Building a safe and socially acceptable concept of operation for drones flying at the very low level

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As part of the Single European Sky ATM Research (SESAR) a number of projects related to the drones flying at the very low level (VLL) have been funded. At its core, the CORUS project is developing the concept of operations (ConOps) of these drones[1]. At the same time, the last European ATM Masterplan has proposed the "Roadmap for the safe integration of drones into all classes of airspace"[2]. This document proposes the set of services for the unmanned air traffic management, named as U-space, together with a calendar for their deployment (from U1 to U4). The CORUS project integrates these services as pillars of the ConOps, with the objective of supporting the new businesses and jobs, improving the safety of the drones, and dealing with their public acceptance.

From the airspace perspective, the main problem of drones flying at the very low level (VLL) is that, although mostly empty, the VLL airspace is shared with other airspace users: military, general aviation, parachutes, gliders, emergencies, take-off and landings, high-precision aerial works, training, etc. Most of the drones are today flying in visual line of sight (VLOS) operations, where the remote pilot can see the aircraft and separate from nearby traffic. On the contrary, beyond visual line of sight (BVLOS) operations, where the pilot cannot directly see the drone, relatively rare today, are expected to be the normal way of operating for many future commercial drone activities. The expectation for 2035 is airspace ten times busier than today due to additional business models related to drones, which involve a large amount of turnover, capital investment, and jobs creation, direct and indirect. Very diverse economic areas such as agriculture, energy, transport, construction, inspection, delivery, security, insurance, commercial, but also arts or leisure, are expected to benefit from the use of drones in the very near future.[3]

As with previous emerging technologies, the social aspects of the risk acceptability include voluntary involvement, the nature of the consequences of failures and transparency[4]. Transparency and inclusiveness are the two most common principles that foster acceptance: Transparency means that information shall be transmitted in an accurate and timely way, using common and understandable language, and shall be verifiable. Inclusiveness means that the affected individuals and social associations shall be empowered to influence the decision-making process[5]. The impact of drones on privacy is also relevant for their acceptance[6]. The obligations to respect privacy for drone operators include the transparency principle again, the proportional principle (by using the proportional technology to avoid collecting unnecessary data), and the purpose limitation principle (to avoid any secondary use of the data without permission)[7]. Similarly, the obligations extend to the necessity to adopt security measures and to embed privacy-friendly procedures in the design of the operations[8]. Two more aspects influence the perception of drones: the capability of law enforcement agents to mitigate and/or punish those responsible for wrong-doings, and the noise[9].

The CORUS ConOps tries to balance the economic growth, the safety and social acceptance. Its current status contains two main issues: a classification of the VLL airspace, and a first U-space services refinement, with special attention to strategical services. CORUS proposes to classify the VLL airspace using a three colours scheme. The colour scheme is inspired by the traffic lights to be easy to understand by all (transparency principle): red for prohibition, amber for alert and green for free access. Colours do not segregate traffic; rather they provide information about the different performance

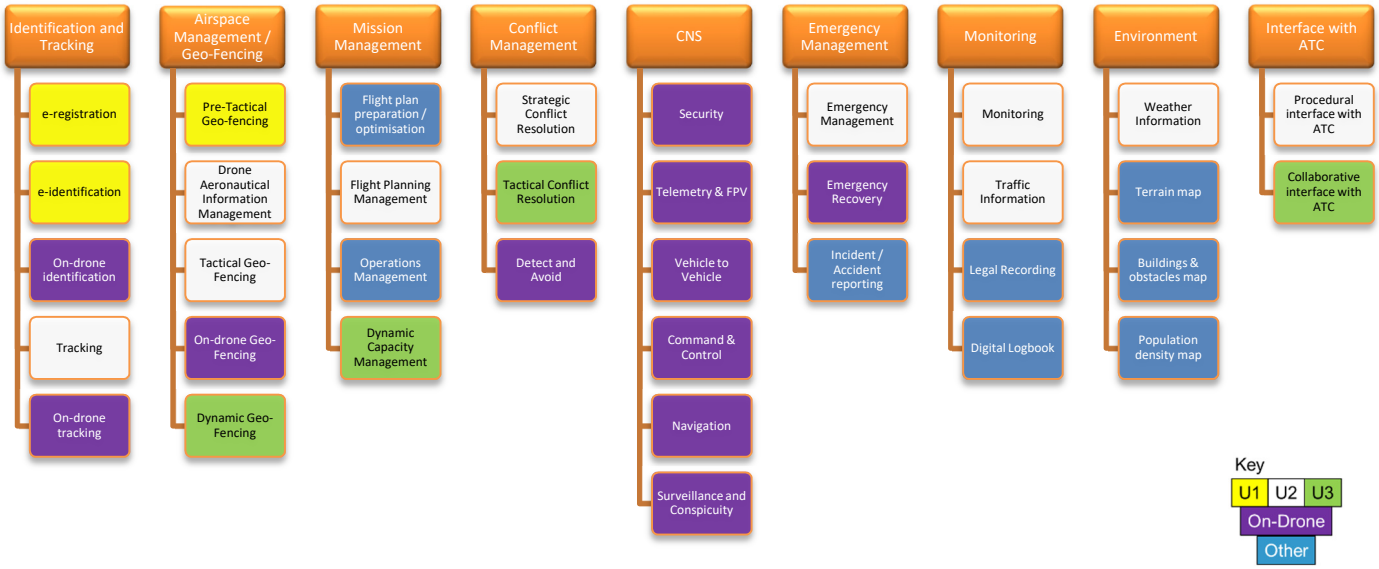
[1] CORUS ConOps V1.0 https://www.eurocontrol.int/sites/default/files/publication/files/corus-concept-of-operations-1.0.pdf
[2] SESAR JU, "Roadmap for the safe integration of drones into all classes of airspace". March 2018.
[3] SESAR JU, "European Drones outlook study, unlocking the value for Europe". November 2016.
[4] Gupta N. et al., "Socio-psychological determinants of public acceptance of technologies: A review", Public understanding of Sciences, Vol 21(7). SAGE Journals 2011.
[5] European Grid Declaration. "Grid infrastructure communication toolkit". https://webgate.ec.europa.eu/multisite /gridcommunicationstoolkit/
[6] Working Party on Article 29 Data Protection, "Opinion 01/2015 on Privacy and Data Protection Issues relating to the Utilisation of Drones", EC 01673/15/EN - WP 231, June 2015.
[7] ULTRA Consortium, "Unmanned Aerial Systems in European Airspace", FP7 Project. EU Available at http://ultraconsortium.eu/, 2014
[8] Reece A. et al., "Risk Perception And The Public Acceptance Of Drones" Risk Analysis Volume 35, Issue 6, Feb 2015.
[9] Lidynia C. et al., "Droning on about drones—acceptance of and perceived barriers to drones in civil usage contexts", Advances in Intelligent Systems and Computing 499, 2017.

requirements and U-space services being offered. National authorities will be responsible for defining the VLL airspace colour distribution within their airspace.

The red airspace can be imagined of as a no-flight-zone area. Reasons for red airspace are related to social acceptance issues, such as environmental preservation, citizens' low noise areas and for privacy or security reasons — for instance, the airspace above a National park, the area close to a hospital or the surrounding of a nuclear power station. However, red airspace might still permit the flight of very controlled and limited drone operations — for instance, an urgent delivery in a hospital, or the surveillance of a natural area for its protection.

The green airspace will be, on the contrary, open to any drone, including citizens' leisure drones. Green airspace will exist where the risk and annoyance associated with the drone operation are low, generally over non-populated areas. For the time being, only VLOS operation are foreseen in the green airspace. Moreover, few U-space services will be offered, basically the foundation services and the emergency service. For social acceptance, the E-identification service is considered to be crucial. Finally, due to safety, the geo-fencing and the emergency services will be available, which could also be used by other VLL airspace users.

Halfway, the amber airspace defines an area of the VLL airspace able to support safe BVLOS operations and foster most emerging drone business. These are operations declared as Specific by EASA, because of their medium risk level. VLOS operations can be declared as Specific if the mass or the speed of the drone is above some given thresholds. For those operations, the legal requirements are more stringent, and the provision of the U-space services will add the necessary safety without reducing airspace capacity. For instance, tracking will be a necessary service to foster a shared use of amber airspace.



The full set of U-space services is shown in the figure as coloured by their deployment phase and grouped by functionality. Moreover, new proposed services (in blue) and on-drone capabilities (in purple) have been added. For instance, three new services related to *Environment* have been included. One of them related to social acceptance, *Population density*, can help operators to find noiseless routes. Highly relevant to the tactical phase are the *Identification and tracking* services. *Tracking* collects unique position reports of the flying drones and triggers some other added value services such as monitoring, conflict and emergency management. For instance, accident and incident investigation will require that position reports to be logged securely for some period. The *Geo-fencing services* extend the basic airspace information service by exploiting the self-separation capability of the drones. The *Mission management* services shall allow the drone operators to express their operations with high flexibility: from "in this volume during that period" for a survey flight, to a precise description of the full path for a delivery drone.

There is still a lot of work to carry out to develop the final version of this ConOps. The consortium will work intensively over the next few months aiming to produce its version 2 by March 2019. The CORUS team is interested to hear your comments. Feel free to send them to our email: *corus-info@eurocontrol.int.*

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