europe in the future.

What is U-space?

U-space is a set of new services and specific procedures designed to support safe, efficient and secure access to airspace for large numbers of drones. These services rely on a high level of digitalisation and automation of functions, whether they are on board the drone itself, or are part of the ground-based environment. U-space provides an enabling framework to support routine drone operations, as well as a clear and effective interface to manned aviation, ATM/ANS⁴ service providers and authorities. U-space is therefore not to be considered as a defined volume of airspace, which is segregated and designated for the sole use of drones. U-space is capable of ensuring the smooth operation of drones in all operating environments⁵, and in all types of airspace (in particular but not limited to very low level airspace⁶). It addresses the needs to support all types of missions⁷ and may concern all drone users⁸ and categories of drones⁹.

The delivery of U-space adopts the following key principles:

- To ensure the safety of all airspace users operating in the U-space framework as well as people on the ground.

¹ SESAR Drone Outlook Study (2016)

² <http://ec.europa.eu/transport/modes/air/aviation-strategy/innovation>

³ The High Level Conference on ‘Drones as a leverage for jobs and new business opportunities’ took place 23-24 November 2016 in Warsaw, Poland and concluded with the so-called “Warsaw Declaration”.

⁴ ATM: Air traffic management; ANS: Air navigation service

⁵ Urban, suburban, rural, regardless the density of population

⁶ Very low level airspace refers to the airspace below 500ft

⁷ Including visual line of sight (VLOS) and beyond visual line of sight (BVLOS) operations

⁸ Including commercial and leisure users as well as State (including military) and public entities with appropriate prioritisation for special missions

⁹ Open, specific and certified as defined in “Prototype” Commission Regulation on unmanned aircraft operations

- To provide a scalable, flexible and adaptable system that can respond to changes in demand, volume, technology, business models and applications, while managing the interface with manned aviation.
- To enable high-density operations with multiple automated drones under the supervision of fleet operators.
- To guarantee equitable and fair access to airspace for all users.
- To enable competitive and cost-effective service provision at all times, supporting the business models of drone operators.
- To minimise deployment and operating costs by leveraging, as much as possible, existing aeronautical services and infrastructure, including GNSS¹⁰, as well as those from other sectors, such as mobile communication services.
- To accelerate deployment by adopting technologies and standards from other sectors where they meet the needs of U-space.
- To follow a risk-based and performance-driven approach when setting up appropriate requirements for safety, security (including cyber-security) and resilience (including failure mode management), while minimising environmental impact and respecting the privacy of citizens, including data protection.

How will U-space operate?

Subject to compliance with applicable regulations, operational limitations and technical requirements linked to the operation of the drone, U-space facilitates any kind of mission, from the delivery of goods, aerial work, and search and rescue, to more complex future applications such as urban air mobility.

U-space services are offered to both private (leisure and professional) and public users of drones, for all types of missions. Some services will include privacy and security needs expressed by the relevant authorities. In addition, the criticality of these services will lead to the establishment of performance requirements for both structural elements and service delivery, covering, for example, safety, security, availability, continuity and resilience.

The U-space framework comprises an extensive and scalable range of services relying on agreed EU standards and delivered by service providers. These services do not replicate the function of ATC¹¹, as known in ATM, but deliver key services to organise the safe and efficient operation of drones and ensure a proper interface with manned aviation, ATC and relevant authorities. They may include the provision of data, supporting services for drone operators such as flight planning assistance and more structured services such as tracking or capacity management. Three services have already been identified as “foundation services”: electronic registration (e-registration), electronic identification (e-identification) and geofencing¹². Current initiatives envisage that electronic registration is mandatory for drone operators, except operators of drones weighing below 250 grams, as well as some classes of drones used in the open category, and all drones used in the specific category. Electronic identification will allow authorities to identify a drone flying and link it to information stored in the registry; the identification supports safety and security requirements as well as law-enforcement procedures.

The following paragraphs and figure describe a possible mission, illustrating various aspects of how the U-space concept could work in reality.

¹⁰ GNSS: Global Navigation Satellite System

¹¹ ATC: Air traffic control

¹² Geofencing is a virtual geographic boundary, defined by GNSS technology that enable software to prevent a drone entering a defined zone.

1. **Preparation of the drone mission:** a drone operator plans to fly a drone to carry a small package from a village to the city centre 30 kilometres away. She selects a suitable drone from her fleet and selects a drone supervisor who will not actually be piloting the drone, but will be supported by automated functions and tools allowing to monitor several drones flying at the same time. To prepare the flight, the drone operator uses information-sharing services connected to ATM via SWIM¹³ (e.g. NOTAMs¹⁴, meteorological conditions and forecasts at the nearest aerodrome), combined with other U-space services, such as navigation and communication coverage services, flight planning assistance services and services providing the expected density of traffic in the mission area. Since the drone is registered, the system automatically links the elements described in the registry with elements of the flight request, in which full details of the airworthiness of the drone and its behaviour in emergency situations are described. For example, this information could include designated safe landing areas, or details of the equipage and capabilities of the drone. That way, if the drone fails at any point in its flight, it will behave in a predictable manner, minimising risk to people and property on the ground.
2. **Submission of a flight request and reception of an acknowledgement:** the planned route adheres to applicable regulation, airspace requirements (including airspace availability, temporary and permanent restricted areas) and requirements on specific drone equipment. If the flight requires an additional approval, then the request is submitted to the relevant entity and an answer is sent to the drone operator. The planned flight does in fact conflict with several other planned drone operations so, the operator is offered the possibility of a longer route or a delay to the drone's arrival by 5 minutes. She chooses the latter option and receives an acknowledgement, which includes the drone's 4D trajectory describing the entire flight. When the drone is airborne, it receives information and alerts and might alter its original route to avoid traffic, meteorological conditions or any changes to airspace accessibility. Throughout the flight, the drone broadcasts its unique identifier. The tracking service allows the drone flight path to be followed and supports other services like the situation awareness, which is provided, with some limitations, to a wide range of customers (e.g. drone operators, ATC, police).



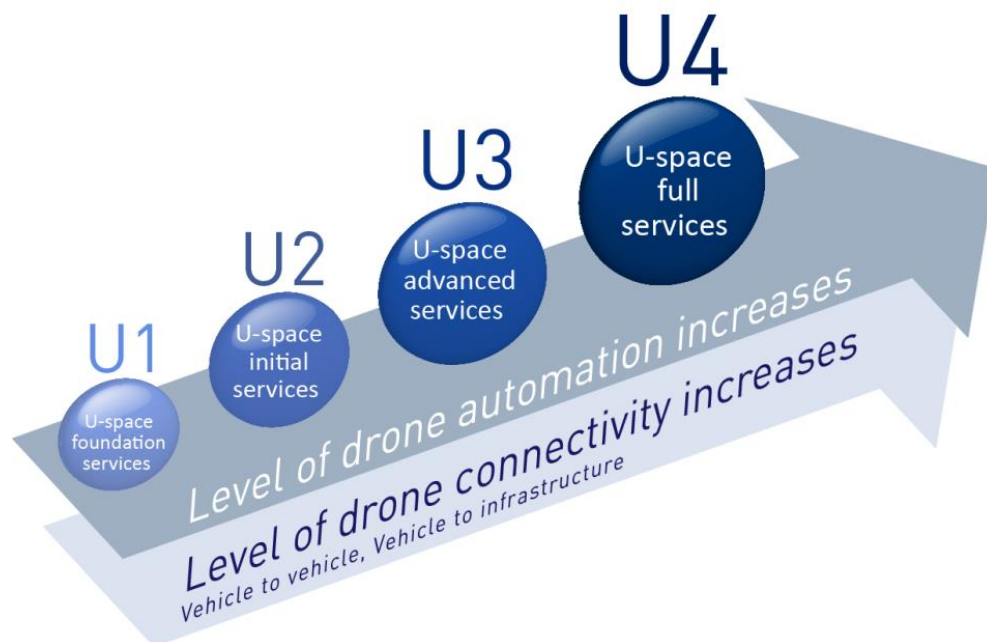
¹³ SWIM: System wide information management

¹⁴ NOTAM: Notice to airmen

3. **Execution of the flight:** the drone is equipped with a 'detect and avoid' (DAA) system which allows it to avoid hazards. The DAA system navigates it around a flock of birds and an unreported obstacle (e.g. a crane). As it arrives in the city, it receives an alert on a modification of airspace availability on its route: a car accident has just taken place and the local police have set up a temporary highly restricted zone to automatically geofence the site. The geofenced zone is not actually empty as the police are using a drone to give them an aerial view of the accident, and this mission is approved. The incoming helicopter ambulance is a priority flight, and this information is shared to ensure drones crossing its path will route round it.
4. **Mission completed:** the drone arrives safely at its destination and delivers the parcel. It is now ready to be prepared for its next mission: a roof survey of a building 500 metres away.

How will U-space be rolled out?

The progressive deployment of U-space is linked to the increasing availability of blocks of services and enabling technologies. Over time, U-space services will evolve as the level of automation of the drone increases, and advanced forms of interaction with the environment are enabled (including manned and unmanned aircraft) mainly through digital information and data exchange.



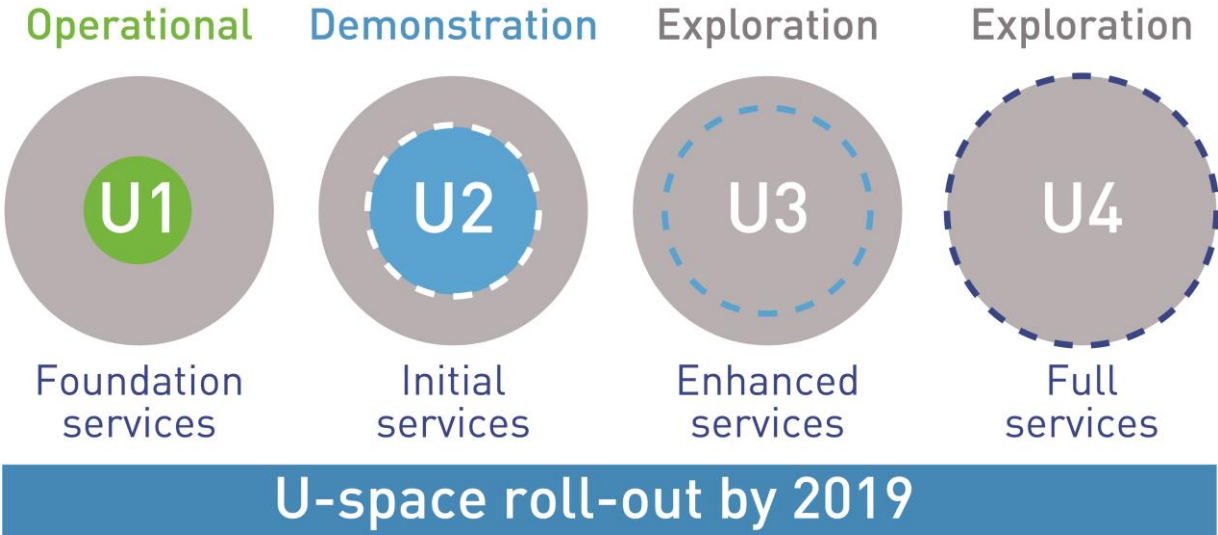
U1 U-space foundation services provide e-registration, e-identification and geofencing.

U2 U-space initial services support the management of drone operations and may include flight planning, flight approval, tracking, airspace dynamic information, and procedural interfaces with air traffic control.

U3 U-space advanced services support more complex operations in dense areas and may include capacity management and assistance for conflict detection. Indeed, the availability of automated DAA functionalities, in addition to more reliable means of communication, will lead to a significant increase of operations in all environments.

U4 U-space full services, particularly services offering integrated interfaces with manned aviation, support the full operational capability of U-space and will rely on very high level of automation, connectivity and digitalisation for both the drone and the U-space system.

Where will we be by 2019? By that time, U-space is expected to be established with U1 services facilitating a great number of current drone operations while enabling new ones. In addition, SESAR plans to deliver some pre-operational SESAR demonstrations of the initial U-space services (U2), as well as first results from SESAR research and development projects, which will pave the way for the roll-out of U-space (U2-U4).



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