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MILITARY AND U-SPACE: GUIDELINES

D1 – U-SPACE EVALUATION

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Document information

GENERAL INFORMATION

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1 - EXECUTIVE SUMMARY

In recent years, '*new entrants*' became one of the most appealing terms in aviation industry, especially *'drones'*, which bring innovation, new markets and jobs, and novel services in an ever more digitalised, interconnected environment. The European Commission (EC) has actively promoted the development of the drone industry, starting through the landmark Warsaw declaration in November 2016 highlighting "*Drones as a leverage for jobs and new business opportunities*".

The EC called for a shift in the way airspace is managed, to ensure that drones can safely and efficiently operate in the existing air traffic system. To guarantee this, the creation of a new service market, called U-space, that will be available to Drone operators in specific parts of the overall airspace has been agreed[1]. U-space represents an ecosystem of services and procedures necessary for Drone operators to access the airspace in a safe, secure and efficient manner.

The role of the military with regard to U-space, and drone operations more generally, has been recognised in the Drone Strategy 2.0 adopted by the Commission on 29 November 2022, notably as potentially contributing to future European Strategic autonomy. The document identifies synergies between the civil, security and military use of drones and related technologies which can be realised through a number of flagship actions involving the military, among other stakeholders.

1.1 - Where military aviation is the most impacted by U-space

Noting that military aviation in Europe shall have effective and safe access to the airspace in order to train for, and conduct, security and defence missions in peacetime, crisis and conflict, the military missions will be impacted by U-space.

States defence and security main missions include identifying all aircraft overflying their respective national territories. The military are in charge to fulfil these tasks in full cooperation with the operational stakeholders and other relevant actors, such as police, customs, etc. The increasing number of drones in the same volume of airspace shared with other airspace users could not only lead to safety issues, but security ones. From a defence point of view, de-risking drone activity goes through having the best possible recognized air picture, which should include the position and identification of all drones.

The strategic military aviation objective[2] is to provide and further improve, effective security and defence in Europe in the changing context of the civil aviation sector, without prejudice to the safety of civil air traffic. Civil-military collaboration and cooperation is thus crucial to minimise the existing gaps between the civil requirements and the military needs, aiming at improving flexibility and bringing mutual benefits to all stakeholders.

> Therefore, the military have to consider their future relation with U-space in order to preserve national and security defence requirements, as already recognised at global and regional level, such as in ICAO documentation and in European Regulations. Furthermore, to enable military to provide security and defence as mandated by national policies and international agreements, it is necessary that any air traffic development takes into account military requirements.

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[1] *Cf. Regulations (EU) 2021/664 ([12]), (EU) 2021/665 ([13]) and (EU) 2021/666 ([14])*

[2] *Cf. Military Aviation Strategy in the context of SES*

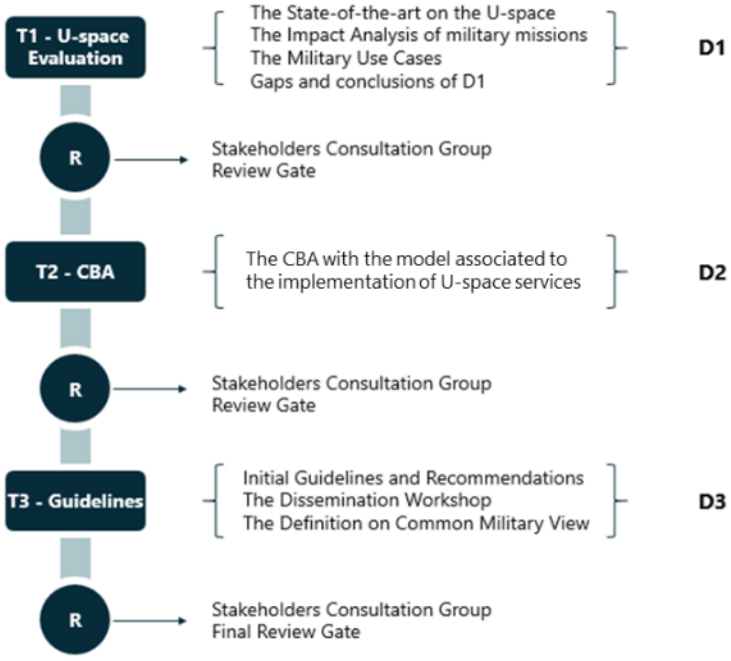
1.2 - An assessment based on an operational approach

Starting from a review of on-going initiatives related to U-space development and Regulation, and paying a specific attention to the military involvement, this report assesses the impact of U-space services on military missions and operations. Through seven Use Cases that provide a complete coverage of typical Military activities, this "D1 – U-space evaluation" report explores how military actors will interact with U-space once it is implemented and identifies a number of gaps in the current U-space definition.

- Section 2 - contains the assessment of the U-space regulatory framework developed by EASA and of the research work undertaken by SESAR to define a U-space concept of operations. In addition, it summarises available information on the U-space regulation development and the main elements coming from existing U-space-related material. This allows developing a better understanding of how drones will operate in the future U-space environment, but raises a number of questions on how they will interact with the other actors.
- Section 3 - presents the outcome of a qualitative assessment of how the main military missions could be impacted by the U-space services mandated by the U-space Regulation and to what extent. It is already recognised that the development of drone operations in uncontrolled airspace creates safety and security challenges. This section investigates how U-space services can help addressing these challenges and can even provide benefits to the military.
- Section 4 - describes in a more detailed manner how military actors could interact with U-space services in a number of Use Cases representative of the main military missions. As the future U-space environment is still under development, these Use Cases clearly state the assumptions on which they have been developed.
- Finally, section 5 - identifies gaps in the current definition of U-space, that could result in issues for the military if they remain unaddressed. However, mitigation means are available to partially or fully address these issues and their application will depend on the future relationship between the military and U-space actors.

1.3 - "Military and U-space: guidelines" study overview

The "Military and U-space: guidelines" study consists of 3 tasks (T1, T2, T3) with their respective deliverables (D1, D2, D3) as depicted in the figure below:



THE TASK 1 (T1) – U-SPACE EVALUATION – The state-of-the-art section reviews the input material and provides necessary knowledge on current stage of U-space implementation including Military involvement. The Impact Analysis assesses the impact of typically military missions and operations by U-space services and sets the basis for the D2. The Use Cases in section 4 show how the mandatory and most beneficial U-space services will affect

Military missions and operations. Task 1 results in the identification of the U-space services with the highest potential for affecting Military missions and operations by the development of the U-space, the description of this impact and a formal description of how the services are operated through Use Cases. The final Use Cases will be distributed to the SESAR projects – and national initiatives – that are contributing to the implementation of U-space across Europe.

THE TASK 2 (T2) – COST AND BENEFIT ANALYSIS (CBA) – T2 results in the identification of the costs and benefits mechanisms associated with the implementation of the U-space services retained in Task 1. Three implementation scenarios are being proposed and compared against the status quo, i.e,. the baseline scenario. Despite the conceptual nature of U-space and limited understanding of the precise implementation requirements in each member state, the CBA considers the implementation-related capital and operating expenditure, including upgrades to military ATS systems and air assets, process reviews, staff related costs and other. As the U-space concept and requirements become clearer throughout the course of this study, and with further input from the individual project stakeholders, this CBA can be developed in greater detail.

THE TASK 3 (T3) – GUIDELINES concludes on the study by consolidating a Common Military View, representing the position of the EDA and its Member States, on the development of U-space services. The initial guidelines and recommendations developed for Military Stakeholders were based on the results of T1 and T2. A Dissemination Workshop was organised on 9 November 2021 to communicate the initial conclusions of D3 to EDA's Member States and to gather the Stakeholder's feedbacks for the final D3 version. The Definition of a Common Military View on the impact of the U-space development was the final D3 deliverable that includes the outcomes from this Dissemination Workshop.

Following the completion of these 3 tasks and the issuance of the corresponding deliverables, the "Military and U-space: guidelines" study foresees to regularly update these deliverables to take account of the progress in the implementation of U-space.

2 - STATE OF THE ART ON U-SPACE DEVELOPMENT

As the same understanding of the terminology is crucial and ensures common comprehension of the study, this section provides main terms and principles and introduces the reader to the U-space world.

Note: Main terms and principles related to ATM are reminded in 7.3 - Appendix 3: General ATM Overview.

2.1 - U-space terms and principles

This sub section provides explanation of the main U-space terms and principles.

2.1.1 - General terminology

Acronym/Term	Definition	Source
Common Information Service	A service consisting in the dissemination of static and dynamic data to enable the provision of U-space services for the management of traffic of unmanned aircraft	[12]
Drone	Drone is an equivalent term to unmanned aircraft	
Dynamic airspace reconfiguration	The temporary modification of the U-space airspace in order to accommodate short-term changes in manned traffic demand, by adjusting the geographical limits of that U-space airspace	[12]
E-conspicuity	Electronic conspicuity As per the new version of EASA requirement SERA.6005(c), which became applicable with IR 2021/664 on 26 January 2023, manned aircraft operating in U-space airspace, and not provided with an ATC service by the ANSP, shall continuously make themselves electronically conspicuous to the USSPs.	[19]
UA	Unmanned aircraft Any aircraft operating or designed to operate autonomously or to be piloted remotely without a pilot on board	[6]
UAS	Unmanned aircraft system Unmanned aircraft and the equipment to control it remotely	[16]
U-space airspace	A UAS geographical zone designated by Member States, where UAS operations are only allowed to take place with the support of U-space services	[12]
U-space service	A service relying on digital services and automation of functions designated to support safe, secure and efficient access to U-space airspace for a large number of UAS	[12]
VLL airspace	Very Low-Level Airspace Corresponds to the airspace below 500 feet above the ground level	[2], [29]
RPAS	Remotely Piloted Aircraft System	
UTM	UAS Traffic Management	

TABLE 1: U-SPACE GENERAL GLOSSARY

In this document, the word "drone" is used to simplify the reading instead of distinguishing UA, UAS and RPAS, except when there is a specific need to make this distinction or when quoting another document using these terms.

2.1.2 - Drone operation categories

There are **THREE TYPES OF REMOTELY PILOTED FLIGHT**:

- **VLOS – VISUAL LINE OF SIGHT OPERATION**: the remote pilot is able to maintain continued unaided visual contact with the aircraft at any time during the flight, allowing the remote pilot to control the flight path of the unmanned aircraft in relation to other aircraft, people and obstacles for the purpose of avoiding collisions; [4], [6], [9]
- **EVLOS - EXTENDED VISUAL LINE OF SIGHT OPERATION**[3]: the remote pilot maintains uninterrupted situational awareness of the airspace in which the drone operation is being conducted via visual airspace surveillance through one or more human visual observers, possibly aided by technological means. The remote pilot has direct control of the drone at all times. [16]
- **BVLOS – BEYOND VISUAL LINE OF SIGHT**: the remote pilot is not in visual contact with the aircraft – any type of operation which is not conducted in VLOS, or EVLOS; [4], [6], [9]

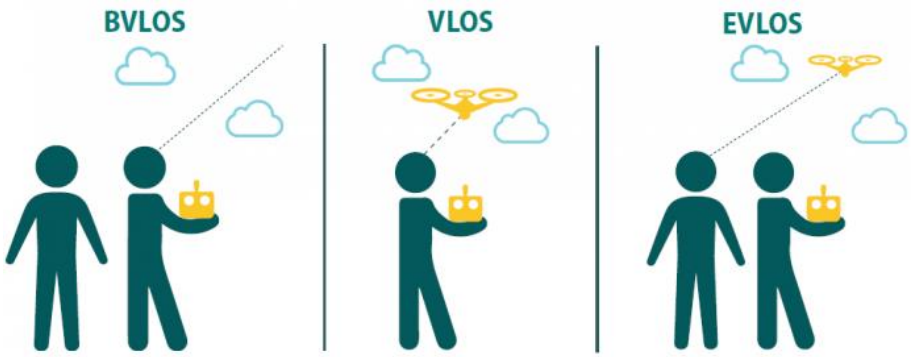


FIGURE 1: TYPES OF REMOTELY PILOTED FLIGHT
[49]

In order to improve the risk assessment related to the different drone operations, **EASA DEFINES THREE CATEGORIES OF OPERATIONS: THE 'OPEN', 'SPECIFIC' AND 'CERTIFIED' CATEGORIES**. The 'open' category is further divided into subcategories (A1, A2, A3, etc.), on which details are provided in Commission Implementing Regulation (EU) 2019/947 and Delegated Regulation (EU) 2020/1058.

All categories of operations associate a level of operational risk with an appropriate risk assessment and mitigation approach.

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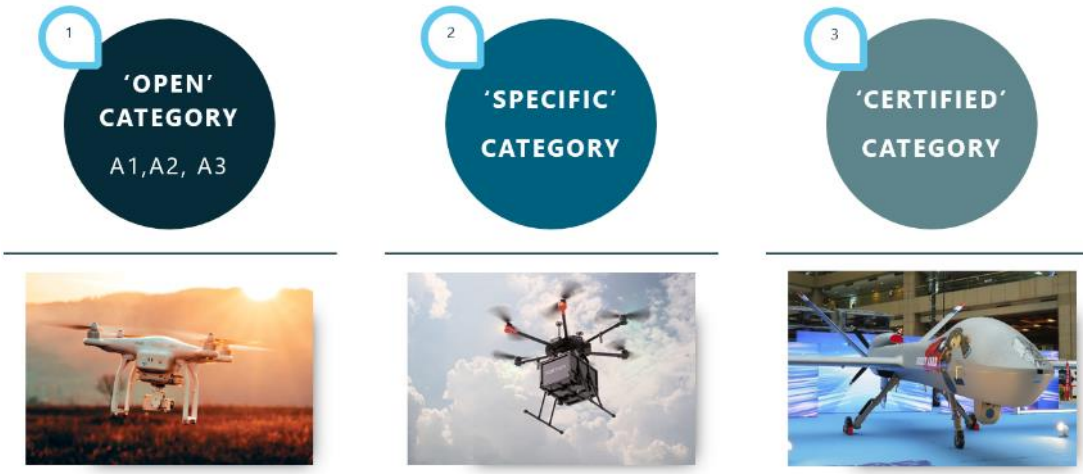
[3] As mentioned in EASA easy access rules for drones, "EVLOS operations are to be considered to be BVLOS for the intrinsic ground risk class determination."



Covers operations that represent the **lowest risks.** Does not require drones that are subject to standard aeronautical compliance procedures, but are conducted using the drone classes that are defined in Commission Delegated Regulation (EU) 2019/945 [6], then amended by DR 2020/1058 [8] Maximum height: **120m**	Includes other types of operations presenting a **higher risk. The risk assessment shall be conducted** to indicate which requirements are necessary to keep the operation safe. [6] Maximum height: **120m for standard scenario, or higher if authorized by the competent authority**	Subject to **rules on certification of the operator, and the licensing of remote pilots**, in addition to the certification of the aircraft pursuant to Delegated Regulation (EU) 2019/945. [6] Maximum height: **as established by the certification**

TABLE 2: EASA CATEGORIES OF DRONE OPERATIONS

The expectation is that most of the professional uses of drones (achieved within the 'Specific' category) is in Very Low Level (VLL) airspace, i.e. the airspace below 500ft (or any other locally defined altitude).

2.1.3 - U-space definition and key principles

Given the very strong growth in drone air traffic, their integration into the airspace and UTM (Unmanned Aircraft System (UAS) Traffic Management) is now becoming a major challenge worldwide.

Since the 2016 Warsaw Declaration, the European Commission (EC) has promoted a **EUROPEAN VISION OF UTM AND ITS ASSOCIATED SERVICES TO DRONE OPERATORS NAMED "U-SPACE"**.

U-space aims to support safe, efficient and secure access to airspace for large numbers of drones (see SESAR Blueprint [9], [21]) and relies on:

- **A SET OF U-SPACE SERVICES AND SPECIFIC PROCEDURES** which "rely on a high level of digitalisation and automation of functions, whether they are on board of the drone itself, or are part of the ground-based environment" (see SESAR Blueprint [21]).
- **SPECIFIC VOLUMES OF AIRSPACE** named "**U-SPACE AIRSPACE**" that is specified as "Geographical zone, defined in accordance with Commission Implementing Regulation (EU) 2019/947, designated by Member States, where U-space services are required "(see IR 2021/664 [12]). These volumes are not intended to be designated for the sole use of drones.
- **NEW SERVICE PROVIDERS** named **"USSP" (U-SPACE SERVICE PROVIDER)** and **"CISP" (COMMON INFORMATION SERVICE PROVIDER).** The USSP is in charge of providing U-space services to drone operators operating in U-space airspace. When designated, the CISP is in charge of providing common information services (i.e., the dissemination of static and dynamic data to enable the provision of U-space services) to

relevant authorities, air traffic service providers, USSPs and drone operators in all or some of the U-space airspaces under their responsibility.

U-space facilitates any kind of operations[4] for both, private and public drone users[5] *"in all operating environments[6], and in all types of airspace (in particular but not limited to very low level airspace[7])"* by *"enabling framework to support routine drone operations, as well as a clear and effective interface to manned aviation, ATM/ANS[8] service providers and authorities."*. [21]

The key principles upon which the delivery of U-space rely on were defined as follows:

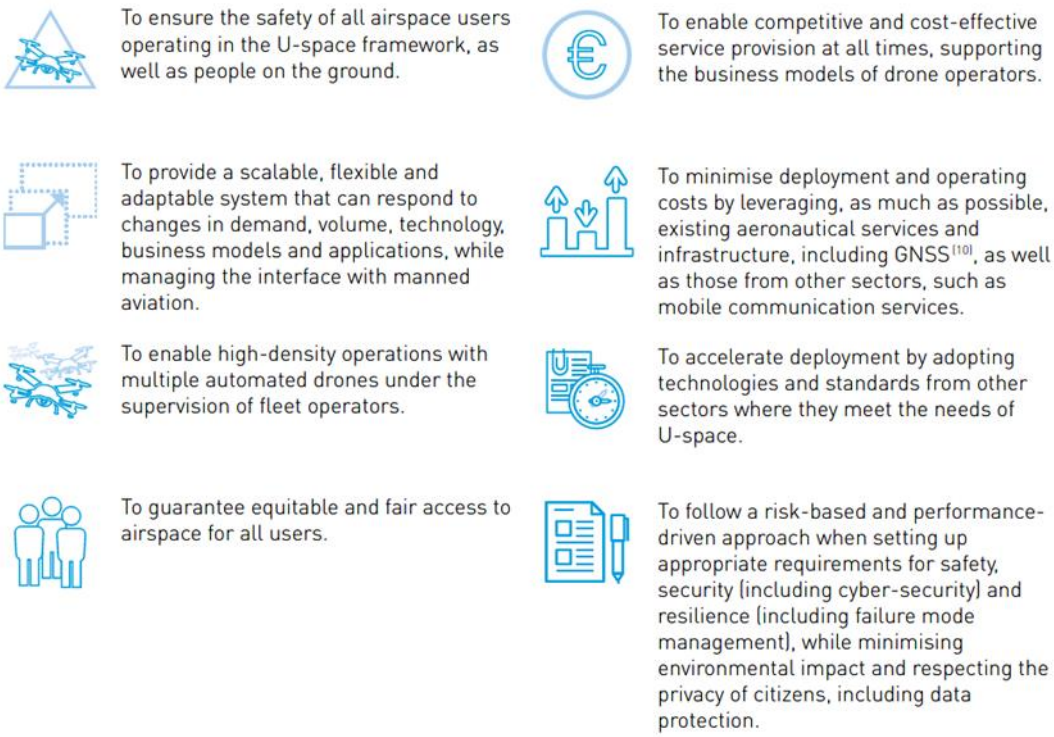


FIGURE 2: KEY PRINCIPLES OF U-SPACE
[21]

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

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

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

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

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

2.1.4 - U-space actors: roles and responsibilities

Even if the main actors of the ATM remain present in U-space due to interaction with manned aviation, new actors are recognised. The following figure lists actors involved in U-space.

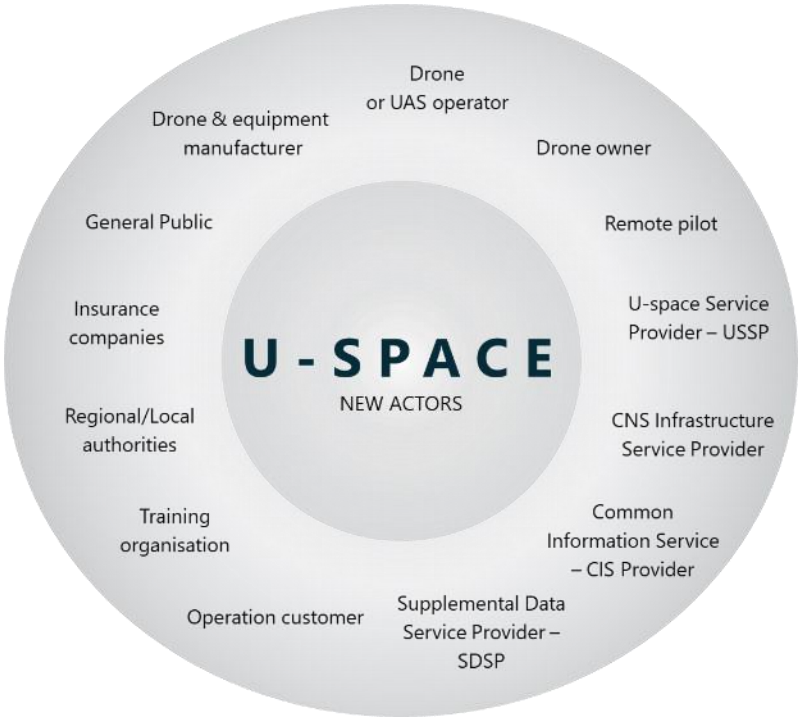

FIGURE 3: NEW U-SPACE ACTORS

The following table describes the roles and responsibilities of new U-space actors.

Actors/Services	Definitions and roles
Drone or UAS Operator	Any legal or natural person, accountable for all the drone operations it performs. Could be civil, military, an authority (special) or a flight club. [6], [22]
U-space Service Provider (USSP)	Any legal person certified as U-space service providers providing or intending to provide U-space services. [12]
Common Information Service Provider (CISP)	The CISP provides the common information services in all or some of the U-space airspaces under their responsibility. This provider ensures that all the necessary information for the functioning of the U-space can be granted to relevant authorities, air traffic service providers, U-space service providers and UAS operators on a non-discrimination basis, including the same data quality, latency and protection levels. [12]
Drone Owner	The legal entity, which can be a natural person, owning the drone. It may be different from the Drone Operator legal entity (e.g. leasing rental mechanisms). [22]
Remote pilot	A natural person responsible for safely conducting the flight of a UA by operating its flight controls, either manually or, when the UA flies automatically, by monitoring its course and remaining able to intervene and change its course at any time. [6]

Actors/Services	Definitions and roles
CNS Infrastructure Service Providers	Provide the technological infrastructure with which the CNS service providers provide the actual CNS services. Where applicable, they also provide relevant monitoring and coverage services. Satellites, for example, are infrastructure, provided by one or more infrastructure providers that are used by the different providers of all three CNS services. Then: ■ Communication service provider, responsible for the provision of a reliable and safe communication link between systems. For the C2 Link, also known as a C2-Link service provider. ■ Navigation service provider, responsible for the provision of a reliable navigation infrastructure to allow safe drone operations. E.g. Satellite Navigation Service Providers; ■ Surveillance service provider, responsible for the provision of surveillance services with different technologies/methodologies and SLA. This encompasses anti-drone surveillance for non-cooperative traffic. Provides services to check coverage and monitor the status of the surveillance service offered. [22]
SDSP – Supplemental Data Service Provider	SDSP provides access to supplemental data to support U-space services. Multiple services could be provided by different Supplemental Data Service Providers. Specific providers of this category are: ■ Weather Data Service Provider, which provides weather information data (hyper local weather data, solar flare information and TAFs and METARs) and ensures that these are reliable, accurate, correct, up-to-date and available; ■ Ground risk observation service provider provides supplemental data which contribute to the knowledge/observation of the ground. It encompasses ground and terrain data modelling (building heights, digital elevation model) and population density, ensuring that these are reliable, accurate, correct, up-to-date and available. [22]
Operation customer	The final stakeholder of the drone operation who may have some roles in the authorisation of the mission itself. [22]
Training organisation	Remote pilot schools & Training centres are responsible for pilot and operator training [22]
Regional/Local authorities (government/city/prefecture)	Supports the definition of operating procedures and rules. Explores applications of U-space to urban needs – for example active measures limit noise "dose" in any one place. [22]
Insurance companies	Collect statistics about drone accident rates in U-space. They propose more affordable insurance for drones that use enabling factors that lowers the risk of incident. They offer per operation insurance based on the specific operational plan. They can be providers of supplemental data related to the insurance. In that case it is an Insurance data service provider. [22]
General Public	Those who may hear, see or otherwise be concerned by a drone [22]

Actors/Services	Definitions and roles
Drone Manufacturer	Produces drones and ensures their compatibility with U-space (technical feasibility, interoperability). [22]
Equipment Manufacturer	Develops solutions needed or effected by U-space services. Scope is equipment for drones, manned aircraft and U-space infrastructure. [22]

TABLE 3: NEW U-SPACE ACTORS AND THEIR ROLES

The following table details the current ATM actors whose roles and responsibilities are impacted by U-space.

Actors/Services	Roles in U-space
Member States	Have full authority on the U-space airspace designation (how the airspace is designed, accessed restricted, they should be able to require that other U-space services than those stated as mandatory by the Commission IR are mandatory and etc.)
Civil Aviation Authority (CAA)	Is in charge of, in particular: ■ Transposing U-space and drone regulations into national or local law and supervise its application; ■ Providing a certificate to USSP and CIS providers and the related oversight process; ■ Establishing, maintaining and making publicly available a registration system for certified U-space service providers. [12]
(Airfield/Airport) Aerodrome operator (civil, military)	Supports the definition of operating procedures and interoperability requirements to ensure safe integration of drones in airspace, especially in airport vicinity. [22]
ANSP – Air Navigation Service Provider (civil, military)	In controlled airspace: ANSP remains responsible for the provision of Air Navigation Services to operators of certified manned and unmanned aircraft, as well as for the dynamic reconfiguration of the airspace within the designated U-space airspace to ensure that manned and unmanned aircraft remain segregated. If a certified drone operates under IFR, the ANSP remains responsible to the provision of ANS as for the other IFR flights. If the certified drone do not comply with IFR rules, the USSP shall be responsible for the provision of U-space services to operators of unmanned aircraft. In non-controlled airspace: ATS remains responsible for the provision of Flight Information Service to the operators of manned aircraft. [12]
Manned aircraft operator	Refers to the person or an organisation which is engaged in, or offering to engage in, an aircraft operation
Airspace User	Organisations operating aircraft and their pilots
Safety and Security Authority	Publishes danger areas in real time – relating to medical evacuation, police helicopter or similar. (Police only) Develops law enforcement methods related to illegal drone use. [22]

TABLE 4: CURRENT ATM ACTORS IMPACTED BY THE U-SPACE

2.1.5 - U-space services

As mentioned previously, U-space relies on a **set of new services and specific procedures** in order to support safe and efficient drone operations.

The U-space Regulation (IR 2021/664 [12]) defines **a set of 7 services** presented in the following figure and table. The four mandatory U-space services are in bold in Table 5. In addition, MS (Member States) can decide, with the support of a risk assessment, that other U-space services such as a weather information service and a conformance monitoring service are needed to support safe and efficient drone operations in the specific U-space volumes.

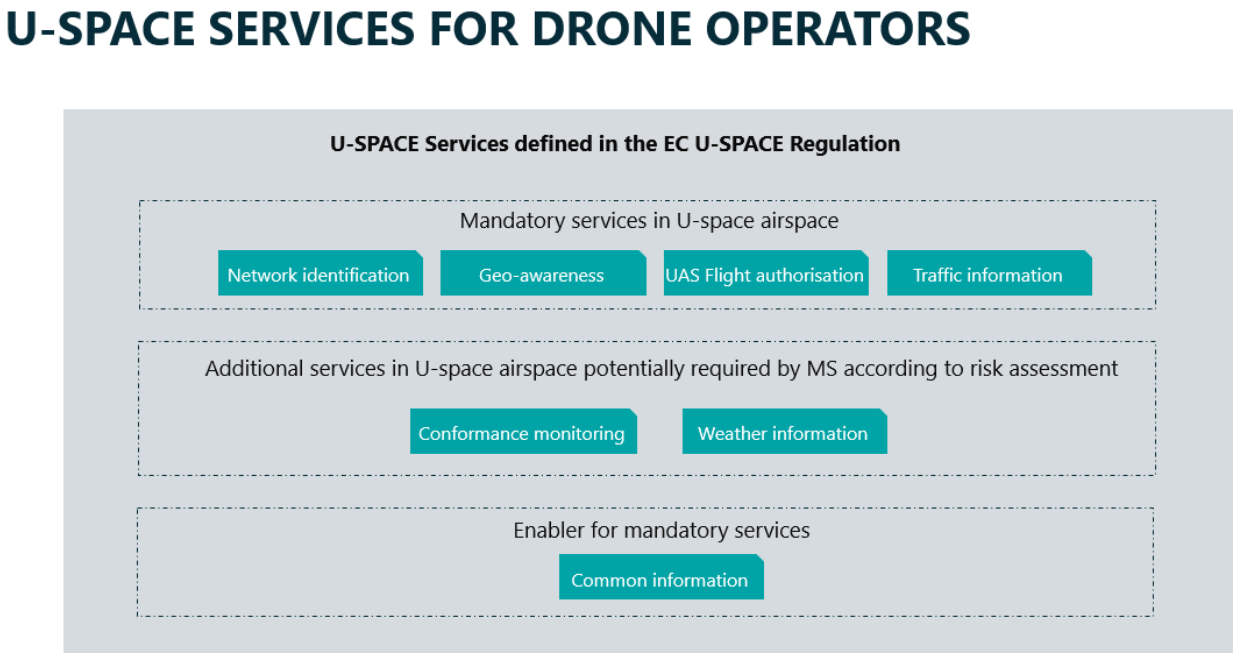

FIGURE 4: DEFINED U-SPACE SERVICES IN THE EU U-SPACE REGULATION

U-space Service	Description
Network identification service	*"A network identification service should provide the identity of UAS operators, and the location and flight vector of UAS during normal operations and in contingency situations, and share relevant information with other U-space airspace users."*
Geo-awareness service	*"A geo-awareness service should provide UAS operators with the information about the latest airspace constraints and defined UAS geographical zones information made available as part of the common information services. In accordance with Implementing Regulation (EU) 2019/947, the establishment of UAS geographical zones should take into account safety, security, privacy and environmental requirements."*
UAS Flight authorisation service	*"A UAS flight authorisation service should ensure that authorised UAS operations are free of intersection in space and time with any other notified UAS flight authorisation within the same portion of U-space airspace."*
Traffic Information service	*"A traffic information service should alert UAS operators about other air traffic that may be present in proximity to their UAS."*
Weather information service	*"A weather information service should support UAS operators during the flight planning and execution phases, as well as improve the performances of other U-space services provided in the U-space airspace."*

U-space Service	Description
Conformance monitoring service	*"A conformance monitoring service should provide real-time alerting of non-conformance with the granted flight authorisation and inform the UAS operators when deviating from it."*
Common Information Service	*"A Common Information Service (CIS) should enable the provision of information to UAS operators, U-space service providers and other organisations and natural persons involved in the U-space. The CIS should be an access point for information on operations and any situations that could have an impact on the airspace."* The information supported by this service are static and dynamic and correspond at least for a designated U-space airspace: the limits of the U-space airspace; the drone requirements set by the competent authorities; the list of different certified USSP effectively offering U-space services, the applicable operational conditions and airspace constraints; any adjacent designated U-space airspace(s);the connectivity methods, constraints and cybersecurity protection measures, as determined by the Agency, terms and conditions for drone flight authorisations, including the authorisation deviation thresholds; requirements related to the use of public key infrastructure, identity management, and authentication; and the list of all the publicly known authorities that can be contacted with regard to the common information.

TABLE 5: EASA U-SPACE SERVICES
[6], [12]

Furthermore, in the frame of the SESAR CORUS-XUAM project as a targeted concept a more completed list of U-space services has been initiated. This concept needs further evolution and it might be possibly converged with EASA U-space regulation framework in the future. These services relate to different aspects of the requirements for integration of drones with ATM and other airspace users. The colour coding indicates in which phase the specific service will be introduced. [22], [24]

This service list has been updated and completed in the frame of the SESAR CORUS-XUAM project, the continuation of the SESAR CORUS project launched at the end of 2020. CORUS-XUAM has published a new version (Edition 4.2) of the CORUS CONOPS which describes the services. [27]

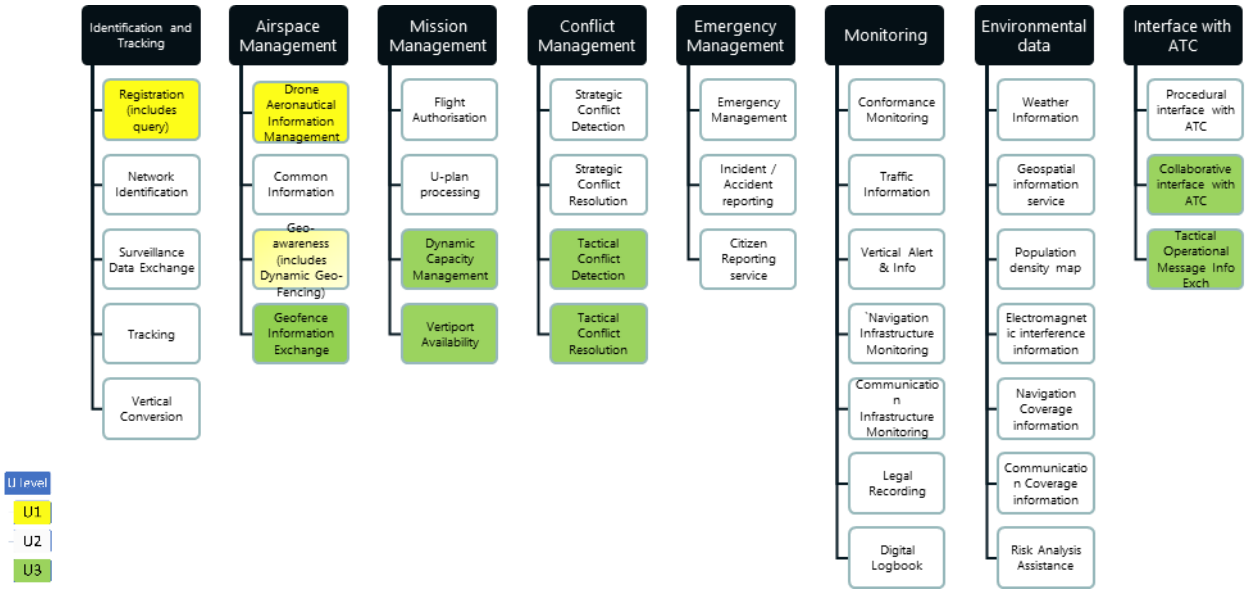

FIGURE 5: LIST OF U-SPACE SERVICES
[27]

The following table provides a description of the different services. Services retained in the EC Regulation are highlighted in bold and the corresponding services in EASA U-space regulatory framework, if they have a different name, are indicated between brackets.

	CORUS U-space service	Description
Identification and tracking	**Registration (including query)**	Drone operators shall be registered and some drones shall be registered. Hence there need to be a registry and a registrar (the operator of the registry) who is approved by the competent authority. The registry should generate unique registration numbers associated with registry entries. The registry should form part of a multi-national network which is coordinated to ensure registration numbers are unique. Interaction with the register to enable the registrations of the drone, its owner, its operator, and its pilot. Different classes of user may query data, or maintain or cancel their own data, according to the defined permissions.
	Network identification	Network Identification corresponds to regular submission of position reports by drone operator or drone itself.
	Surveillance data exchange	Exchanges data between the tracking service and other sources or consumers of tracks – radar, other drone trackers, etc.
	Tracking	Receives location reports, fuses multiple sources and provides tracking information about drone movements.
	Vertical conversion*	The Vertical Conversion Service ensures the conversion of altitudes between barometric and geodetic reference systems to both manned and unmanned aircraft in Geodetic Altitude Mandatory Zones (GAMZ). It uses other services and ICARUS sub-services to calculate the geometric height a manned plane is flying at, and the barometric height of a drone and shares these with other aircraft in the vicinity.
Airspace management	**Drone Aeronautical Information Management**	The drone equivalent of the Aeronautical Information Management (AIM) service. This service maintains the map of X, Y and Z airspaces, and permanent and temporary changes to it (e.g. a weekend festival will change an area from sparsely to densely populated). This service provides information to the geo-fencing services as well as operational planning preparation service.
	Common Information	This service publishes the geographic bounds of U-space Airspace, the associated conditions / requirements / restrictions and the USSP certified to operate in the U-space airspace.

	CORUS U-space service	Description
	Geo-awareness (includes Dynamic Geo-Fencing)	This provides geo-fence and other flight restriction information to drone pilots and operators for their consultation up to the moment of take-off. It includes existing aeronautical information, such as: ■ restricted areas, danger areas, CTRs etc.; ■ information extracted from NOTAMS, and legislation; ■ temporary restrictions from the national airspace authority; to produce an overall picture of where drones may operate This includes an enhancement of geo-awareness that allows geo-fence changes to be sent to drones immediately. The drone must have the ability to request, receive and use geo-fencing data.
	Geo-fence Information Exchange	The Geo-fence Information Exchange is between U-space and ATC and enables dynamic updates.
	Flight authorisation	Performs various checks and pre-flight services, manages authorisation workflows with relevant authorities, including ATC, and dynamically takes airspace changes into account to participate to strategic conflict detection and resolution.
	U-plan processing	Maintains and gives access to the data set for each active flight.
	Dynamic Capacity Management	Responsible for balancing traffic demand and capacity constraints during operational plan processing.
	Vertiport Availability	Publishes the short-term planning of Vertiports, enabling their safe use as emergency landing sites.
Conflict management	**Strategic Conflict Detection**	Checks for possible conflicts in a specific operation plan before flight
	Strategic Conflict Resolution	Proposes solutions, during operational plan processing and before flight. It may be also in flight but "down stream"
	Tactical Conflict Detection	Checks for possible conflicts in real time and provides conflict alerts
	Tactical Conflict Resolution	Advices or instructions to aircraft to change their speed, level or heading as needed to resolve these conflicts. These instructions should reach the pilot (or piloting system) rapidly and reliably.

	CORUS U-space service	Description
Emergency management	**Emergency Management**	Provides assistance to a drone pilot experiencing an emergency with their drone, and communicates emerging information to interested parties.
	Incident/Accident Reporting	A secure and access-restricted system that allows drone operators and others to report incidents and accidents, maintaining reports for their entire life-cycle. A similar citizen-access service is possible.
	Citizen reporting service	A secure and access-restricted system that allows citizens to report what they have observed when they believe incidents or accidents involving drones have occurred.
Monitoring	**Conformance monitoring**	Provides monitoring alerts (preferably audible) about the progress of a flight (e.g. conformance monitoring, weather compliance monitoring, ground risk compliance monitoring, electromagnetic monitoring).
	Traffic Information	Provides the drone pilot or operator with information about other flights that may be of interest to the drone pilot; generally where there could be some risk of collision with the pilot's own aircraft.
	Vertical Alert & Information*	Alerts GA pilots and drones / drone pilots in any Geodetic Altitude Mandatory Zones (GAMZ) to any risk of collision with ground obstacles.
	Navigation Infrastructure Monitoring	Provides status information about navigation infrastructure during operations. This service should give warnings about loss of navigation accuracy.
	Communication Infrastructure Monitoring	Provides status information about communication infrastructure during operations. The service should give warnings about degradation of communication infrastructure.
	Legal Recording	A restricted-access service to support accident and incident investigation by recording all input to U-space and giving the full state of the system at any moment. A source of information for research and training.
	Digital Logbook	Produces reports for a user based on their legal recording information.
Environment	**Weather Information**	Collects and presents relevant weather information for the drone operation including hyperlocal weather information when available/required.
	Geospatial information service	Collects and provides relevant terrain map, buildings, obstacles - with different levels of precision – for the drone operation.
	Population density map	Collects and presents a population density map for the Drone operator to assess ground risk. This could be proxy data (e.g. mobile telephone density).
	Electromagnetic interference information	Collects and presents relevant electromagnetic interference information for the drone operation.
	Navigation Coverage in-formation	Provides information about navigation coverage for missions that will rely on it. This information can be specialised depending on the navigation infrastructure available (e.g. ground or satellite based).

	CORUS U-space service	Description
	Communication Coverage information	Provides information about communication coverage for missions that will rely on it. This information can be specialised depending on the communication infrastructure available (e.g. ground or satellite based).
Interface with ATC	**Procedural Interface with ATC**	A mechanism invoked by the operation plan processing service for coordinating the entry of a flight into controlled airspace before flight. Through this, ATC can either accept or refuse the flight and can describe the requirements and process to be followed by the flight.
	Collaborative Interface with ATC	Offers verbal or textual communication between the remote pilot and ATC when a drone is in a controlled area. This service replaces previous ad-hoc solutions and enables flights to receive instructions and clearances in a standard and efficient manner.
	Tactical Operational Message Information Exchange	Sends ATC instructions to UAS operators.

TABLE 6: U-SPACE SERVICES (SESAR)
[22], [30], [27]

*__Vertical conversion__ and __Vertical Alert and Information services__ are services defined by the ICARUS project ([28]) which propose a common altitude reference system. Within zones where there is a risk of altitude confusion, the competent authority may declare a "Geodetic Altitude Mandatory Zone" (GAMZ). In a GAMZ, when aircraft exchange altitude information, it shall be exchanged in the form of geodetic height, that is referenced to the WGS84 ellipsoid. The need for a GAMZ is independent of other properties of the airspace.

2.1.6 - U-space organisation

2.1.6.1 - EASA approach to the airspace structure

As mentioned previously, U-space also relies on specific volumes of airspace named "***U-space airspace***" – it means **geographical zones where U-space services are required**.

The U-space Regulation applies to operators of manned (except military and state aircraft) and unmanned aircraft and U-space service providers, in the volumes of airspace designated as U-space airspace. For application of U-space Regulation to operators of manned aircraft, additional rules (e.g. specific coordination procedures) are laid out in EU Implementing Regulation 2017/373.

U-space airspace establishment is under responsibility of the EU Member States (MSs) as "*'U-space airspace' means a UAS geographical zone designated by Member States, where UAS operations are only allowed to take place with the support of U-space services.*" [12]:

- Within controlled airspace, U-space airspace is dynamically managed by the Air Navigation Service Provider (ANSP). The unmanned and manned traffic will not mix with each other as they are dynamically segregated.
- The ANSP remains responsible for the provision of air navigation services to operators of manned aircraft and certified unmanned aircraft operated under IFR, the U-space Service Provider (USSP) is responsible for the provision of U-space services to operators of unmanned aircraft that do not comply with IFR rules. Within uncontrolled airspace, airspace remains uncontrolled for manned aircraft and certified drones. USSP is "responsible for providing the UAS operators with the U-space services referred to in Article 3(2) and (3) *(of regulation IR 2021/664)* during all phases of operations in that U-space airspace" [12]

When MSs designate a volume of airspace as U-space airspace, a restriction occurs for (could be established as a restricted area):

- Drone operators to use U-space services to fly in that airspace (except in subcategory A1 of 'open' category);
- Manned aircraft which are provided with an air traffic control service and drones remain segregated through dynamic airspace reconfiguration.

Indeed, according to the regulation IR (EU) 2019/947, the competent authority may establish a portion of airspace named "***UAS geographical zone"*** that "*facilitates, restricts or excludes UAS operations in order to address risks pertaining to safety, privacy, protection of personal data and security or the environment, arising from UAS operations*".

The summary of the airspace structure for the drone operations is provided below:

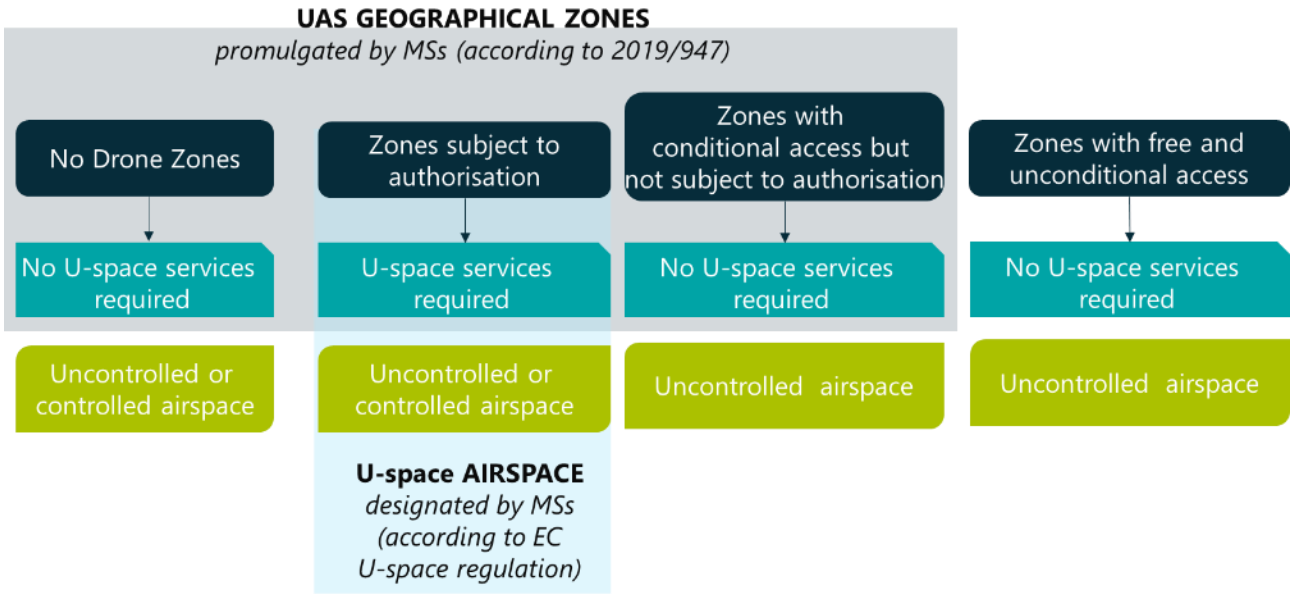

FIGURE 6: U-SPACE ORGANISATION

2.1.6.2 - SESAR JU approach to the airspace structure

Note: Outside of the accepted European Union regulatory framework, SESAR Joint Undertaking (JU) in their Research and Demonstration (R&D) activities has proposed different U-space approach. It is worth to note, that these R&D activities has not been taken into account by the regulatory framework at the moment and are here to provide view on the current U-space initiatives.

According to SESAR CORUS-XUAM CONOPS, VLL airspace could rely on three types of volumes according to the services provided:

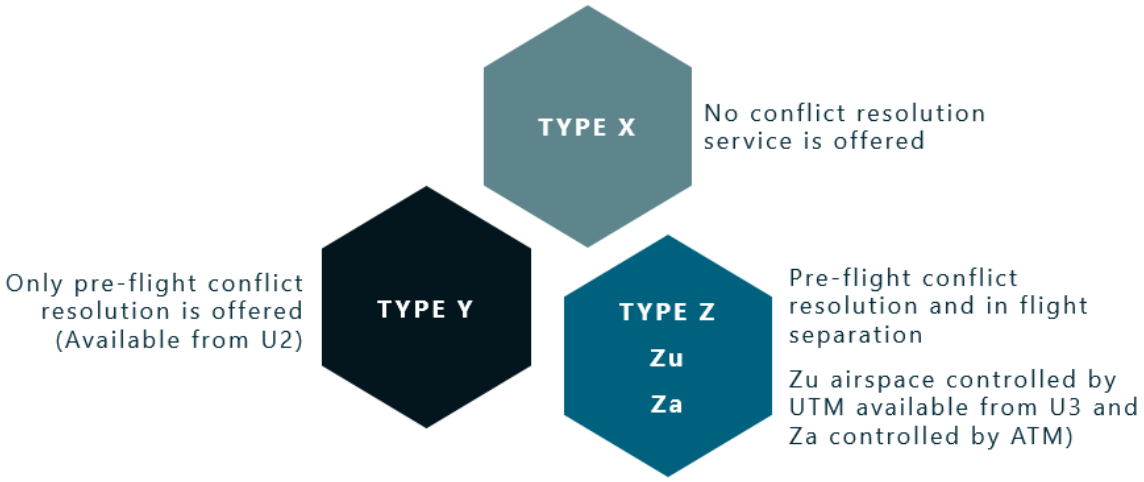

FIGURE 7: AIRSPACE TYPES
[22]

<u>Note:</u> The expectation is that the most of the drones used for professional purposes (operating in the 'Specific' category) will fly in Very Low Level (VLL) airspace.

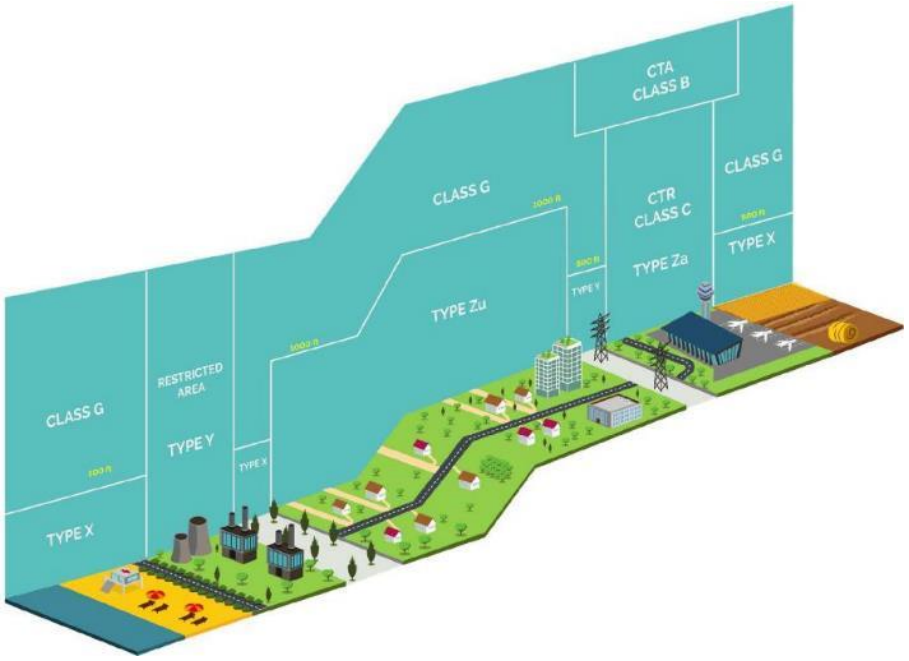

FIGURE 8: X, Y, Z VOLUMES
[22]

The following table lists a minimum set of services and possible operations for each volume:

XUAM-CORUS U-space volume	Access conditions	Mandatory services	Possible operations

X	• Few basic requirements on the operator, the pilot or the drone
	• The pilot remains responsible for collision avoidance at all times
		• Registration
		• Traffic Information
		• Incident/Accident Reporting
		• Vertical Conversion
		• Emergency Management
			• Drones:
			  ○ Open category
			  ○ VLOS, EVLOS , Follow me
			  ○ Other flight modes require risk assessment
			• Other airspace users: manned VFR flight

Y[9]	• Requires an approved operation plan
	• A pilot trained for Y operation
	• A remote piloting station connected to U-space
	• A drone and remote piloting station capable of position reporting when available
		In addition to X volume mandatory services:
		• Tracking
		• Flight Authorisation
		• U-plan processing
		• Geo-awareness (including dynamic Geo-fencing)
		• Strategic Conflict Prediction and Resolution
		• Monitoring including Conformance Monitoring
		• Collaborative Interface with ATC
		• Vertical Alert and Information
		• Navigation Infrastructure Monitoring
		• Digital logbook
			• Drones:
			  ○ Open, Specific and Certified category
			  ○ VLOS, EVLOS , BVLOS
			  ○ Other flight modes require risk assessment
			• Other airspace users: manned VFR flight

Z[10]
• **Za: ATM controlled airspace**
• **Zu: UTM controlled volume in which U-space will provide a tactical conflict resolution service**
	• An approved operation plan
	• A pilot trained for Z operation and/or a compatible, connected automatic drone
	• A remote piloting station connected to U-space
		In addition to Y volume mandatory services:
		• Dynamic Capacity Management
		• Tactical Conflict Prediction and Resolution
		• Procedural Interface with ATC
			• Drones:
			  ○ Open, Specific and Certified category
			  ○ VLOS, EVLOS , BVLOS, automated flight in Zu
			  ○ Other flight modes require risk assessment
			• Other airspace users: manned IFR and VFR flight

[9] *Y airspaces may also have specific technical requirements attached to them*

[10] *Z airspaces may also have specific technical requirements attached to them, most probably that the drone will be fitted with the collaborative detect and avoid system for collision avoidance.*

• **Zz: UTM controlled volume in which U-space will provide a tactical conflict advisory service**	• A drone and remote piloting station capable of position reporting		

TABLE 7: VOLUME TYPES, ACCESS CONDITIONS, MINIMUM SET OF SERVICES AND POSSIBLE OPERATIONS

More details on CORUS-XUAM vision on separations between drones are provided in CORUS-XUAM CONOPS[27]

2.2 - U-space regulation development

The official work on a UTM framework of the European institutions has started only in 2015, even though it has been known and discussed for several years. The Military and State aircraft operations are excluded from the scope of this regulation. However, military as an airspace user needs to consider how the regulation is shaping the U-space, notably the future rules of the air, the new structure of the airspace, the roles and responsibilities of current and new stakeholders and the possible interactions between them.

The key actors in the European U-space development are:

FIGURE 9: ACTORS IN THE EUROPEAN U-SPACE DEVELOPMENT

It is important to mention that ICAO is leading efforts towards the development of the UTM framework.

ICAO has recently issued a fourth edition of the *Unmanned Aircraft Systems Traffic Management (UTM) – A Common Framework with Core Principles for Global Harmonisation* [5] .This document provides the framework and core capabilities of a "typical" UTM system taking into consideration the needs of the military and security communities.

The following table provides an overview of the different steps taken in the scope of the drone regulatory framework:

1944 ● **ICAO DOC 7300** Article 8	**The first reference to the drone regulations appeared in Article 8 of the original ICAO Document 7300: "*No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without*** *special authorisation by that State* ***and in accordance with the terms of such authorization.*** *Each contracting State undertakes to ensure that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft***."** [1]
Over the years ● **Member States developing their own rules**	However, no further initiatives were taken, and Member States started to develop their own regulations without collaboration between them.

2015 ● **EASA Advance Notice of Proposed Amendment (A-NPA 2015-10) and Technical Opinion 2015** Proposal of Regulatory framework for all UA	In 2015, EASA developed proposals for an **operation centric**, **proportionate, risk- and performance-based regulatory framework for all UA**. The main outcome is a general concept of three drone operations categories ('open', 'specific' and 'certified') that formed basis for drone operations.
2017 ● **JARUS guidelines** Specific Operations Risk Assessment (SORA)	In 2017, JARUS developed guidelines on Specific Operations Risk Assessment (SORA).
2018 ● **EASA Regulation (EU) 2018/1139** Competences extension	In 2018, the regulation on common rules in the field of civil aviation and establishing a European Union Aviation Safety Agency (EU) 2018/1139 extended the competence of the Union to all drones, irrespective of their weight or size.
2019 ● **Commission Delegated Regulation (EU) 2019/945** Detailing technical requirements for drones operating in the EU ADOPTED: MARCH 2019 APPLICABLE: JULY 2019 **Commission Implementing Regulation (EU) 2019/947** Detailing the rules and procedures for the operation of unmanned aircraft ADOPTED: MAY 2019 APPLICABLE: JULY 2020 (SOME PARTS FROM 2021)	In 2019, 2 regulations are promulgated: • DR (EU) 2019/945: on unmanned aircraft systems and on third-country operators of unmanned aircraft systems, amended in 2020 to address new drone classes (2020/1058); • IR (EU) 2019/947: on rules and procedures for drone operation (2019/947), amended in 2020 to address standard scenarios for operations executed in or beyond the visual line of sight (2020/639). As well as related Guidance Material (GM) and Acceptable Means of Compliance (AMC).
2020 ● **EASA: Opinion 01/2020** High-level regulatory framework for the U-space	EASA published in 2020 a proposal for the High-level regulatory framework for the U-space including: • Annex to EASA Opinion N° 01/2020; • Draft acceptable means of compliance (AMC) and Guidance Material (GM) to Opinion N° 01/2020 on a high-level regulatory framework for the U-space.
Rev. 2021 ● **EASA Easy Access Rules for Unmanned Aircraft Systems** Regulation (EU) 2019/947 and (EU) 2019/945	This document makes the regulation accessible in an efficient and reliable way to stakeholders. It addresses the cover regulation (recitals and articles) with the Implementing Rules (IR) points, the related acceptable means of compliance (AMC) and guidance material (GM). As last comes the delegated rules (DR).
2021 ● **European Commission U-space regulatory package** Commission Implementing Regulations (EU) 2021/664, 2021/665 & 2021/666 APPLICABLE: 26/01/2023	The regulatory package lays down rules for the: • Safe operations of UAS in the U-space, • Safe integration of the UAS into the aviation system • Provision of U-space services.

2022 ● **EASA: Acceptable Means of Compliance (AMC) and Guidance Material (GM) to IR (EU) 2021/664** Support for UAS Operators and MS in complying with U-space regulatory package PUBLISHED: DECEMBER 2022	This document provides the means enabling the implementation of the U-space, i.e., to ensure interoperability and provide means to give the necessary flexibility to allow for regional or local implementation of U-space

TABLE 8: REGULATORY OVERVIEW

The following timeline highlights the applicability date to be considered by the Member States and related competent authority.

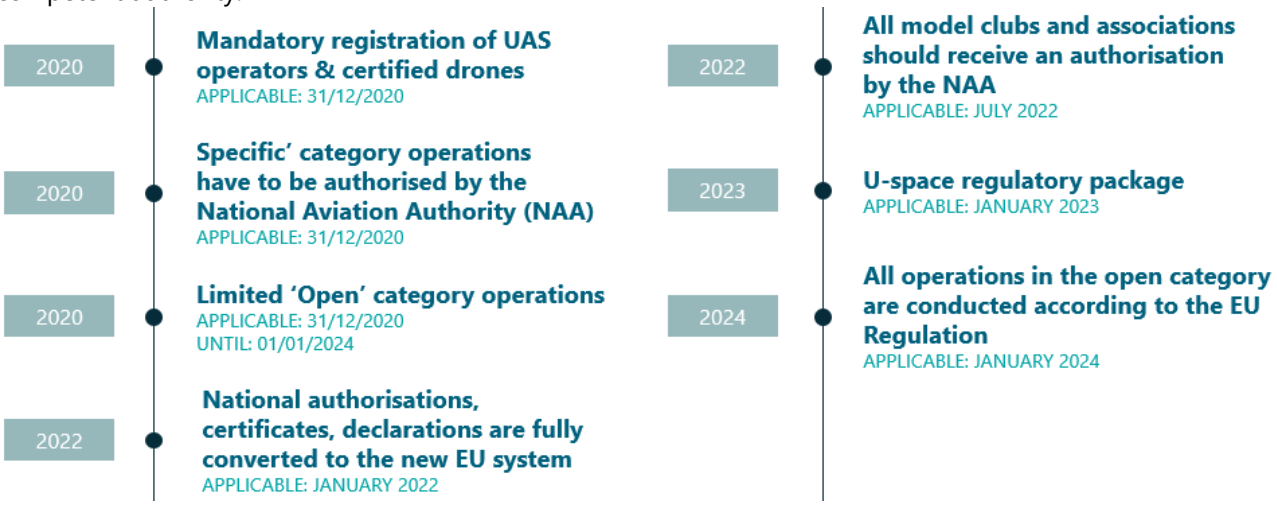

FIGURE 10: EASA DRONES REGULATORY FRAMEWORK APPLICABILITY TIMELINE

In addition, several studies that provide additional material and guidelines on U-space were conducted.

	Studies
SESAR JU developments	U-space Blueprint
	SESAR JU U-space research and innovation results of more than 20 research and demonstration projects including particularly: ■ U-space Concept of Operations developed by the CORUS and CORUS-XUAM projects.
EUROCONTROL	UAS-ATM Integration – Operational Concept (11/2018)

TABLE 9: U-SPACE SUPPORTING DOCUMENTATION

2.3 - Main elements from the U-space existing material

This sub-section takes the most relevant documentation on U-space, both regulatory documents and studies development and **analyses the main outcomes**. Additionally, it sums up any **information provided on military involvement in the U-space.**

2.3.1 - EC Drone Strategy 2.0

The European Drone Strategy 2.0 has been published on 29/11/2022 by the European Commission. This communication sets out the vision of the Commission for a mature and thriving drone eco-system in 2030 in the EU, and identifies 19 flagship actions to further build the drone service market and strengthen the drone civil, security and defence industry capabilities and synergies. This document recognises the potential contribution of military drones to the European strategic autonomy and identifies the defence/military dimension as part of the overall European drone ecosystem.

Among the 19 flagship actions, the following ones stand out as particularly relevant for the military, whether in terms of operations, financing or development of capabilities:

- Flagship action 3: The Commission intends to adopt new European standard scenarios for low to medium risk aerial operations, possibly to address needs related to military operations;
- Flagship action 9: The Commission intends to continue to provide funding for R&I on drones and their integration into the airspace under the Horizon Europe programme and the European Defence Fund.
- Flagship action 10: The Commission intends to set up a coordinated series of calls under the existing EU instruments and EIB loans to support a new flagship project on 'drone technologies'. These technologies can correspond to civil, military or dual-use systems.
- Flagship action 11: The Commission will consider possible amendments to the existing financing/funding framework to ensure a consistent approach in support of dual-use research and innovation to improve synergies between civil and defence instruments.
- Flagship action 12: The Commission intends to develop a Strategic Drone Technology Roadmap in order to identify priority areas to boost research and innovation, reduce existing strategic dependencies and avoid the emergence of new ones.
- Flagship action 13: The Commission intends to coordinate with other relevant EU actors a common approach with the aim of providing sufficient radio frequencies spectrum for drone operations.
- Flagship action 14: The Commission intends to set up an EU network on civil-defence drone testing centres to facilitate exchanges between civilian and defence sectors.
- Flagship action 15: The Commission will encourage all relevant actors to further align certification requirements for civil and military applications towards those set by EASA while considering military specificities and existing military certification standards.
- Flagship action 16: The Commission intends to adopt new standard scenarios for civil operations that could facilitate corresponding military use cases.

2.3.2 - EASA U-space materials

Regulations and establishment of common rules are one of the most important elements. To ensure smooth and safe drone operations, EASA has currently developed the Common European rules that are based on the operational risk assessment of drone manufacturers and operators. **The military are out of the scope of these regulations but are identified as stakeholders in the U-space concept**.

- DR (EU) 2019/945 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems, amended in 2020 to address new drone classes (DR 2020/1058);
- IR (EU) 2019/947 on rules and procedures for the drone operation, amended in 2020 to address standard scenarios for operations executed in or beyond the visual line of sight (IR 2020/639). The application dates of these regulations have then been postponed through IR 2020/746, IR 2021/1166 and IR 2022/425;
- IR (EU) 2021/664, IR (EU) 2021/665 and IR (EU) 2021/666 on a regulatory framework for the U-space.

2.3.2.1 - Commission Delegated Regulation (EU) 2019/945 on unmanned aircraft systems and on third-country operators of unmanned aircraft systems

In a nutshell, the DR (EU) 2019/945 does:

- Provide the requirements for the design and manufacture of drone that are supposed to be operated under the rules and conditions defined in Implementing Regulation (EU) 2019/947;
- Define the type of drones that should be subject for the certification in design, production and maintenance;

- Set up rules to make accessories kit and remote identification add-ons for drones available on the market and on their free movement in the EU;
- Establish rules for third-country drone operators. [6]

2.3.2.2 - Commission Delegated Regulation (EU) 2020/1058 amending Delegated Regulation (EU) 2019/945 as regards the introduction of two new unmanned aircraft systems classes

This regulation introduces new types of the drone classes: C5 and C6 as well as requirements for the drone operated in the 'certified' and 'specific' categories except when conducted under a declaration.

2.3.2.3 - Commission Implementing Regulation (EU) 2019/947 on the rules and procedures for the operation of unmanned aircraft

The European Regulation IR (EU) 2019/947 has entered into force 31st of December 2020. This regulation replaces EU wide national legislation and provides a new framework for the use of drones in different types of airspace, most notably in Low-Level Airspace.

This regulation divides flights into 3 drone operation categories: 'Open', 'Specific' and 'Certified' and further specifies:

- Categories of drone operations;
- The rules and procedures for the drone operations;
- The rules and procedures for the competency of remote pilots and their minimum age;
- The rules and procedures for the airworthiness of drones;
- The rules for conducting on operational risk assessment;
- Authorising operations in the 'specific' category;
- Cross-border operations or operations outside the state of registration;
- Registration of drone operators and certified UAS;
- Operational conditions for UAS geographical zones;
- Drone operations in the framework of model clubs and associations;
- Designation of the competent authority;
- Tasks of competent authority;
- Safety information;
- Particular provisions concerning the use of certain drones in the 'open' category;
- Adaptation of authorisations, declarations and certificates;
- Transitional provisions;
- Entry into force and application. [9], [16]

2.3.2.4 - Commission Implementing Regulation (EU) 2020/639 amending Implementing Regulation (EU) 2019/947 as regards standard scenarios for operations executed in or beyond the visual line of sight

The IR (EU) 2020/639 develops two standard scenarios VLOS and BVLOS operations in specific conditions created a need to amend IR (EU) 2019/947. [10]

It has to be noted that this regulation introduces a requirement regarding Application for an operational authorisation (UAS.SPEC.030). According to the EASA GM1 UAS.SPEC.030(3)(e), the operational manual template when compiling chapters of operational manual in the pre-flight preparation and checklists the drone operator should include: "*coordination with third parties, if applicable (e.g. requests for additional permits from*

various agencies and the military when operating, for example, in environmentally protected areas, areas restricted to photographic flights, near critical infrastructure, in urban areas, emergency situations, etc.)". [10].

2.3.2.5 - 2021 U-space regulatory package

The European Commission has adopted the U-space regulatory package in April 2021. The U-space regulation is based on two existing EU implementing regulations and the whole package consists of:

- Commission Implementing Regulation (EU) 2021/664 on a regulatory framework for a U-space;
- Commission Implementing Regulation (EU) 2021/665 amending Implementing Regulation (EU) 2017/373 as regards requirements for providers of air traffic management/air navigation services and other air traffic management network functions in the U-space airspace designated in controlled airspace;
- Commission Implementing Regulation (EU) 2021/666 amending Regulation (EU) No 923/2012 as regards requirements for manned aviation operating in U-space airspace.

The package aims to allow drone operations in low level airspace and in urban area, and defines the roles and the responsibilities of the different stakeholders. Each Member State is responsible for defining portions of airspace that is designated as U-space airspace. These are subject to a risk assessment. Within this airspace, all stakeholders provide and share data about their operations thus making sure the information required for safe operations is available to everybody, including the military. USSPs and relevant air traffic service units shall share information about manned aircraft and UAS traffic, so that they can manage the segregation and the deconfliction. In controlled airspace, the dynamic reconfiguration of the airspace is applied in order to make sure that manned aircraft which are provided with an air traffic control service and UAS remain segregated.

More details on U-space services and the U-space airspace concept can be found in sections 2.1.3 - , 2.1.4 - and 2.1.5 - .

The main principles introduced by this regulatory package are:

- U-space airspace
  - Member States are responsible for designating UAS geographical zones as U-space airspaces, where all drone operations are subject to at least four mandatory U-space services;
  - In each U-space airspace, Member States are responsible for determining capabilities and performance requirements, U-space services performance requirements and applicable operational conditions and airspace constraints;
  - Cross-border U-space airspace can be established jointly by several Member States.
- Common Information Service (CIS)
  - The MSs may designate a single CISP (centralised model) where a single CISP collects CI elements from CA, ATSP and USSPs, and make them available to all operational stakeholders. The single CISP is certified.
  - The distributed model of CIS remains the default option where each element of the Common Information is unique and comes from a given source – no duplication or competition in CI provision. Each provider of CI elements makes them available to other operational stakeholders and the ATSPs and USSPs are certified, including for the provision of CI.
- Dynamic Reconfiguration of Airspace
  - Clarification of roles and responsibilities where USSPs ensure a strategic deconfliction of drone flights in U-space, and provide tactical traffic information to drone operators and the drone operators are responsible to avoid collision between themselves and with manned aircraft. When the drone is flying in accordance with IFR and can fly like manned aircraft, ATSP are responsible to provide them services;

- The dynamic airspace reconfiguration procedures will need to take into account manned aircraft navigation performance and available surveillance means as well as the airspace classification and design so that the ATSPs can ensure that manned aircraft remains at all time out of U-space airspace actively managed by USSPs. Within controlled U-space airspace designated by a Member State, the dynamic reconfiguration of the airspace should be applied to make sure that manned aircraft which are provided with ATC service and UAS remain segregated;
- USSPs use a combination of the UAS flight authorisation, geo-awareness services and traffic information to allow safe operations of drone in the remaining portion of U-space;
- In the extreme case of complete U-space airspace 'deactivation', all ongoing drone flights may need to be discontinued and landed safely;
- Dynamic Reconfiguration of Airspace is specifically needed in cases where the U-space airspaces is established in controlled airspace so that ATSPs can exercise their responsibilities and is expected to be subject to full cost recovery as part of the CI (Common Information) pricing.

Military is mentioned in IR 2021/664 as follows:

- (recital 13) Although military and State aircraft operations are excluded from the scope of this Regulation, there is a need to ensure safe separation of aircraft in the U-space airspace. Therefore, Member States should be able to define static and dynamic U-space airspace restrictions to enable such operations in a safe and efficient manner.
- (recital 28) This Regulation should not apply to aircraft operations carrying out military, customs, police, search and rescue, firefighting, border control and coastguard or similar activities and services undertaken in the public interest, under the control and responsibility of a Member State or on behalf of a body vested with the powers of a public authority unless the Member State has decided pursuant to Article 2(6) of Regulation (EU) 2018/1139 to apply rules on unmanned aircraft to some or all of those activities. [12]

On 20/12/2022, EASA has published its first set of acceptable means of compliance (AMC) and guidance material (GM) for the U-space regulatory package (IR (EU) 2021/664, (EU) 2021/665 and (EU) 2021/666). This AMC/GM is supported by an Explanatory Note that clarifies that:

- Through this GM, EASA expressly includes military organisations as relevant stakeholders in the U-space as third party. The need for military cooperation is acknowledged to improve safety of both civilian and military flights by sharing relevant data between them.
- EASA suggests limiting the U-space airspace to a 150 m (500 ft) height above the ground. This limitation is deemed desirable to ensure safety of operations, considering the novelty of U-space and the lack of experience with its implementation. Although this limitation helps in keeping drones outside of controlled airspace and thus in improving the safety of mixes manned/unmanned operations, this does not fully address the issue for military flights, which can routinely take place in very low level airspace.
- The AMC/GM envisages the Dynamic Airspace Reconfiguration (DAR) mechanism as a mean to define U-space airspace restrictions to enable military operations. However, the DAR is only applicable in controlled airspace and no similar solution is proposed in uncontrolled airspace.

A new version or update is scheduled later in 2023 to take account of the feedback from the first U-space implementers.

2.3.3 - JARUS material: Specific Operations Risk Assessment (SORA)

SORA is a specified methodology that guides the drone operator and the competent authority to see if a drone operation can be conducted in a safe way. It is a multi-stage risk assessment process which goal is to analyse the risk of certain unmanned aircraft operations and determine necessary mitigations and robustness level. As a result it should help to integrate drone operations with manned aviation.

SORA is used to determine the acceptability of a proposed operation of drone 'specific' category. Two classes of risk that are foundations for the Specific Assurance and Integrity Levels (SAIL) have been determined:

- Ground Risk Class (GRC);
- Air Risk Class (ARC).

SAIL represents the confidence level whether the drone operation stays under the control within the boundaries of the intended operation. To mitigate the risk, SORA permits the operators to use treat barriers and or mitigating measures. The last step of the risk assessment is the recommendation of the Operational Safety Objectives (OSO) that should be met.

SORA has been recognised by the European Union Aviation Safety Agency (EASA) as being an Acceptable Means of Compliance (AMC) to fulfil the requirements of the EU Regulations (Basic Regulation, Implementing Act, Delegated Act and Annexes).

Any other aspects not related to safety (e.g. privacy, security) should be assessed by the MS's Applicable requirements in which the operation will take place, or by another EU regulation. [16], [12], [46]

Following a few years of use of the SORA 2.0 methodology, JARUS is preparing an update called SORA 2.5 that affects the main body of the supporting document as well as several annexes. This update introduces a quantitative definition of ground risk assessment and makes a general revision of the text to simplify the language and make it easier to understand. The updated methodology will be published following a public consultation period in which took place in Q1 2023.

In parallel, JARUS has also initiated the work on the subsequent update, SORA 3.0, which should notably focus on a more accurate air risk model, enabling better airspace integration, and add a new annex for aviation authorities to the main body of the document.

2.3.4 - SESAR JU U-space vision[11]

SESAR Joint Undertaking launched several initiatives for SESAR 2020 wave 1 2017 - 2020 with the aim to support safe and efficient access to airspace for large numbers of drones. The timeline of this work is shown below.

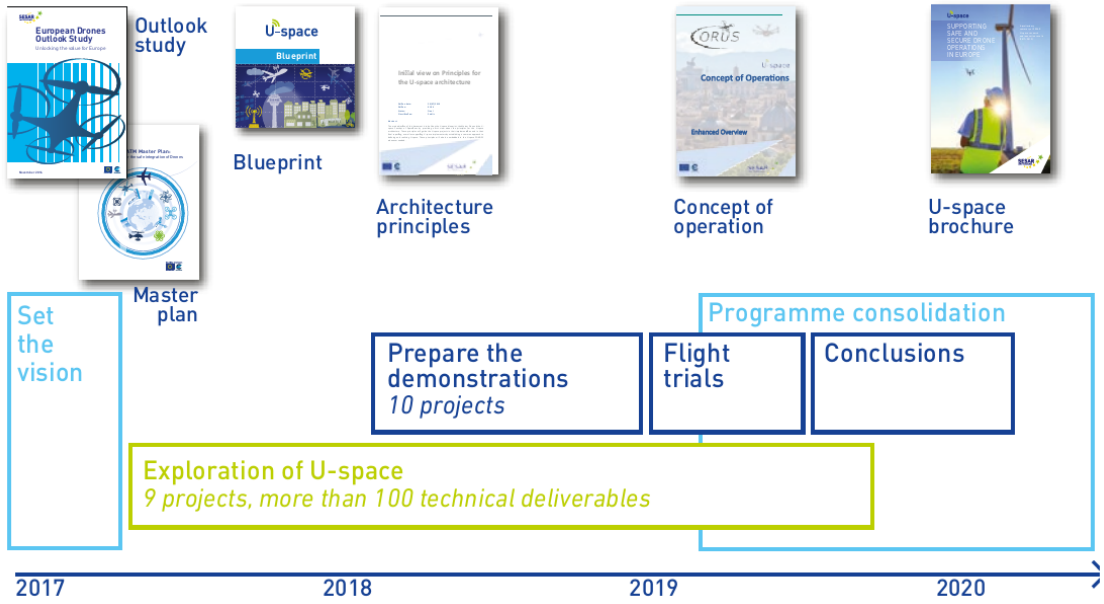

FIGURE 11: SESAR JU U-SPACE OVERVIEW
[24]

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[11] *Note: Outside of the accepted European Union regulatory framework, SESAR Joint Undertaking (JU) in their Research and Demonstration (R&D) activities has proposed different U-space approach. It is worth to note, that these R&D activities has not been taken into account by the regulatory framework at the moment and are here to provide view on the current U-space initiatives.*

SESAR JU initiative has continued its research and demonstration projects in SESAR 2020 Wave 2 (2020-2022), with a second set of projects. The list of projects concerning UAM, U-space & ATM and Advanced Services is displayed in Figure 12. Additional details on these projects are provided in Annex 7.4.1 - .

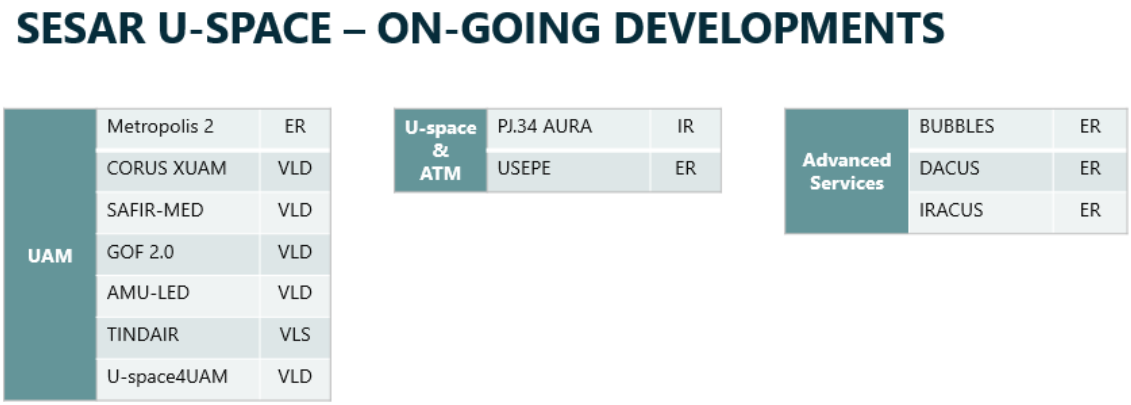


FIGURE 12: SESAR U-SPACE – SESAR 2020 WAVE2 PROJECTS

Since end of 2022 SESAR3 has launched new U-space digital sky SESAR demonstrators: BURDI, U-ELCOME and EALU-AER. And in 2023 SESAR 3 JU has selected 48 research projects within the framework of its ambitious Digital European Sky research and innovation programme (2022 – 2040). These projects address exploratory research, industrial research, and activities to fast-track innovative solutions, all with a view to making air traffic management in Europe smarter and more sustainable. Among these 48 new projects, 8 are about U-space and Urban Air Mobility:

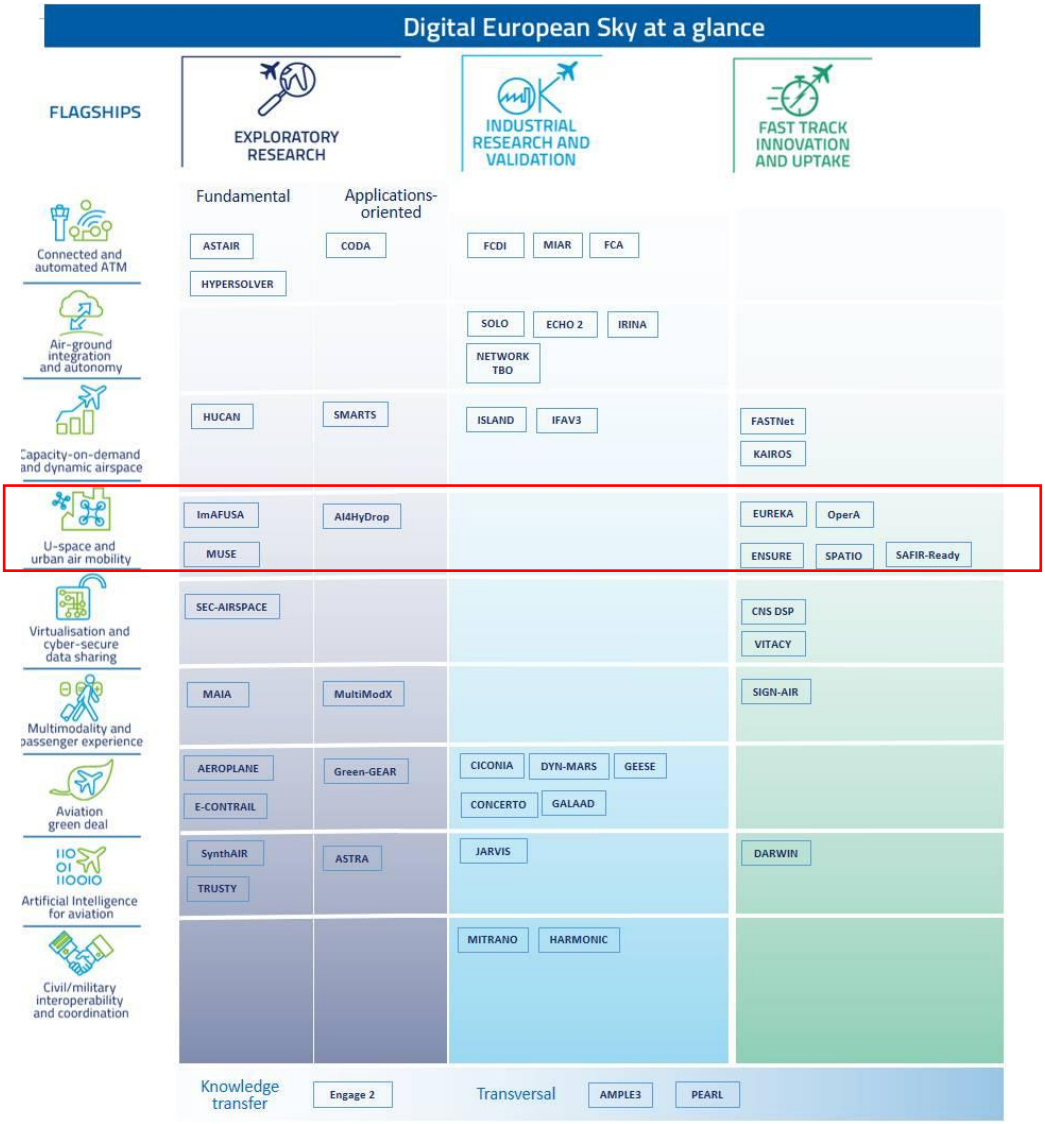


FIGURE 13: SESAR 3 - U-SPACE AND UAM PROJECTS

Additional details on these projects are provided in Annex 7.4.1 -

2.3.4.1 - U-space Blueprint

The U-space Blueprint specifies the U-space as a set of services and procedures designed to support safe, efficient and secure access to airspace for large numbers of drones, although the U-space Blueprint did not focus on military involvement and view. For more information on U-space definition and key principles, please refer to 2.1.3 - , 2.1.5 -

The deployment is associated with the development of block of services and technologies that are supposed to be gradually introduced over 4 phases (U1-U4).

U1 – Foundation services	E-registration, e-identification and geofencing.
U2 – 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 – Advanced services	Support more complex operations in dense areas and may include capacity management and assistance for conflict detection. Indeed, the availability of

automated 'detect and avoid' (DAA) functionalities, in addition to more reliable means of communication, will lead to a significant increase of operations in all environments.

U4 – 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. [21]

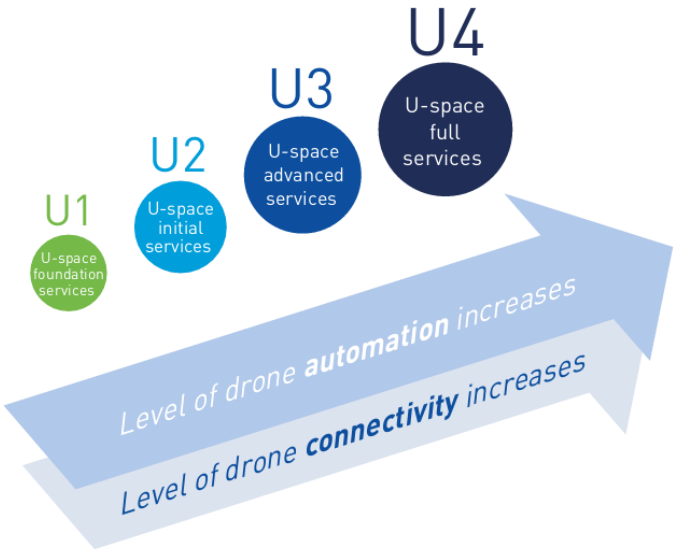


FIGURE 14: U-SPACE DEPLOYMENT PHASES
[21]

The current focus in on U1 and U2 development stages, however, all the U2, U3 and U4 services are subject to future research and innovation activities. [21]

2.3.4.2 - U-space Concept of Operations by CORUS (2019) / CORUS-XUAM (2023)

SESAR's U-space Concept of Operations (ConOps) for EuRopean Unmanned Air Traffic Management Systems (CORUS) is one of the first outcomes of the SESAR U-space initiative. The CORUS project produced three editions of the U-space ConOps between 2017 and 2019 in an iterative process involving collaboration with a large number of stakeholders including other research projects.
This ConOps is a target concept used as a reference for SESAR projects to enable safe and efficient Very Low-Level drone (VLL) operations.

But since the third version of the CORUS ConOps [23] published in 2019, the "U-space regulations" EU 2021/664 [12], 2021/665 [13] and 2021/666 [14] together with their Acceptable Means of Compliance and Guidance Material have been published so a new version of the CONOPS was needed. This new version, the fourth edition [27] has been published in April 2023 by the CORUS-XUAM project.

The key elements of CORUS-XUAM CONOPS are:

- the U-space services and how they are used and the environment in which they are used. See section 2.1.5 -
- Urban Air Mobility which is defined as air operations which are:

- above urban areas, at least for part of the flight,
- in 'U-space airspace,' – see Section 2.1.6.2 -
- performed by a mix of traffic which includes aircraft, incapable of flying IFR or VFR and with very limited range,
- in traffic dense enough that tactical separation is needed to ensure safe operations.

In addition, the CORUS-XUAM ConOps describes:

- Management of remotely piloted aviation of any level of autonomy
- Management of Pilot-on-board aviation
- Use of U-space in flight scenarios by different stakeholders
- Ground infrastructure such as Vertiports
- Contingency scenarios
- Safety
- Security including cyber-security
- Risk assessment and mitigation
- Social acceptability
- Flight rules
- Traffic management
- Optimisation of flight or traffic or airspace use according to key performance areas

The CORUS-XUAM ConOps recognises military as Airspace Users (manned and unmanned aircraft) but not in the role of defence and security providers, regulators, airport owners, Communication, Navigation and Surveillance and Air Navigation service providers.

Despite the lack of information, the CORUS-XUAM CONOPS identified:

- That the VLL airspace is also used by other classes of airspace users, such as military aircraft;
- One example of planned entry into VLL could be Military training and that U-space shall give the priority to military and public service mission, such as very low level training, Search and Rescue, medical evacuation, police, etc.;
- The need to communicate emergency information from Emergency management U-space service to those who may be interested such as the military.

The CORUS-XUAM CONOPS thus highlights the need for protection of priority operations, such as military operations but does not specify any details.

2.3.4.3 - Consolidated report on SESAR U-space research and innovation

2.3.4.3.1 - SESAR 2020 Wave 1 (2017-2019)

From 2017 until the end of 2019, SESAR JU and its partners have completed 19 research and demonstration projects, addressing everything from the concept of operations for drone operations, critical communications, surveillance and tracking, and information management to aircraft systems, ground-based technologies, cyber-resilience and geo-fencing. *Consolidated report on SESAR U-space research and innovation results* [24] summarises the outcomes from these 19 projects.

It is important to note, that all are civil aviation projects and even though many stakeholders were participating, the military were not involved.

Projects have worked in U1-U3 U-space service blocks, in a variety of geographical environments and airspace classes, while taking into account several types of flight mode, operational environment, density and complexity of drone traffic and complexity of the service provision.

All U1 services were fully addressed and almost all U2 services were addressed. The projects have demonstrated that **U1 and U2 services were ready for use in environments with low levels of complexity** (rural areas, segregated airspace) and a low density of traffic. The projects demonstrated:

- The feasibility of providing multiple services;
- Strategic deconfliction;
- The possibility of increasing situational awareness through information sharing;
- The importance of reliable tracking and monitoring;
- The interface with manned aviation.

However, it has also highlighted the areas for improvement and future needs:

- A strong need for performance requirements and system standardisation;
- Further develop and validate U-space to cater for high complexity/high density operating environments (urban operations, mixed traffic).

The SESAR JU 19 research and demonstration projects outlined the future research and developments news in key areas:

- **Urban air mobility (UAM)** (UAM-related scenarios, services, procedures, infrastructures and tools to enable expected operations at low and very low level in inter-urban, suburban and urban areas). This area of work should aim to investigate the ecosystem required for managing UAM operations in which more strategic management services are provided along with more tactical management services, such as en-route tactical separation management and departure and arrival management at vertiports.
- **Air traffic management (ATM)/U-space convergence** - (development of a common altitude reference system (CARS), transition to autonomous vehicles, and a collaborative decision-making process between the urban operations, ATM and city authorities).
- **Advanced U-space services and technologies (U3 & U4)** – (including the development of miniaturisation, automated detect and avoid functionalities, and reliable means of communication). [22], [24]

2.3.4.3.2 - SESAR 2020 Wave 2 (2020-2023)

In 2020, a second wave of industrial and exploratory research projects and very large-scale demonstrations got underway to extend the scope of U-space to address more advanced services, including addressing the requirements for urban air mobility (UAM).

This has created an innovation pipeline for U-space, supporting the delivery of exciting new opportunities, such as medical services, goods delivery, air taxis and emergency response.

The complete project list is described in section 7.4.1 -

Some of these projects have demonstrated very interesting results on the readiness of U-space services to manage a broad range of drone operations and related applications, and their interaction with manned aviation.

Relevant results of these projects include:

ICARUS:

Currently there is no common altitude reference in manned vs unmanned aviation, or between different drone manufacturers. ICARUS project proposes an innovative solution to the challenge of the **Common Altitude Reference inside VLL airspaces** with the definition of a new U3 U-space service and its validation in a real operational environment.

In manned aviation, the methods of determining the altitude of an aircraft are based on pressure altitude difference measurements (e.g., QFE, QNH and FL) referred to a common datum. As its main results, ICARUS introduces GNSS-based altitude and provides a two-way height-transformation that can be provided as a service to manned and unmanned aircraft in a given airspace. The ICARUS project has shown the feasibility of a Common Altitude Reference for UAS based on WGS-84 that provides safe and reliable vertical UAS.

However, the concept is still at an early stage of maturity (i.e., TRL 2) and significant work remains to be conducted before operational use (i.e. TRL 9) can be envisaged: development of documentation, certification of the service, and proven highly scalable data models and algorithms.

GOF 2.0:

GOF2.0 is a project aiming to safely, securely, and sustainably demonstrate the operational validity of serving combined UAS, eVTOL and manned operations in a unified, dense urban airspace using current ATM and U-space services and systems.

The demonstrations focus on validation of the GOF 2.0 architecture for highly automated real-time separation assurance in dense air space including precision weather and telecom networks for air-ground communication and significantly contributing to understanding how the **safe integration of UAM and other commercial drone operations into ATM airspace** without degrading safety, security or disrupting current airspace operations can be implemented.

GOF2.0 has demonstrated an unified air operation traffic management with high levels of automation serving both manned and unmanned aircraft in a safe, interconnected, distributed, interoperable, efficient, scalable and environmentally optimized manner. Highly automated separation assurance in dense airspace – specifically in areas where urban mobility and aerodrome traffic is expected – is becoming a critical capability to efficiently manage a unified airspace. Integrated trajectory management service based on flight plan information and real-time surveillance combined with a digitally connected environment will provide the basic safety net for all aviators.

AURA:

The global objective of AURA was to lay the foundations for the integration of the new entrants in current and future air traffic environment, developing the required concept of operations and validating U-space services information exchanges with ATM systems. In order to achieve this objective, all relevant stakeholders (drone operators, U-space service providers, data services providers, ATM providers and authorities) are included during the project development and throughout its lifetime.

AURA project identifies the requirements for U-space information exchange with ATM through SWIM and validates a set of selected U-space services, developing the service definition for the SWIM candidate services. Secondly, it defines a novel Collaborative ATM-U-space ConOps for drones in a fully collaborative environment with ATM that go beyond the existing concepts developed for an U-space and validates these new concepts. A key concept within AURA is that flight plans are authorised by default. However, manual authorization of flight plans is required for very high-risk environments, such as airports and their surrounding areas.

The different AURA trials through several use cases (strategic and tactical coordination, validation of process for requesting authorisation and activation form USSP, emergency situation with Dynamic Reconfiguration, UAS deviation and associated conformance alert raised…) validated how manned and unmanned operations could coexist in controlled airspace, thanks to the extensive use of dynamic airspace reconfiguration. The proposed solution allows keeping safe segregation between drones managed by U-space and manned aircraft controlled by air traffic management.

The project results serve as input to regulators such as EASA, and to standardisation bodies working actively in U-space. A collaborative ATM U-space environment increases airspace interoperability and improves the security of operations, while new standards enable development and realisation of the economic potential of the drone market, according to project partners. It is also worth noting that some project partners have defined a field for military flight plan in the SWIM-based interface between USSPs and the ANSP.

AMU-LED

The AMU-LED aims at first defining, and then testing in live conditions, UAM operations in a U-space eco-system for coordinated flights of several types of drones in different scenarios, use cases and applications (e.g. air taxis, emergency services, delivery of goods, surveys, etc.) for surveillance, logistics and mobility using air vehicles.

Among the most important outcomes, AMU-LED showed that U-space services can manage prioritised flights safely. This includes rerouting flights and enabling different vehicles and mission types to co-exist. Other capabilities included safe management of planned and unintended flight paths, coordination with air traffic control making use of CISP and USSP services, and beyond visual line of sight (BVLOS) flights.
AMU-LED stakeholders collaborated with aviation safety authorities in each state to ensure all planned flights were authorised, and provided feedback to standardisation bodies and regulators, which is helping to define the future U-space regulatory framework. The project also identified gaps in standards development, and specifically how it can evolve to enable UAM operations.

2.3.5 - EUROCONTROL UAS-ATM Integration – Operational Concept

The UAS-ATM Integration Operational Concept by EUROCONTROL with the collaboration of EASA, proposed different UAS Airspace Structures:

Airspace Structure		Airspace Volume	Comments
No Drone Zone (NDZ)		Y or Z	Drones are totally prohibited unless authorised
Limited Drone Zone (LDZ)		Y or Z	Drones are allowed if specific requirements are met
Exclusive Drone Zone (EDZ)	**EDZu (unplanned)**	X	Restricted area for manned aviation reserved for unplanned drones flights
	EDZp (planned)	Y or Z	Restricted area for manned aviation reserved for planned drone flights

	EDZm (passenger carrying operations)	Y or Z	Reserved for urban mobility
Dedicated drone routes			Waypoints dedicated to drone traffic to support segregation of manned and unmanned traffic

TABLE 10: DRONE AIRSPACE STRUCTURE FROM ECTL OPERATIONAL CONCEPT
[31]

Each airspace structure is possibly using X, Y, and Z volumes. The report also provides an example of classes separation by height that could be achieved by layering Z or Y volumes above X.

2.3.6 - EUROCONTROL Airspace Risk Assessment guidelines

The U-space regulation requires that the designation of a UAS geographical zone as a U-space airspace shall be supported by "*an evaluation of operational, safety and security risks that takes into account the required levels of safety performance as defined in the European Plan for Aviation Safety and the State Safety Programme referred to in Articles 6 and 7 of Regulation (EU) 2018/1139, the type, complexity and density of the traffic, the location, altitudes or heights and the airspace classification*." This Airspace Risk Assessment (ARA) can result in mandating additional U-space services in the U-space airspace, such as weather information and conformance monitoring, and determines the performance requirements and operational conditions associated with this specific U-space airspace.

EUROCONTROL has developed guidelines to support this process in the "U-space Airspace Risk Assessment, Method and Guidelines - Volume 1" document ([33]), providing States with written guidance on how to perform the airspace risk assessments. This document is fully aligned with the AMC/GM for IR (EU) 664 and describes a systematic process for conducting an ARA through its three main phases:

- Preparatory Phase: to define the scope of the assessment and the required resources;
- Reference Scenario Phase: to compile a full picture of the airspace being assessed;
- Assessment Phase: to address safety, security, privacy and environmental hazards, as well as the required risk mitigation measures.

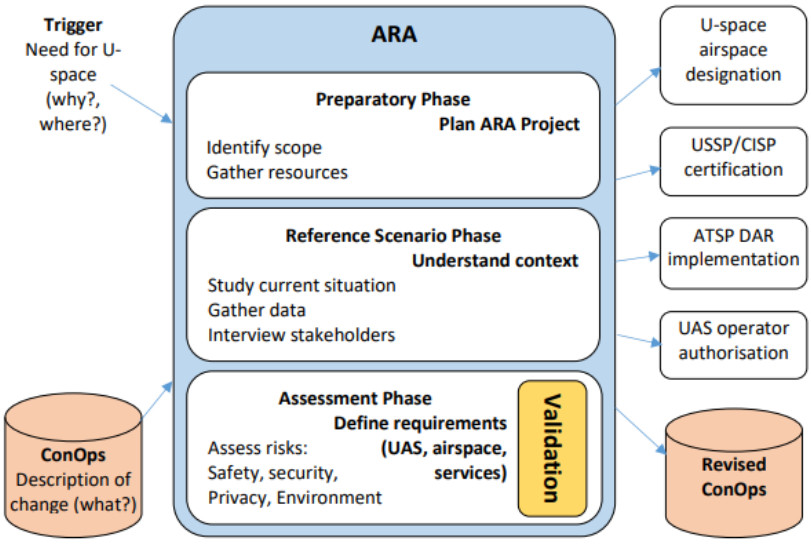


FIGURE 15: OVERVIEW OF THE AIRSPACE RISK ASSESSMENT PROCESS

The guidance applies EUROCONTROL's soon-to-be-published Expanded Safety Reference Material (E-SRM) to perform a complete safety assessment of the change, which in this case is the designation of a new U-space airspace.

2.3.7 - EUROCAE WG-105 – Unmanned Aircraft Systems (UAS)

EUROCAE WG-105 – Unmanned Aircraft Systems (UAS) aims to develop standards and guidance documents for the safe operation of UAS in all types of airspace for all types of operations. These standards are monitored by the European UAS Standards Coordination Group (EUSCG) that coordinates the European standardisation activities in the area of UAS and link them to those at international level. This information are listed in the European UAS Standardisation Rolling Development Plan (RDP).

WG-105 consists of six Focus Teams which work is coordinated by a Steering Committee.

- UAS Traffic Management (UAS)
- Command, Control, Communication (C3)
- Detect and Avoid (DAA)
- Design and Airworthiness Standards
- Specific Operations Risk Assessment (SORA)
- Enhanced RPAS Automation (ERA)

The objective of new WG-105 Work Programme is to support the U-space implementation and is based on the draft U-space regulation. The list of intended deliverables is shown below:

- Technical Specification for Geographical Zones and U-Space data provision and exchange;
- Minimum Operational Performance Standards for Network Identification Service of UAV in UTM U-space;
- Minimum Operational Performance Standard for Traffic Information Situation Dissemination Exchange;
- Minimum Operational Performance Standards for Flight Planning and Authorisation Service for Global awareness in UTM U-space;
- Minimum Operational Performance Standard for U Space Geo Awareness Service.

2.4 - U-space developments in selected countries

This section provides a brief overview of U-space developments in some of the EU countries and illustrates different approaches taken by each state. The countries present different geographical areas and stages of U-space development.

For additional information on U-space services implementation in different EU countries see eATM Portal - *https://www.atmmasterplan.eu/depl/U-space.*

2.4.1 - Belgium

Skeyes, the Belgian ANSP, has been preparing for the implementation of the new European regulation (IR (EU) 2019/947) that is valid from 31/12/2020 for several years.

The ***Droneguide map*** is used for consulting the restrictions and measures in Belgium airspace including the military airspace, their status (active, non-active) and the conditions to access it.

In early 2020, Skeyes has created a commercial subsidiary ***skeydrone*** that is in charge of delivering services to Drone operators (USSP).

As the drones are now able to operate in the entire airspace except if there is a "UAS (Unmanned Aircraft System) geographical zone", skeydrone has developed ***UAS Geo-zone management software*** around airports

to guarantee safe operations. This software offers a range of applications enabling to manage and monitor flight authorizations in the most complex UAS geographical zones. The skeydrone ***Drone Service Application (DSA)*** is used for controlled airspace above and around 6 major Belgian airports. [34], [35], [36],[37]

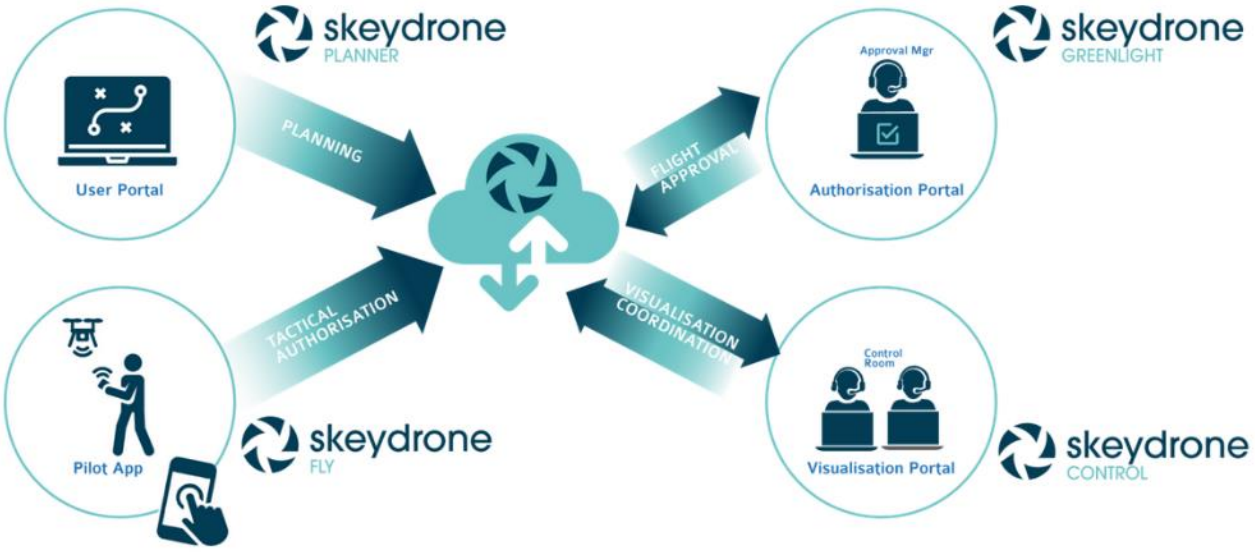


FIGURE 16: SKEYDRONE GEO-ZONE MANAGEMENT SOFTWARE

In addition, skeydrone works on other solutions as for example ***6th NeTWork (NW)*** that targets to implement a 24/7 drone (network) infrastructure allowing drones to perform on-demand missions for business purposes. [38]

Skeyes and the Belgian Civil Aviation Authority are currently preparing the future implementation of U-space airspaces over Belgium. This joint activity will enable elaboration of a framework to designate U-space airspaces after a risk assessment process, and to certify Skeyes as Common Information Service Provider (CISP) and SkeyDrone as U-space airspace Service Provider (USSP).

2.4.2 - France

In France, the '***U-space Together***' **programme** has been created by DSNA (French Air Navigation Service Provider) in cooperation with UTM Service Providers.

In order to experiment and develop the future French traffic management system dedicated to civil drones, DSNA has launched an innovative approach based on collaborative and competitive partnerships with industry suppliers. Operational trials of Minimum Viable Product level solutions are carried out since early 2020 on several aerodromes such as Clermont-Ferrand, Nice and Paris-Orly. These successive trials of pre-operational services paved the way for a second phase of the programme, initiated in 2022, to test the provision of U-space services at a wider scale and with more technologically-mature solutions.

DSNA is also supporting several pioneering projects such as:

- **SOFIA DRONE** (Provision of Aeronautical Information Services) – the Aeronautical Information Management (AIM) programme launched by DSNA. SOFIA DRONE transfers aeronautical information into digital form and provides no-fly and restricted zones to Drone operators.
- **COUNTER UAV** (Detection and management of non-cooperative drone intrusions) – **HOLOGARDE** solution that provides high-level features for drone intrusions detection, classification and decision-making.

- **RPAS WITHIN CIVIL AIR TRAFFIC** – DSNA together with French Air Force have been involved in the integration of medium altitude long endurance drones (MALE). Drones are integrated in civil air traffic other than in segregated airspace.
- Participation in different SESAR JU Projects (PODIUM, USIS, Solution PJ.34-W3-01 Collaborative U-space-ATM interface, etc.).

Furthermore, several portals for drone operations have been launched in France:

- **Géoportal:** provides a map of restricted areas for the use of recreational drones in metropolitan France. Aimed at recreational drone pilots, this map is designed to provide users with visual support to easily locate areas where recreational drone flights are - or are not - permitted, and if so, under what conditions.
- **Mon espace drone:** Drone portal for professional drone users. Drone operators can register on the site to fill in their activity reports and notify the Ministry of Defence (Ministère des Armées) of any flights BVLOS flights or flights above 50m in airspace used by military aircraft. [39], [40]

2.4.3 - Poland

PANSA (Polish ANSP) introduced the 'PansaUTM' concept, a digitalised and automated drone flight coordination and flight plans management concept which is comprised of PANSA's own operating solutions and the system part integrated with *Droneradar*, the most popular mobile application among Drone operators in Poland. It is used as the source of primary information and aeronautical data. The system:

- Facilitates the flight coordination process (providing license and drone registration information);
- Specifies electronic creation of BVLOS and VLOS missions (bearing in mind terrain, airspace structure occupation, operational limitations and weather);
- Analyses the mission and issues permissions for specific drone flights at the pre-tactical stage;

All is happening electronically and in real time, detecting potential conflicts at the strategic level. The system has an air traffic control interface.

Among other functionalities of the PANSA UTM are:

- Real-time e-identification and drone location;
- Dynamic geo-fencing (enabling to create alert zones);
- Direct two-way non-verbal communication between ATS and Drone operator [41], [42]].

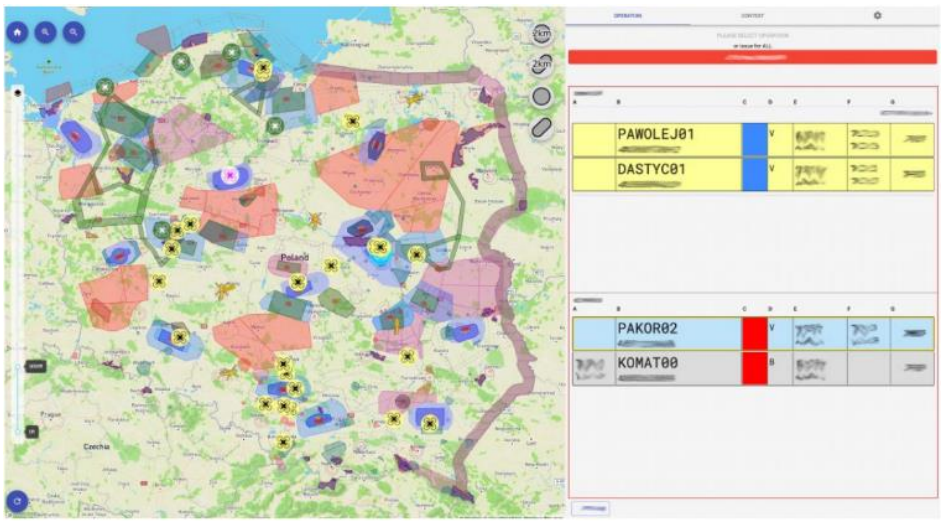


FIGURE 17: PANSAUTM

2.4.4 - Germany

In 2019, DFS - Deutsche Flugsicherung GmbH (the German ANSP) and Telekom founded the Joint Venture Droniq GmbH which is offering a commercial UTM system. The application gives information about the restrictions, rules and regulations to fly drones and is also used for planning and tracking drone flights in the territory of the Federal Republic of Germany. The regulation is compliant with EU Regulation dated to 31st December 2020. A drone operator can register its drone, plan flights and validate them against the new EU regulation through this app. It is also possible to transmit the take-off location for other users to make the drone visible for other airspace participants (in the UTM). They can be warned if they use the Droniq app. A logbook is available to document the flights. [31], [43], [44]

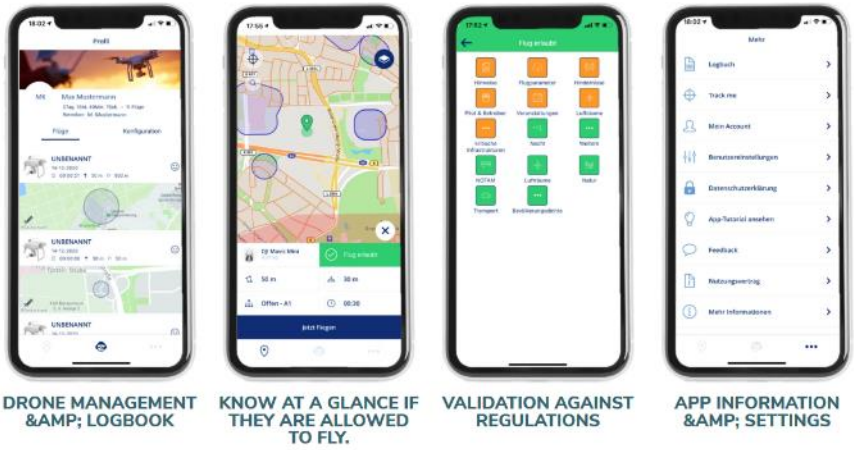


FIGURE 18: DRONIQ APP

In December 2022, the German Federal Ministry for Digital and Transport (BMDV) published their U-space concept in a document intended to provide the basis for the establishment of U-space airspaces. It serves to define the responsibilities, necessary structures and the procedure for the designation of U-space airspaces in accordance with the U-space regulation.

This concept document sets forth a number of principles:

- U-space airspaces will be primarily designated in urban areas, but also to facilitate the safe integration of drone traffic into specific areas (e.g., military airspace, cross-border drone operations).
- U-space airspaces will be defined as sets of hexagonal portions of airspace to enable a smooth reconfiguration of the U-space airspace.
- The BMDV will designate a U-space coordinator in charge of performing safety, security, environmental and privacy assessments in the process of designating U-space airspaces. The approval of the Federal Ministry of Defence is required for the designation of U-spaces if (low altitude) flight routes and airspaces under military responsibility are affected.
- The BMDV will designate a single CISP for all U-space airspaces in Germany.
- Entities in charge of security (e.g., military, police, domestic intelligence services, customs, civil protection, emergency services) are exempt from the obligation to use an USSP in U-Space. If they operate manned or unmanned aircraft in U-space airspace, they should be digitally connected to the Single CISP and transmit the routes and destinations of their aircraft as well as necessary temporary airspace restrictions to the Single CISP as soon as they are known.

The following diagram developed by the German LUV project illustrates the overall U-space architecture foreseen in Germany:

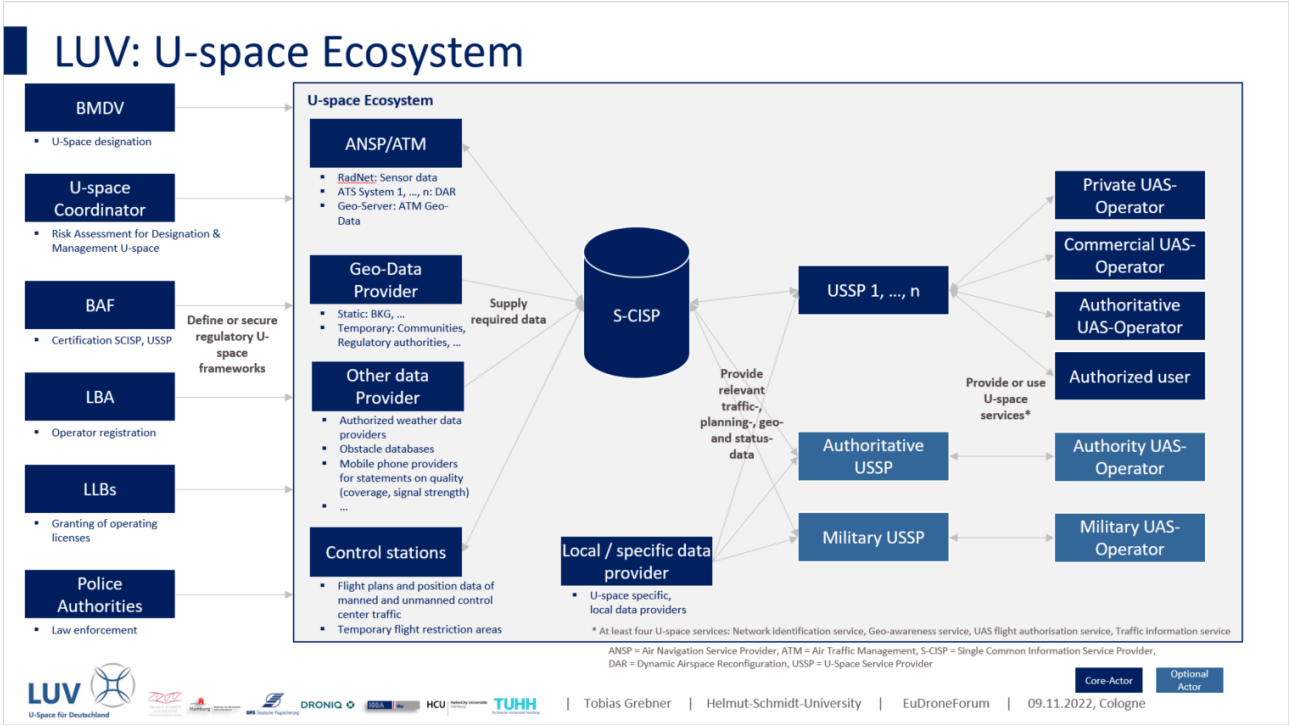


FIGURE 19: U-SPACE ARCHITECTURE FORESEEN FOR GERMANY

2.4.5 - Spain

The Ministry of Transport, Mobility and Urban Agenda has established the National Action Plan for the Deployment of the U-space (PANDU). The document has been developed under the leadership of the Directorate General of Civil Aviation (DGAC) with the co-authorship of the State Aviation Safety Agency (AESA) and ENAIRE, as well as the collaboration in its development of the Ministry of Defence.

The Plan sets out four objectives, which will be translated into specific action lines and actions along its time horizon:

1. Actions in the area of airspace.
2. Implementation of the national service delivery model.
3. Deployment of U-space and CIS services and enablers for their provision.
4. Establishment of mechanisms for cooperation and collaboration between administrations.

Spanish air navigation service provider ENAIRE, once certified, will become the single CISP for all U-space airspaces and a USSP for specific public sector activities. In order to prepare for these future roles, ENAIRE has entrusted Indra in a public tender with the deployment of its U-space system in Spain.

2.4.6 - Italy

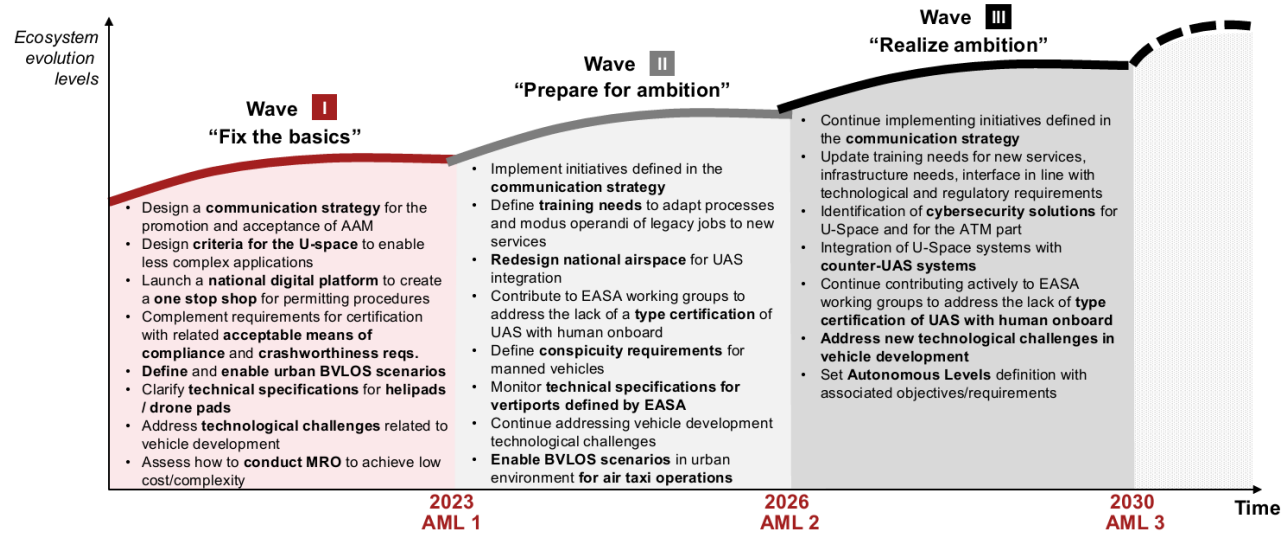
Italian CAA, ENAC, has developed an AAM National Strategic Plan (2021-2030) for the development of Advanced Air Mobility in Italy, which clearly identifies U-space as an enabler for future concepts such as AAM, allowing the integration of different airspace users in urban airspace. The strategic plan proposes an AAM framework around six pillars, including:

- Airspace design and implementation, which develops topics of airspace integration, definition of flight zones, restriction of certain flight altitudes, infrastructure requirements, ground risk assessment;
- Vehicle Management, which develops topics of risk classes, pilot licensing, flight over people, operations in BVLOS (Beyond Visual Line of Sight), autonomous flight, response to different weather conditions, maintenance requirements;

- Air Traffic Management, which develops topics of registration and identification, operator certification and licensing, U-Space requirements.

Three maturity levels (called AML, Advanced Air Mobility Maturity Level) have been defined, which will have to be reached at the end of different development waves in order to enable more and more applications in terms of complexity and number. The three waves, covering the periods 2021-2023, 2024-2026 and 2027-2030, will provide for the implementation of the activities identified in an overarching Roadmap with a continuous approach.

Roadmap waves overview



The strategic plan posits that integration of U-Space and ATM requires the definition of standardized SWIM interfaces between U-Space and ATM, but also between other stakeholders such as data service providers, aeronautical data providers and authorities. However, the Military are not explicitly mentioned among these stakeholders and the strategic plan makes no provision to address their specificities.

3 - IMPACT ASSESSMENT

3.1 - Assessment approach

The objective of section 3 - is to assess how the future U-space services will affect identified military objectives and missions. It is important to note that **the objective of this assessment is not to determine the impact of civilian drone operations on the military**, but rather the additional **consequences, both positive and negative, of the implementation of U-space services** in the near future. It also explores **how the military could benefit from the U-space services** that will be provided by USSPs.

As detailed in section 2 - , a large number of U-space services has been foreseen and is under definition. However, U-space regulation IR 2021/664 only mandates USSPs to implement four services in any given U-space airspace (cf. 2.3.1 -). The U-space regulation also mandates a set of common information services (CIS) that are considered as building blocks for the services delivered by USSPs. Finally, the U-space regulation allows Member States to require a weather information service and a conformance monitoring service in each of their U-space airspaces.

This section thus **focuses on the services mandated by the U-space regulation** as they are currently more mature in terms of development and will form a consistent baseline across all future U-space airspaces. Other services are still in the process of being defined and may not be available through all USSPs. They may be considered in future updates to this D1 document.

The services in the scope of this assessment are defined as follows in the U-space regulation:

- The **common information services** mean services "consisting in the dissemination of static and dynamic data to enable the provision of U-space services for the management of traffic of unmanned aircraft".
- The **geo-awareness service** "*should provide UAS operators with the information about the latest airspace constraints and defined UAS geographical zones information made available as part of the common information services. In accordance with Implementing Regulation (EU) 2019/947, the establishment of UAS geographical zones should take into account safety, security, privacy and environmental requirements*".
- The **UAS flight authorisation service** "*should ensure that authorised UAS operations are free of intersection in space and time with any other notified UAS flight authorisation within the same portion of U-space airspace*".
- The **network identification service** "*should provide the identity of UAS operators, and the location and flight vector of UAS during normal operations and in contingency situations, and share relevant information with other U-space airspace users*".
- The **traffic information service** "*should alert UAS operators about other air traffic that may be present in proximity to their UAS*".

The military are not only one of the major Airspace Users, but have also several important roles in the aviation community (regulator, airspace manager, service provider, airfield operator, etc.) that all have to be considered when evaluating the potential impact of U-space on the military. In order to assess the impact of U-space on these different roles of the military, we consider in this document the services they deliver to other actors and how these services will be affected by the future environment where U-space is implemented and U-space services are available to drone operators in U-space airspace. This approach indeed allows assessing **how the services provided by the military will be impacted or could be improved by the future U-space services**.

FIGURE 20: SERVICES PROVIDED BY THE MILITARY IN THEIR DIFFERENT ROLES

The different roles of the military entail a large range of missions, which are categorised in Figure 21 below according to NATO's allied joint doctrine for air and space operations ([53]), complemented with the support to public services that the military can provide, as well as with Air Policing.

> For the purposes of this document, we assume that the assessment only covers the training aspects of the Joint Air Operations in peacetime, and this ensures the analysis remains in a civil-military context. All forces (Air Force, Navy, Army and Special Forces) are considered in the assessment.

Figure 21 provides an overview of these missions and indicates, in light blue text, how the military Use Case developed in section 4 - of this document are covering them.

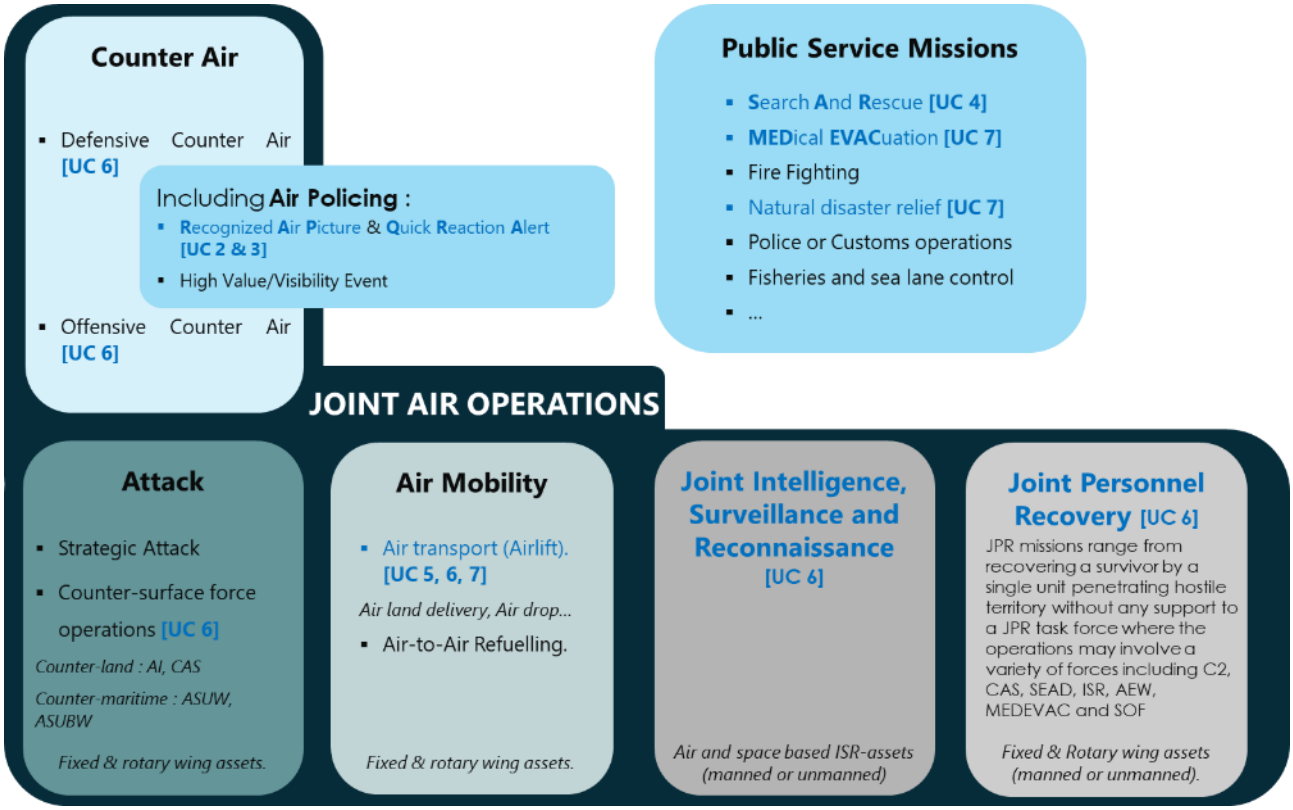


FIGURE 21: MILITARY MISSIONS CONSIDERED IN THE IMPACT ASSESSMENT

For each U-space service, an assessment matrix combining the key military missions and the services provided by the military will be applied to assess how they will be affected by the U-space service under consideration and how they could be improved if the military would contribute to this service. The outcome of this assessment is presented as a table providing answers and rationales to the three same questions:

- Is the Use-space service **detrimental** to military activities? In other words, what are the **negative effects** on the military if civilian drone operators have access to and use a given U-space service?
- Is it **useful** to the military, without their contribution to the service? Can the military derive any **indirect benefit** from the service being operated and used by the CISP, USSPs and drone operators, without the military actively using it themselves?
- Can it bring **potential benefits** if the military actively use or contribute to the service, e.g. by providing information on their own drone flights to USSPs? Given, that U-space is still under development, the answers to this question proposed in this document need to rely on assumptions that will be explicitly mentioned in each case and confirmed or revised in subsequent updates to this document.

If a given service is assessed as having an impact, whether beneficial or detrimental, on a given military mission, this impact is categorised against the following areas in order to generalise the assessment and support a quantitative cost-benefit analysis in the next steps of this study (cf. D2 deliverable):

- System costs;
- Operational efficiency and mission effectiveness;
- Safety;
- Cyber security;
- Training and human factors.

Figure 22 provides an overview of the assessment approach described above.

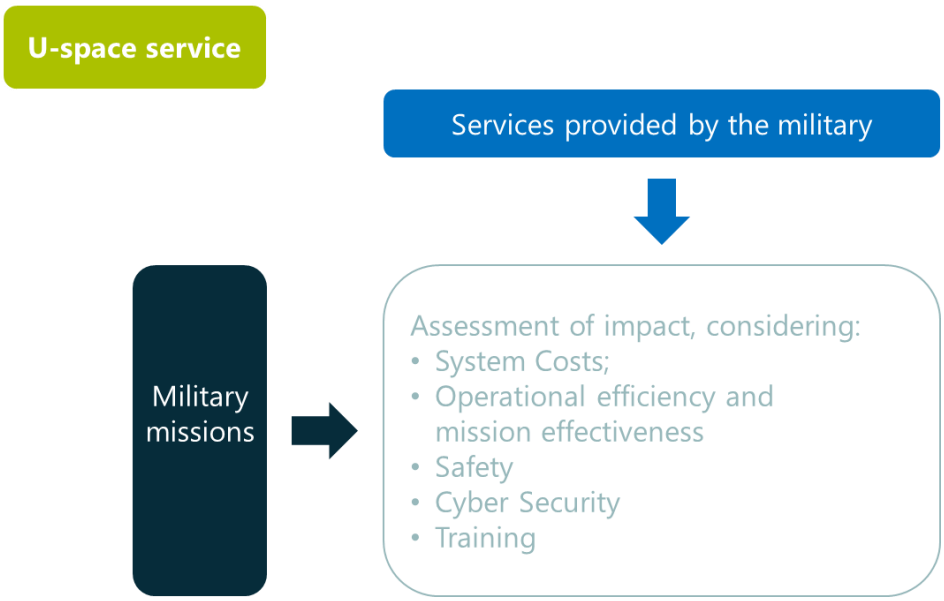


FIGURE 22: OVERVIEW OF IMPACT ASSESSMENT APPROACH

Lastly, it is already understood from the U-space state of the art in section 2 - that the development of civilian drone operations carries an inherent **SAFETY** issue in uncontrolled airspace as a new class of flying objects will operate, possibly without conspicuity means. U-space will provide a layer of safety as drones will have to comply with mandatory services, including conspicuity, to operate in these designated areas, but the corresponding requirements for drone operators are not yet known and they may not be compatible with military systems. Consequently, there is currently no guarantee that U-space will address this safety issue for military assets operating in U-space airspace. This issue is not specific to the military, though, and affects all airspace users in uncontrolled airspace.

Similarly, the development of drone operations creates **SECURITY** issues as there is currently no universally available solution to detect accidental or unlawful interferences of drone flights with sensitive assets. This D1 document recognises that the development of Counter-UAS (C-UAS) solutions is progressing and that they can mitigate some detrimental impacts identified in the following sections. However, our focus is on nominal operations and our impact assessment will not consider whether and how C-UAS can reduce or counterbalance any of the negative impacts identified.

Having noted that the development of drone operations, including outside of U-space, creates these underlying, and already recognised, **SAFETY** and **SECURITY** issues, the impact assessment presented in this section focuses on individual U-space services.

3.2 - Common information services

According to the description from U-space regulation IR 2021/664, a *"'common information service' means a service consisting in the dissemination of static and dynamic data to enable the provision of U-space services for the management of traffic of unmanned aircraft"*.

Member States are required to make the following data available to relevant authorities, air traffic service providers, U-space service providers and UAS operators as part of the common information services (CIS) of each U-space airspace:

- Horizontal and vertical limits of the U-space airspace;
- UAS capabilities and performance requirements, U-space services performance requirements and applicable operational conditions and airspace constraints;
- A list of certified U-space service providers offering U-space services in the U-space airspace, with the following information:
  - Identification and contact details of active U-space service providers;
  - U-space services provided;
  - Certification limitation(s), if any;
- Any adjacent U-space airspace (s);
- UAS geographical zones relevant to the U-space airspace and published by Member States;
- Static and dynamic airspace restrictions defined by the relevant authorities and permanently or temporarily limiting the volume of airspace within the U-space airspace where UAS operations can take place.

CIS are a critical U-space component, ensuring that common authoritative data is used by the respective operating entities and systems (both civil and military) utilising shared airspace, and providing the data needed by USSPs to deliver the other services.

U-space regulation IR 2021/664 also requires access to common information services to be granted to relevant authorities, air traffic service providers, U-space service providers and UAS operators. The military are thus identified as intended users of the CIS, which would allow them to **define their own services based on the data delivered through the CIS**.

To enable the dissemination of static and dynamic airspace restrictions to USSPs and drone operators, military agencies will have to provide military AIS and other data to the CIS. Although much of that data provision may be covered through existing aviation channels (AIRAC, NOTAM, etc.), additional military data may have to be supplied directly to the CIS, and this would need to be defined and standardised. Moreover, should military agencies use U-space services, the CIS must be able to supply information that may be of particular interest to the military.

The CIS will thus impact the Airspace Management (ASM) and Aeronautical Information Services (AIS) services provided by the military. If the military need to implement new channels to provide the information expected by the CIS, this may also impact the Communications Navigation Surveillance (CNS) service they provide as these new channels would likely have to be supported by data exchanges. Accurate and up-to-date information on the airspace restrictions in U-space airspaces will be a key input for the Air Navigation Services (ANS) and Recognised Air Picture (RAP)/Air Mission Control (AMC) services, as it will provide military Air Traffic Controllers (ATCOs), Air Surveillance Officers (ASOs) and Tactical Controllers (TAC C2) with the structure of the airspace where civilian and military aircraft, helicopters and drones operate. This information can also be used to plan flights if the military chose not to use the geo-awareness U-space service (cf. 3.3 -).

To interface with the CIS, ATS units and military controlling units (and possibly the airspace management cell) systems would need to be connected with the Common Information Service Provider (CISP). This will create **ADDITIONAL COSTS** to adapt and maintain military systems. Receiving information from CISP systems would

also create an **ADDITIONAL CYBER SECURITY RISK** for which the military would need to define and implement appropriate controls, and require additional work/studies in terms of **SAFETY MANAGEMENT SYSTEM**.

Military actors would also have to be trained to understand and use the information provided through the CIS, requiring **ADDITIONAL TRAINING**. As CISPs are not necessarily designed to have a human counterpart to military actors (as in current coordination between military and civil ATCOs for e.g.), the **HUMAN FACTORS** aspects of this new coordination will need to be carefully considered, particularly when urgent coordination on sensitive military topics is required.

Regarding Airspace Management (ASM) and Aeronautical Information Services (AIS), military authorities will incur **ADDITIONAL COSTS** to set up (or expand) the appropriate coordination cell, to define and implement new processes, and to train the personnel in charge of ASM and AIS

The CIS do not have a detrimental effect or a direct useful impact on the provision of the Meteo service by the military.

3.3 - Geo-awareness service assessment

According to the description from U-space regulation IR 2021/664, the geo-awareness service *"should provide UAS operators with the information about the latest airspace constraints and defined UAS geographical zones information made available as part of the common information services. In accordance with Implementing Regulation (EU) 2019/947, the establishment of UAS geographical zones should take into account safety, security, privacy and environmental requirements."*

Drone operators use the **geo-awareness service to prepare the drone flight and receive the latest information about airspace constraints** in the U-space airspace where they plan to operate.

U-space regulation IR 2021/664 also expects Member States and military authorities to promulgate restrictions in the form of permanent or temporary no drone zones to protect state and military operations (cf. 3.2 -), therefore contributing to strategic and pre-tactical airspace management (cf. also illustrative Use Case 1 in 4.1 -). This assessment thus **assumes that the military Airspace Management cell and Aeronautical Information Services processes will be expanded to include U-space airspaces** in their scope and that information regarding airspace restrictions decided by the military will be made available to CISPs, USSPs and, through them, to civilian drone operators.

Mission	Impact		Rationale
Joint Air Operations	Detrimental?	No	Civilian drone operators receiving information about the latest airspace constraints, including military ones, has no detrimental effect on Air Navigation Services (ANS), Communications Navigation Surveillance (CNS), Recognized Air Picture (RAP)/Air Mission Control (AMC), Flight Planning or Meteo services in the context of Joint Air Operations.
	Useful?	Yes	Civilian drone operators have a better awareness of existing military CTRs, R zones, P zones published by the national AIS, as well as of military airspace reserved for training through the ASM service. This is **IMPROVING SAFETY** when training for Joint Air Operations is conducted in U-space airspace. The geo-awareness service has no direct useful effect on ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Joint Air Operations.
	Potentially beneficial?	Yes	If the military receive information about U-space airspace constraints, ANS and AMC services could be improved thanks to a better awareness by Military ATCOs and Tactical Controllers of the status of the airspace concerned. Regarding Flight Planning, military pilots of both manned and unmanned aircraft involved in Joint Air Operations would also have a better awareness of the status of the airspace where they operate. Such information sharing would result in **IMPROVING SAFETY** in the U-space airspace where Joint Air Operations are conducted.

Mission	Impact		Rationale
			To benefit from the geo-awareness service for ANS and AMC, ATS units and military controlling units would need to be connected with the USSP. The information provided by the service would need to be directly displayed on controller working positions or on a separate network/display, which will be the case if no (automated) data feed from USSP via existing (ATM) interfaces, protocols and formats into the military systems is provided. The first option would create **ADDITIONAL COSTS** to adapt and maintain military systems. Receiving information from USSP systems would also create an **ADDITIONAL CYBER SECURITY RISK** for which the military would need to define and implement appropriate controls, and require additional work/studies in terms of **SAFETY MANAGEMENT SYSTEM**. Military actors would also have to be trained to understand and use the information provided through the geo-awareness service, requiring **ADDITIONAL TRAINING**. As USSPs are not necessarily designed to have a human controller equivalent (as in current coordination between military and civil ATCOs), the **HUMAN FACTORS** aspects of this new coordination will need to be carefully considered for future Joint Air Operations, particularly when urgent coordination on sensitive military topics is required. The geo-awareness service has no potential benefit on CNS, RAP/AMC or Meteo services in the context of Joint Air Operations.

Mission	Impact		Rationale
Air Policing	Detrimental?	No	Civilian drone operators receiving information about the latest airspace constraints, including military ones, has no detrimental effect on ASM, AIS, ANS, CNS, RAP/AMC, Flight Planning or Meteo in the context of Air Policing.
	Useful?	No	Civilian drone operators receiving information about the latest airspace constraints, including military ones, has no direct useful effect on ASM, AIS, ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Air Policing.
	Potentially beneficial?	Yes	If the military use the geo-awareness service[12], the Air Surveillance Operators in charge of the RAP could receive information about the latest airspace constraints. This would have a beneficial effect on their ability to identify drone flights operating in U-space airspace, if the tracks displayed on the tactical air situation display were underlaid with information on U-space airspace. This would lead to **OPERATIONAL EFFICIENCY** benefits. For AMC, Tactical Controllers could request temporary restrictions of U-space airspaces to prevent QRA interceptor flights from conflicting with civilian drone traffic, resulting in **IMPROVING SAFETY**. To benefit from the geo-awareness service for RAP/AMC, military controlling units would need to be connected with the USSP and the information provided by the service to be displayed on ASO/Tactical Controllers working positions or on a separate network/display. The first option would create **ADDITIONAL COSTS** to adapt and maintain military systems. Receiving information from USSP systems would also create an **ADDITIONAL CYBER SECURITY RISK** for which the military would need to define and implement appropriate controls, and require extra work/studies in terms of **SAFETY MANAGEMENT SYSTEM**. Military ASOs and Tactical Controllers would also have to be trained to understand and use the information provided through the geo-awareness service, requiring **ADDITIONAL TRAINING**. The geo-awareness service has no potential benefit on ASM, AIS, ANS, CNS, Flight Planning or Meteo services in the context of Air Policing.

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[12] This assessment assumes that the geo-awareness service will enable the notification of dynamic airspace reconfigurations to drone operators, which is not explicitly mentioned in EASA U-space Regulation. The forthcoming AMC/GM for U-space regulation IR 2021/664 may confirm this assumption.

Mission	Impact		Rationale
Public Service Missions	Detrimental?	No	Civilian drone operators receiving information about the latest airspace constraints, including military ones, has no detrimental effect on ANS, CNS, RAP/AMC, Flight Planning or Meteo in the context of Public Service Missions.
	Useful?	Yes	With appropriate ASM processes in place, as assumed in this assessment, the Tactical Controller and ATCO providing AMC to military pilots and drone operators involved in Public Service Missions could request the USSP to implement airspace restrictions to geo-fence the area where operations are conducted. This would prevent future drone flights from entering the area and **IMPROVE THE SAFETY** of military assets. The geo-awareness service has no direct useful effect on CNS, RAP/AMC, Flight Planning or Meteo services in the context of Public Service Missions.
	Potentially beneficial?	Yes	Regarding Flight Planning, military pilots of both manned and unmanned aircraft involved in Public Service Missions would also have a better awareness of the status of the airspace where they operate. Such information sharing would result in **IMPROVING SAFETY** in the U-space airspace where Public Service Missions are conducted. In case Public Service Missions involve both military and civilian drones, sharing information between drone operators would **INCREASE OPERATIONAL EFFICIENCY**. To benefit from the geo-awareness service for ANS and AMC, ATS units and military controlling units would need to be connected with the USSP. The information provided by the service would need to be directly displayed on controller working positions or on a separate network/display, which will be the case if no (automated) data feed from USSP via existing (ATM) interfaces, protocols and formats into the military systems is provided. The first option would create **ADDITIONAL COSTS** to adapt and maintain military systems. Receiving information from USSP systems would also create an **ADDITIONAL CYBER SECURITY RISK** for which the military would need to define and implement appropriate controls, and require extra work/studies in terms of **SAFETY MANAGEMENT SYSTEM**. Tactical Controllers and military ATCOs would also have to be trained to coordinate with USSPs and request airspace restriction, requiring **ADDITIONAL TRAINING**. As USSPs are not necessarily designed to have a human controller equivalent (as in current coordination between military and civil ATCOs), the

			HUMAN FACTORS aspects of this new coordination will need to be carefully considered for future Public Service Missions, particularly when urgent coordination on sensitive military topics is required. The geo-awareness service has no potential benefit on CNS, RAP or Meteo services in the context of Public Service Missions.

3.4 - UAS flight authorisation service

According to the description from the U-space regulation IR 2021/664, the UAS flight authorisation service *"should ensure that authorised UAS operations are free of intersection in space and time with any other notified UAS flight authorisation within the same portion of U-space airspace."*

The UAS flight authorisation service is used in pre-flight to **request and receive authorisation for the drone flight**.

Mission	Impact		Rationale
Joint Air Operations	Detrimental?	No	Civilian drone operators requesting and receiving flight authorisations has no detrimental effect on ASM, AIS, ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Joint Air Operations.
	Useful?	Yes	USSPs have to accept or reject requests for UAS flight authorisations against U-space airspace restrictions and temporary airspace limitations (including military ones), but also against new dynamic airspace restrictions and limitations, and information about manned aircraft traffic. If they are informed through ASM and AIS services about military training operations close to their area of responsibility, they can reject flight authorisations, resulting in **IMPROVING SAFETY** for military assets. The UAS flight authorisation service has no direct useful effect on ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Joint Air Operations.
	Potentially beneficial?	Yes	If the military use the UAS flight authorisation service, military ATCOs and Tactical Controllers could be notified of authorised drone flights, and thus develop a better awareness of these flights. This would result in **IMPROVING SAFETY** for the military flights to which they are providing ANS and AMC services. Regarding Flight Planning, military pilots of both manned and unmanned aircraft involved in Joint Air Operations would also have a better awareness of the drone flights expected in the airspace where they operate. To benefit from the UAS flight authorisation service for ANS and AMC, ATS units and military controlling units would need to be connected with the USSP. The information provided by the service would need to be directly displayed on controller working positions or on a separate network/display, which will be the case if no (automated) data feed from USSP via existing (ATM) interfaces, protocols and formats into the military systems is provided. The first option could generate significant **ADDITIONAL COSTS** to adapt and maintain military systems. Receiving information from USSP systems would also create an **ADDITIONAL CYBER SECURITY RISK** for which the military would need to define and implement

Mission	Impact		Rationale
			appropriate controls. Finally, potential extra work/studies could be requested in terms of **SAFETY MANAGEMENT SYSTEM**. Military ATCOs and Tactical Controllers would also have to be trained to understand and use the information provided through the UAS flight authorisation service, requiring **ADDITIONAL TRAINING**. As USSPs are not necessarily designed to have a human controller equivalent (as in current coordination between military and civil ATCOs), the **HUMAN FACTORS** aspects of this new coordination will need to be carefully considered for future Joint Air Operations, particularly when urgent coordination on sensitive military topics is required. The traffic information service has no potential benefit on ASM, AIS, CNS, RAP or Meteo services in the context of Joint Air Operations

Mission	Impact		Rationale
Air Policing	Detrimental?	No	Civilian drone operators requesting and receiving flight authorisations has no detrimental effect on ASM, AIS, ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Air Policing.
	Useful?	No	Civilian drone operators requesting and receiving flight authorisations has no direct useful effect on ASM, AIS, ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Air Policing.
	Potentially beneficial?	Yes	If the military use the UAS flight authorisation service, they could improve the RAP/AMC service. Air Surveillance Operators could correlate drone tracks to flight authorisations and thus to more easily identify drone flights. This would result in increased **MISSION EFFECTIVENESS**. Tactical Controllers could be aware of authorised drone flights when guiding QRA interceptor flights, resulting in **IMPROVING SAFETY** for the flights they are responsible for. To benefit from the UAS flight authorisation service for RAP/AMC, the military controlling units would need to be connected with the USSP and have the ability to analyse flight authorisations delivered by the USSP. Although this could be done via a separate network/display, it could generate significant **ADDITIONAL COSTS** to adapt and maintain military systems. Receiving information from USSP systems would also create an **ADDITIONAL CYBER SECURITY RISK** for which the military would need to define and implement appropriate controls. Finally, potential extra work/studies could be requested in terms of **SAFETY MANAGEMENT SYSTEM**. Air Surveillance Operators and Tactical Controllers would also have to be trained to understand and use the information provided through the UAS flight authorisation service, requiring **ADDITIONAL TRAINING**. The UAS flight authorisation service has no potential benefit on ASM, AIS, ANS, CNS, Flight Planning or Meteo services in the context of Air Policing.

Mission	Impact		Rationale
Public Service Missions	Detrimental?	No	Civilian drone operators requesting and receiving flight authorisations has no detrimental effect on ASM, AIS, ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Public Service Missions.
	Useful?	Yes	USSPs have to accept or reject requests for drone flight authorisations against U-space airspace restrictions and temporary airspace limitations, but also against new dynamic airspace restrictions and limitations, and information about manned aircraft traffic. If they are informed through ASM and AIS services of Public Service Missions being conducted in their area of responsibility, they can reject flight authorisations, resulting in **IMPROVING SAFETY** for military assets. Civilian drone operators requesting and receiving flight authorisations has no direct useful effect on ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Public Service Missions.
	Potentially beneficial?	Yes	If the military use the UAS flight authorisation service, military drone operators participating to Public Service Missions would benefit from an improved Flight Planning service, resulting in **IMPROVING OPERATIONAL EFFICIENCY**. Tactical Controllers and military ATCOs could be aware of authorised drone flights in U-space airspaces close to areas where Public Service Missions are conducted and could also request flight authorisations for military drones. This would result in **IMPROVING SAFETY** for the flights they are responsible for and in **IMPROVING MISSION EFFECTIVENESS**. To benefit from the UAS flight authorisation service for ANS and AMC, ATS units and military controlling units would need to be connected with the USSP, and have the ability to submit flight authorisations requests and receive notifications of authorised flights (possibly for non-military drones too). Although this could be done via a separate network/display, which will be the case if no (automated) data feed from USSP via existing (ATM) interfaces, protocols and formats into the military systems is provided, it could generate significant **ADDITIONAL COSTS** to adapt and maintain military systems. Receiving information from USSP systems would also create an **ADDITIONAL CYBER SECURITY RISK** for which the military would need to define and implement appropriate controls. Finally, potential extra work/studies could be requested in terms of **SAFETY MANAGEMENT SYSTEM**. Tactical Controllers and military ATCOs would also have to be trained to use the UAS flight authorisation service, requiring **ADDITIONAL TRAINING**. As USSPs are not necessarily designed to have a human controller equivalent (as in current coordination between military and civil ATCOs), the **HUMAN**

Mission	Impact		Rationale
			FACTORS aspects of this new coordination will need to be carefully considered for future Joint Air Operations, particularly when urgent coordination on sensitive military topics is required. The UAS flight authorisation service has no potential benefit on CNS, RAP or Meteo services in the context of Public Service Missions.

3.5 - Network identification service

According to the description from U-space regulation IR 2021/664, the network identification service *"should provide the identity of UAS operators, and the location and flight vector of UAS during normal operations and in contingency situations, and share relevant information with other U-space airspace users"*.

Drone operators use the network identification service in flight to **broadcast the identification and the position of the drone to authorised users**, which include air traffic services providers concerned by the drone flight and the relevant competent authorities, as defined in the U-space Regulation. Although the military are thus part of these authorised users, the assessment of the **usefulness** of the network identification service considers that the military make no change to their current operations, procedures or systems, and thus they do not actively use the service. In this case, any disadvantage or benefit comes indirectly from other stakeholders using the service.

When assessing the **potential benefits** of the network identification service, this assessment assumes that the military are actively using the service to receive information on civilian drones, but also providing information on their drones through this service.

Mission	Impact		Rationale
Joint Air Operations	Detrimental?	No	Civilian drone operators providing the identification and the position of their drones to USSPs has no detrimental effect on ASM, AIS, ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Joint Air Operations.
	Useful?	Yes	Civilian drone operators providing the identification and the position of their drones to USSPs has no direct useful effect on ASM, AIS, ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Joint Air Operations.
	Potentially beneficial?	Yes	If the military receive drone identification and position shared through the network information service, military ATCOs and Tactical Controllers could be aware of drone flights in proximity to the flights they are responsible for. Using the Network information service would also improve their ability to manage the traffic. This would result in **IMPROVING SAFETY**, notably for the military flights to which they are providing ANS and AMC services. By providing USSPs with the identification and the position of military drones involved in Joint Air Operations (if the mission allows it), the military would allow USSPs to consider military drones in the U-space airspace under their responsibility, resulting in **IMPROVING SAFETY** for military drones. To benefit from the network identification service for ANS and AMC, ATS units and military controlling units would need to be connected with the USSP and have the ability to process the information provided through the network identification service for military needs. Although this could be done via a separate network/display, which will be the case if no (automated) data feed from USSP via existing

Mission	Impact		Rationale
			(ATM) interfaces, protocols and formats into the military systems is provided, it could generate significant **ADDITIONAL COSTS** to adapt and maintain military systems. Receiving information from USSP systems would also create an **ADDITIONAL CYBER SECURITY RISK** for which the military would need to define and implement appropriate controls. Finally, potential extra work/studies could be requested in terms of **SAFETY MANAGEMENT SYSTEM**. Military actors would also have to be trained to understand and use the information provided through the network identification service, requiring **ADDITIONAL TRAINING**. As USSPs are not necessarily designed to have a human controller equivalent (as in current coordination between military and civil ATCOs), the **HUMAN FACTORS** aspects of this new coordination will need to be carefully considered for future Joint Air Operations, particularly when urgent coordination on sensitive military topics is required. The UAS flight authorisation service has no potential benefit on ASM, AIS, CNS, RAP or Meteo services in the context of Joint Air Operations

Mission	Impact		Rationale
Air Policing	Detrimental?	No	Civilian drone operators providing the identification and the position of their drones to USSPs has no detrimental effect on ASM, AIS, ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Air Policing.
	Useful?	No	Civilian drone operators providing the identification and the position of their drones to USSPs has no direct useful effect on ASM, AIS, ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Air Policing.
	Potentially beneficial?	Yes	If the military receive drone identification and position shared through the network information service, they could improve the RAP/AMC service. Air Surveillance Operators would be able to detect, track and identify drones in the U-space airspace. This would result in **INCREASED MISSION EFFECTIVENESS**. Tactical Controllers could be aware of drone flights when guiding QRA interceptor flights, resulting in **IMPROVING SAFETY** for the flights they are responsible for. If a dynamic reconfiguration request has been sent to the USSP to temporarily restrict the U-space airspace, the Tactical Controller task is limited to monitoring that there is no drone traffic in this U-space airspace**.** On the other hand, military providing the identification and the position of their drones to USSPs (if the mission allows it) would have no beneficial effect on the ability of the military to perform Air Policing missions. This would however provide a more complete situation awareness to the USSP. To benefit from the network information service for RAP/AMC, the military controlling units would need to be connected with the USSP and have the ability to analyse flight authorisations delivered by the USSP. Although this could be done via a separate network/display, it could generate significant **ADDITIONAL COSTS** to adapt and maintain military systems. Receiving information from USSP systems would also create an **ADDITIONAL CYBER SECURITY RISK** for which the military would need to define and implement appropriate controls. Finally, potential extra work/studies could be requested in terms of **SAFETY MANAGEMENT SYSTEM**. Air Surveillance Operators and Tactical Controllers would also have to be trained to understand and use the information provided through the network information service, requiring **ADDITIONAL TRAINING**. The network information service has no potential benefit on ASM, AIS, ANS, CNS, Flight Planning or Meteo services in the context of Air Policing.

Mission	Impact		Rationale
Public Service Missions	Detrimental?	No	Civilian drone operators providing the identification and the position of their drones to USSPs has no detrimental effect on ASM, AIS, ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Public Service Missions.
	Useful?	No	Civilian drone operators providing the identification and the position of their drones to USSPs has no direct useful effect on ASM, AIS, ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Public Service Missions.
	Potentially beneficial?	Yes	If the military receive drone identification and position shared through the network information service, Tactical Controllers and military ATCOs could be aware of drone flights in U-space airspaces close to areas where Public Service Missions are conducted. This would result in **IMPROVING SAFETY** for the flights they are responsible for and in **IMPROVING OPERATIONAL EFFICIENCY**. By providing USSPs, through the network identification service, with the identification and the position of military drones participating to Public Service Missions (if the mission allows it), the military would allow USSPs to be aware of all drone traffic in the U-space airspace they are responsible for, resulting in **IMPROVING SAFETY** for military drones. To benefit from the network identification service for ANS and AMC, ATS units and military controlling units would need to be connected with the USSP and have the ability to process the information provided through the network identification service for military needs. Although this could be done via a separate network/display, which will be the case if no (automated) data feed from USSP via existing (ATM) interfaces, protocols and formats into the military systems is provided, it could generate significant **ADDITIONAL COSTS** to adapt and maintain military systems. Receiving information from USSP systems would also create an **ADDITIONAL CYBER SECURITY RISK** for which the military would need to define and implement appropriate controls. Finally, potential extra work/studies could be requested in terms of **SAFETY MANAGEMENT SYSTEM**. Military actors would also have to be trained to understand and use the information provided through the network identification service, requiring **ADDITIONAL TRAINING**. As USSPs are not necessarily designed to have a human controller equivalent (as in current coordination between military and civil ATCOs), the **HUMAN FACTORS** aspects of this new coordination will need to be carefully considered for future Joint Air Operations, particularly when urgent coordination on sensitive military topics is required. The network information service has no potential benefit on CNS, RAP or Meteo services in the context of Public Service Missions.

3.6 - Traffic information service

According to the description from the U-space regulation IR 2021/664, the traffic information service *"should alert UAS operators about other air traffic that may be present in proximity to their UAS."*

Drone operators use the traffic information service in flight to **receive information on any other conspicuous air traffic, that may be in proximity** to the position or intended route of the drone flight. The traffic information service includes information about manned aircraft and drone traffic shared by USSPs and relevant air traffic service units.

In U-space regulation IR 2021/664, the traffic information service is thus envisaged to provide drone operators with information about military air traffic under General Air Traffic (GAT), and possibly under Operational Air Traffic (OAT). Depending on how this information is provided to the Common Information Service, e.g. by ATSPs already having this information and sharing it or directly by the military, the traffic information service may result in **ADDITIONAL COSTS** to the military and thus have a general **detrimental impact** on them. This option is not detailed further in the assessment of the impact of the traffic information service on the different military missions below.

The assessment of the **usefulness** of the traffic information service considers that the military make no change to their current operations, procedures or systems, and thus they do not actively use the service. In this case, any disadvantage or benefit comes indirectly from other stakeholders using the service.

When assessing the **potential benefits** of the traffic information service, this assessment assumes that the military are using the service, allowing military drone operators and aircraft and helicopter pilots to receive information on other air traffic. The assessment also assumes that military provide information on their drones, aircraft and helicopters (as far as their mission allows) through this service for the benefit of civilian drone operators. However, the information about civilian drone traffic is the same as through the network information service assessed above (3.5 -) and this assessment does not further analyse the resulting impact. Finally, the traffic information service is intended for drone operators, not ATCO/TAC C2/ASO, and the service may not meet the requirements of the latter. Therefore, this assessment does not explore the use of the service by other military actors than drone operators or aircraft/helicopter pilots.

Mission	Impact		Rationale
Joint Air Operations	Detrimental?	No	Civilian drone operators receiving traffic information has no detrimental effect on ASM, AIS, ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Joint Air Operations.
	Useful?	Yes	Civilian drone operators receiving traffic information allows more tactical training during peacetime operations, for example for helicopter night flying with night vision optics and lights off, when civilian drone operators cannot see helicopters. This results in **IMPROVING OPERATIONAL EFFICIENCY**. Civilian drone operators receiving traffic information has no direct useful effect on ASM, AIS, ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Joint Air Operations.

Mission	Impact		Rationale
	Potentially beneficial?	Yes	If the military use the traffic information service and if the mission allows it, military drone operators and pilots participating to Joint Air Operations could receive traffic information about manned aircraft and drone traffic close to the area where these operations are conducted (in case no previous U-space airspace restriction has been implemented). Military drone operators and pilots could report the alerts about other air traffic they have received from the USSP to the military ATCOs and Tactical Controllers, who could re-broadcast the information to other aircraft - manned and unmanned. These improvements to ANS and AMC services would result in **IMPROVING SAFETY** for military assets. By providing USSPs with the identification and the position of military drones participating to Joint Air Operations (if the mission allows it), the military allow the USSPs to issue traffic information to civilian drones operating in the U-space airspace they are responsible for, resulting in even more **IMPROVING SAFETY** for military drones. To use the traffic information service, military drones, aircraft and helicopters would need to be connected with the USSP and have the ability to process the alerts provided through the traffic information service. Although this could be done via a separate network/display, it could generate significant **ADDITIONAL COSTS** to adapt and maintain military systems. Receiving information from USSP systems would also create an **ADDITIONAL CYBER SECURITY RISK** for which the military would need to define and implement appropriate controls. Finally, potential extra work/studies could be requested in terms of **SAFETY MANAGEMENT SYSTEM**. Military drone operators and pilots would also have to be trained to understand and respond to alerts provided through the traffic information service, requiring **ADDITIONAL TRAINING**. The traffic information service has no potential benefit on ASM, AIS, CNS, RAP, Flight Planning or Meteo services in the context of Joint Air Operations.

Mission	Impact		Rationale
Air Policing	Detrimental?	No	Civilian drone operators receiving traffic information has no detrimental effect on ASM, AIS, ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Air Policing.
	Useful?	No	Civilian drone operators receiving traffic information no direct useful effect on ASM, AIS, ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Air Policing.
	Potentially beneficial?	Yes	Military drone operators and pilots could report the alerts they have received from the USSP about other air traffic to the military Air Surveillance Operators, who could use this information to develop a better situational awareness. This improvement to the RAP service would result in **IMPROVING OPERATIONAL EFFICIENCY**. To use the traffic information service, military drones, aircraft and helicopters would need to be connected with the USSP and have the ability to process the alerts provided through the traffic information service. Although this could be done via a separate network/display, it could generate significant **ADDITIONAL COSTS** to adapt and maintain military systems. Receiving information from USSP systems would also create an **ADDITIONAL CYBER SECURITY RISK** for which the military would need to define and implement appropriate controls. Finally, potential extra work/studies could be requested in terms of **SAFETY MANAGEMENT SYSTEM**. Military drone operators and pilots would also have to be trained to understand and respond to alerts provided through the traffic information service, requiring **ADDITIONAL TRAINING**. The traffic information service has no potential benefit on ASM, AIS, ANS, CNS, AMC, Flight Planning or Meteo services in the context of Air Policing.

Mission	Impact		Rationale
Public Service Missions	Detrimental?	No	Civilian drone operators providing the identification and the position of their drones to USSPs has no detrimental effect on ASM, AIS, ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Public Service Missions.
	Useful?	No	Civilian drone operators providing the identification and the position of their drones to USSPs has no direct useful effect on ASM, AIS, ANS, CNS, RAP/AMC, Flight Planning or Meteo services in the context of Public Service Missions.
	Potentially beneficial?	Yes	If the military use the traffic information service, military drone operators and pilots participating to Public Service Missions could receive traffic information about manned aircraft and drone traffic, resulting in **IMPROVING SAFETY** for military drones and **IMPROVING OPERATIONAL EFFICIENCY**. By providing USSPs with the identification and the position of military drones, aircraft and helicopters participating to Public Service Missions (if the mission allows it), the military would allow the USSPs to issue traffic information about military drones, aircraft and helicopters to civilian drones, resulting in **IMPROVING SAFETY** in the U-space airspace. To use the traffic information service, military drones, aircraft and helicopters would need to be connected with the USSP and have the ability to process the alerts provided through the traffic information service. Although this could be done via a separate network/display, it could generate significant **ADDITIONAL COSTS** to adapt and maintain military systems. Receiving information from USSP systems would also create an **ADDITIONAL CYBER SECURITY RISK** for which the military would need to define and implement appropriate controls. Finally, potential extra work/studies could be requested in terms of **SAFETY MANAGEMENT SYSTEM**. Military drone operators and pilots would also have to be trained to understand and respond to alerts provided through the traffic information service, requiring **ADDITIONAL TRAINING**. The network information service has no potential benefit on ASM, AIS, ANS, CNS, RAP/AMC or Meteo services in the context of Public Service Missions.

3.7 - Overview of U-space impacts on the military

3.7.1 - Impact from the implementation of U-space

The assessment of the different mandatory U-space services shows that the deployment and use of these services by civilian operators will have **no detrimental impact on the main military missions** beyond the need for the military Airspace Management cell and Aeronautical Information Services processes to be expanded to include U-space airspaces and the safety and security issues resulting from the development of drone traffic, including outside of U-space, that are already well identified and recognised.

On the contrary, **a number of military missions will be made safer** by the implementation of the geo-awareness and UAS flight authorisation U-space service, as indicated in the following table. A '+' indication denotes, in a qualitative manner, an improvement for the military mission mentioned in the top row. A '-' indication means that the U-space service has no impact, whether detrimental or beneficial, on the mission.

U-space services	Joint Air Operations	Air Policing	Public Service
Geo-awareness	SAFETY+	-	-
UAS flight authorisation	SAFETY+	-	SAFETY+
Network identification	-	-	-
Traffic information	-	-	-

TABLE 11: BENEFITS FROM U-SPACE SERVICES ON MILITARY MISSIONS

3.7.2 - Potential effects of the military using U-space

In case the military decide to use U-space services and contribute to these services by sharing information with the USSPs, they will face a number of negative impacts due to the necessary adaptation of their systems, personnel and procedures:

- **Financial costs** to upgrade systems, or to develop new ones, in order to connect with the USSP, process the information received through the service and share their information with the USSP;
- Additional **cybersecurity risks**, as they will open their systems to external stakeholders. These risks will have to be managed through appropriate processes and measures.
- **Training** of ATCOs, Tactical Controllers, ASO and Drone operators to use the U-space services and **adaptation of the Safety Management System**.

Significant safety and efficiency benefits could however result from the use of U-space, as summarised in the following table. A '++' indication denotes, in a qualitative manner, an additional improvement over those resulting from the implementation of U-space (cf. Table 11) or a very significant improvement when none result from the implementation of U-space ('-'result in Table 11).

U-space services	Joint Air Operations	Air Policing	Public Service
Geo-awareness	SAFETY+	SAFETY+	SAFETY+ EFFICIENCY+
UAS flight authorisation	SAFETY++	SAFETY+ EFFICIENCY+	SAFETY+ EFFICIENCY+
Network identification	SAFETY++	SAFETY+ EFFICIENCY++	SAFETY+ EFFICIENCY+
Traffic information	SAFETY++	-	SAFETY+ EFFICIENCY+

TABLE 12: POTENTIAL BENEFITS OF U-SPACE SERVICES ON MILITARY MISSIONS

The balance between these costs and benefits will be investigated later during this study (in the D2 – Cost-Benefit Analysis report), resulting in a quantitative, rather than qualitative, assessment of the impact of U-space on the military.

4 - MILITARY USE CASES DESCRIPTION

While military missions vary widely across the nature of joint operations, the framework and processes for air operations command and control (C2) shall remain consistent in today's complex aeronautical environment, especially when it is about sharing airspace with new entrants. The coordination between civilian and military control agencies, complemented with procedural, informative and positive control measures, allows users to access the airspace whilst preventing operational conflicts and flight safety issues. Air mission control will be a key requirement to guide, control and support military air traffic in a Flexible Use of Airspace (FUA) process.

The rising number of drones entering the airspace and the increased complexity of drone operations beyond visual line of sight (BVLOS), notably at Very Low Level, pose safety and security challenges. In order to allow drones to operate safely alongside manned aircraft, the European Union Aviation Safety Agency (EASA) has released a regulatory framework for the U-space (cf. 2.3.1 -). This framework focusing on the civilian regulation, which is recognizing that the military and State aircraft operations are out of the scope, is based on the following key principles:

- Drone geographical zones restrictions;
- Specific coordination procedures and communication facilities between relevant Air Traffic Service Units (ATSUs), U-space Service Providers (USSPs) and Drone operators.

The following figure illustrates how the different types of airspace resulting from the implementation of the U-space Regulation can coexist, how it is organised and notably which are the roles and responsibilities of the entities involved.

FIGURE 23: EXAMPLE OF U-SPACE AIRSPACE IMPLEMENTATION IN 2D AND 3D

In this section, seven Use Cases (UCs) have been chosen to illustrate how air operations will be performed in the future U-space environment, supported by ASM and ATM actors.

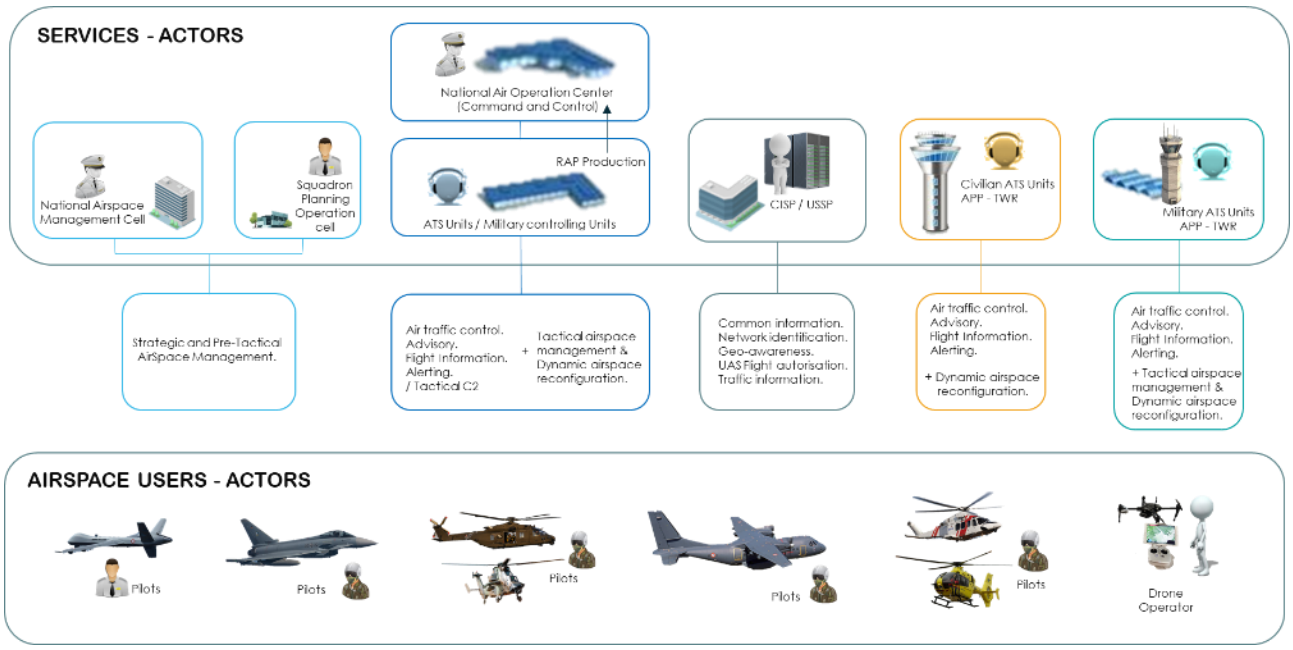

FIGURE 24: KEY ACTORS IN A CIVIL-MILITARY CONTEXT

As the military can operate in any type of airspace, each of the Use Cases has been developed in up to three different operational contexts, to further explore the possible interactions with U-space:

- **Outside U-space airspace**, to describe a context where no U-space service is available to the military and to provide a **baseline against which the potential benefits of U-space services can be compared**. As U-space will not be available in the whole Very Low Level airspace, this case is also useful to describe the limited means that the military will have to face the growing drone traffic in this context;
- **Inside a U-space airspace, not managed or controlled** by a military or civilian ATSP. Many military operations are conducted in uncontrolled airspace (e.g. in class G). This case aids to understand in a concrete manner **how U-space services can help to address issues** identified in the previous context (outside U-space airspace);
- **Inside a U-space airspace, controlled** by military and/or civilian ATC. This case corresponds to the more complex environments and is intended to illustrate **how U-space can support the coordination** between the different actors and improve operations involving different types of air traffic.

From an organisational point of view, the U-space Services Providers will have a key role to play in these contexts, notably in terms of coordination and information to be provided to all relevant actors.

As the organisation between the military and future civilian USSPs is a Member State prerogative, the presented Use Cases provide scenarios where the military is cooperating with the USSP in a supporting role and, on the contrary, where the military is in a leading role, conducting operations without using U-space services. The Use Cases do not mention the Common Information Service Provider, as they focus on the U-space services built on information provided by the CISP. The military may develop their own services using the CIS, but it is not an objective of this report to investigate this possibility.

This exercise has been done after having defined main assumptions as presented in Figure 25 which provides an overview of the way Use Cases are structured and described in this document. Throughout this section, a consistent colour scheme helps the reader to identify the operational context in which the Use Case is taking place. Each of the Use Case can be read independently from the others as key information and assumptions are repeated in their respective overview.

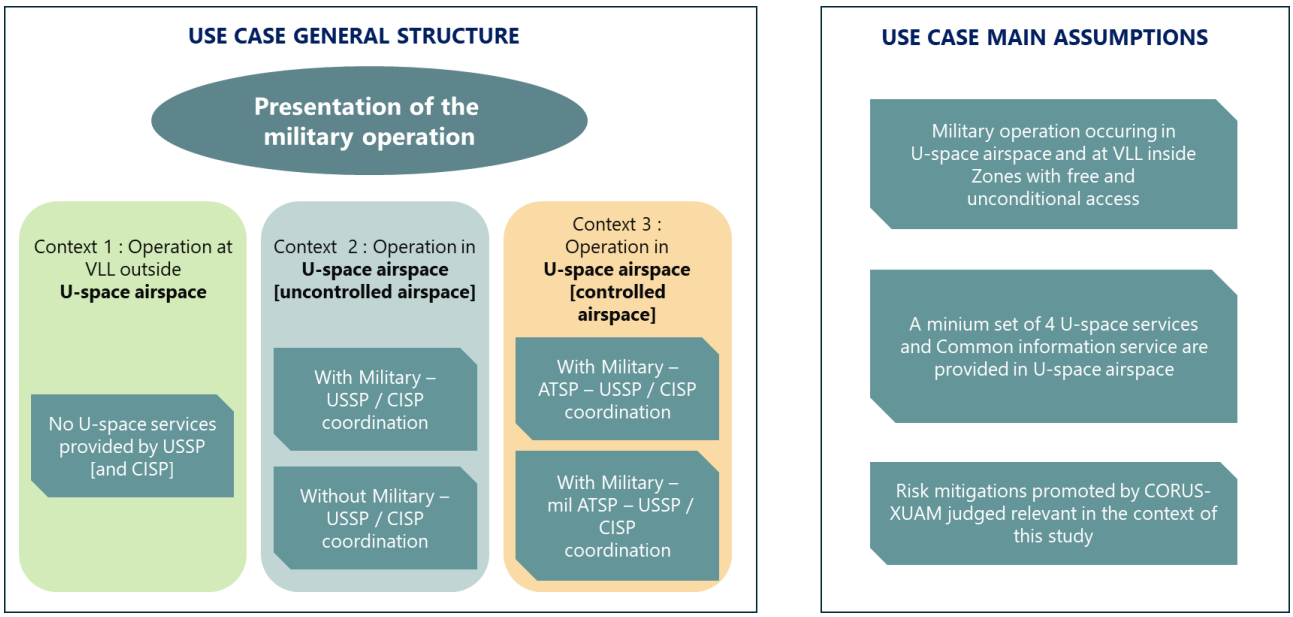

FIGURE 25: USE CASES - GENERAL STRUCTURE AND MAIN ASSUMPTIONS

It is worth noting that in context 3 (*U-space airspace within a controlled airspace*[13]), the case of a U-space airspace where no coordination is implemented between a military ATSP and a USSP (e.g. a U-space airspace within a military CTR) is not considered. Indeed, the EASA U-space Regulation requires the USSP to coordinate with the ATSP in any controlled airspace and no coordination between the military and the USSP in this context would be equivalent to context 1 for military actors.

Each Use Case is presented by a summarising table and described in a step-by-step manner the flow of actions undertaken by the actors involved in **nominal conditions**. At the beginning of each table, the operational environment in which the Use Case takes place is described through the following items:

- The airspace class(es) where the Use Case can take place;
- The potential airspace restrictions affecting operations (whether military or civilian);
- The type of drone activities permitted in this airspace;
- The U-space services available to the different military actors.

When relevant, the following additional items are provided:

- The flight rules (General Air Traffic/Operational Air Traffic) applicable to military aircraft;
- The flight conditions (Instrument Meteorological Conditions/Visual Meteorological Conditions);
- The level of control provided to military aircraft and helicopter pilots, and the safety barriers available to them;
- The information whether No Drone Zones (NDZ) can be created dynamically;
- The services delivered by the ATSP, if in controlled airspace;

NOTE: Main terms dedicated to military are reminded in 7.5 - **APPENDIX 5: MILITARY TERMINOLOGY**

NOTE: More details on joint air operations can be found in 7.6 - **APPENDIX 6: JOINT AIR OPERATIONS**

[13] *Controlled/uncontrolled status is to be understood in the ICAO classification sense*

4.1 - Use Case 1: Low-level airspace management

4.1.1 - Use Case overview

There is a need to ensure safe separation of aircraft in the U-space airspace. This is notably translated into requirements to Member States in IR 2019/947, article 15[14], and in IR 2021/664, article 4[15]. Therefore, MSs have to make publicly available the information on drone geographical zones, including their period of validity, in a common unique digital format. In addition, the new IR 2021/664 [12] requires MSs to apply the dynamic reconfiguration of a U-space airspace within controlled airspace, to make sure that manned aircraft and drones remain segregated. Therefore, MSs and military authorities should be able to define static and dynamic U-space airspace restrictions to enable such operations in a safe and efficient manner.

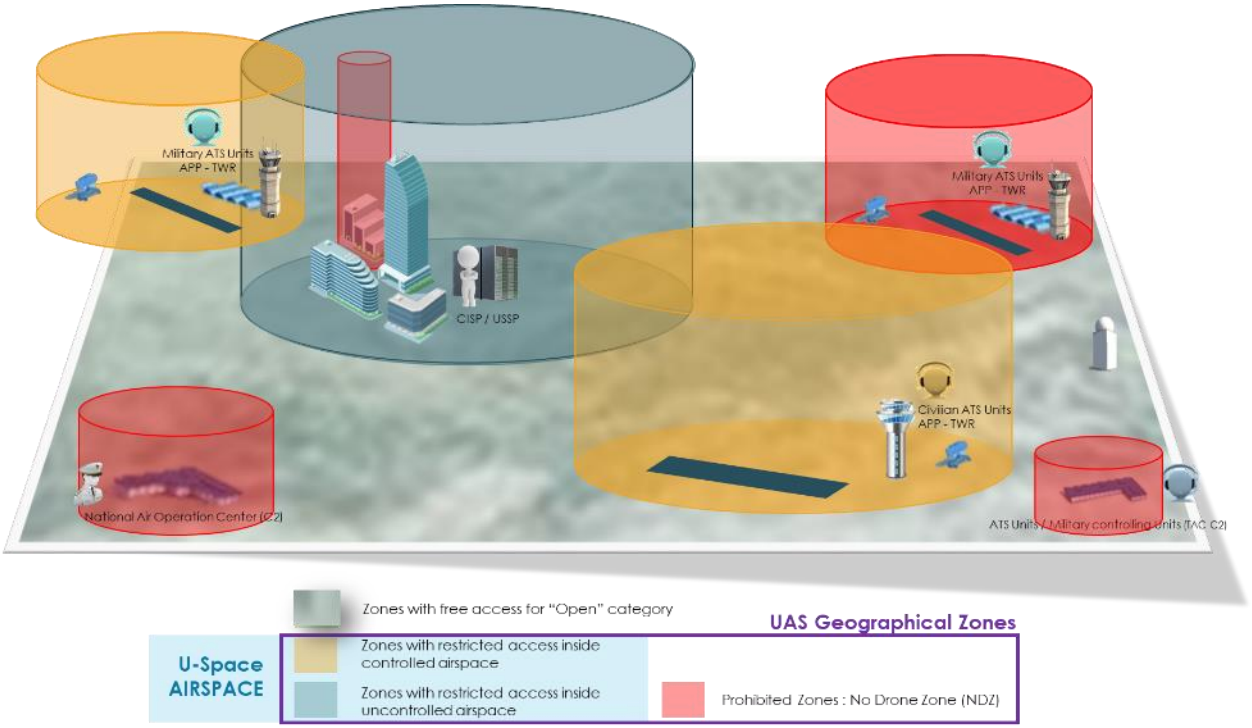

FIGURE 26: UC1 – U-SPACE AIRSPACE CONFIGURATION DEFINITION

In the end it will be in the scope of the national implementation to build up a civil-military coordination process similar to FUA. However much more on the bases of a fast time data exchange rather than a traditional day by day FUA process.

Use Case 1 is divided into two sub-Use Cases describing low-level airspace management:

- At strategic and pre-tactical level (sub Use Case 1.1 in 4.1.2.1 -);
- At tactical level (sub Use Case 1.2 in 4.1.2.2 -);
- At tactical level – Dynamic reconfiguration (sub Use Case 1.3 in 4.1.2.3 -).

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[14] *Member States shall make publicly available the information on drone geographical zones, including their period of validity, in a common unique digital format.*

[15] *Member States shall apply the dynamic reconfiguration of a U-space airspace within controlled airspace, to make sure that manned aircraft and drones remain segregated*

The overall view, showing different scenarios is depicted in Figure 27 below:

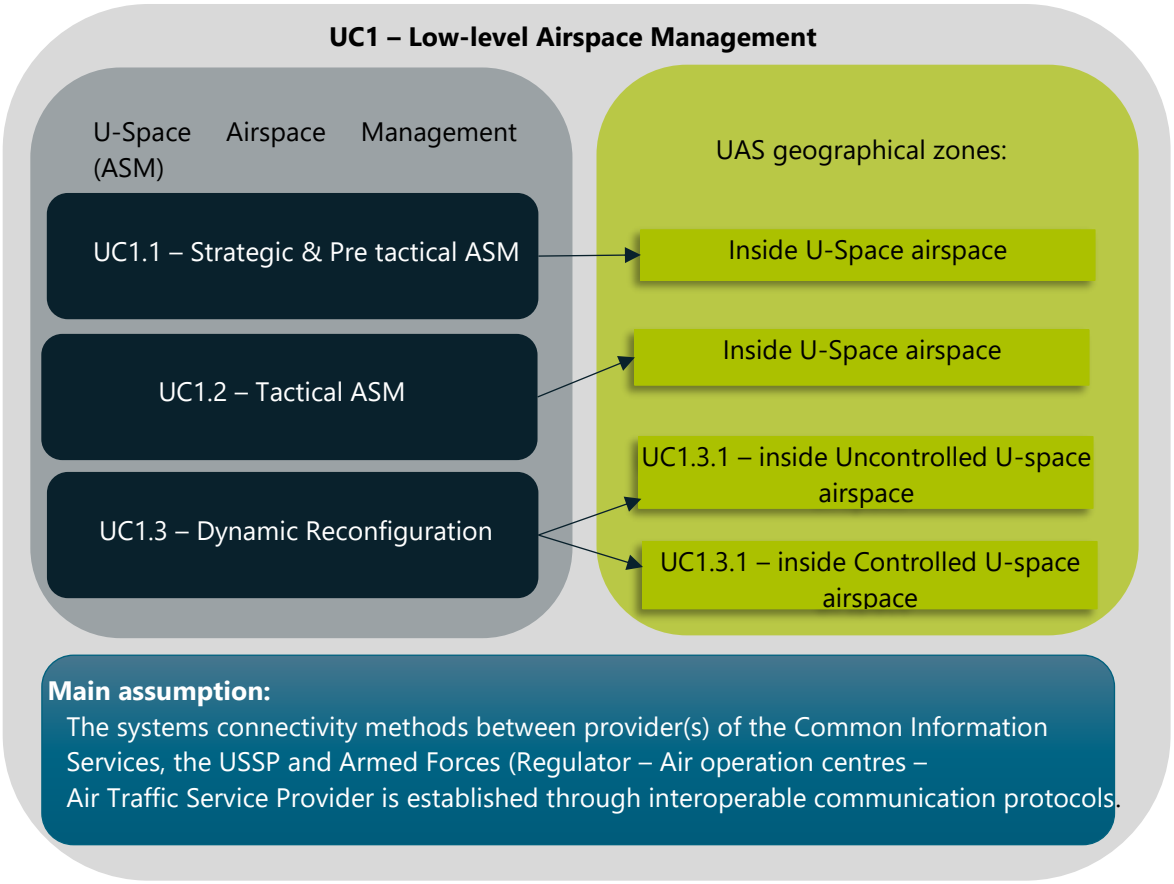


FIGURE 27: UC1 – LOW-LEVEL AIRSPACE MANAGEMENT OVERVIEW

- Actors (individuals and organisations)

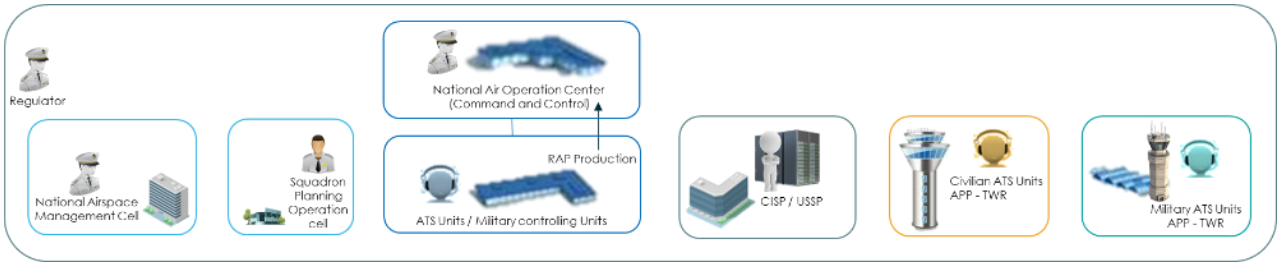


FIGURE 28: UC1 – ACTORS

- Armed Forces Regulator
- National Airspace Management Cell
- National Air Operation Centre
- Squadron Planning Operation cell
- ATS Units / Military controlling Units
- (Military) Air Traffic Controller (ATCO)
- Weapon Controller – Tactical Controller (TAC C2)
- Civilian ATS Units (APP-TWR)
- Military ATS Units (APP – TWR)
- Drone Operator
- U-space Service Provider (USSP)

- Common Information Service Provider (CISP)

- General assumptions
  - U-space – military cooperation is in place and allows to define static and dynamic U-space airspace restrictions to enable air operations in a safe and efficient manner. The Use Case assumes that this cooperation uses the same three coordination levels as FUA:
    - At strategic level; to allow military authorities to define and promulgate airspace restrictions in U-space airspace, in the form of permanent or temporary no drone zones;
    - At pre-tactical level: to allow military authorities to activate temporary no drone zones defined at strategic level inside uncontrolled U-Space airspace;
    - At tactical level: .to allow military authorities to contribute to managing the U-space airspace in real time.
  - The Use Case assumes that connectivity methods between providers are in place.
- Event initiating the Use Case
  - The need to segregate military manned traffic from unmanned civilian traffic.

4.1.2 - Nominal flow of actions

4.1.2.1 - Sub-Use Case UC1.1: strategic/pre-tactical low-level airspace management

	Airspace Class	Potential airspace restrictions	Drone activities	U-space services
Outside or inside U-space Airspace Free or Restricted ACCESS	All	R, P, D, NDZ (Permanent or temporary)	VLOS/BVLOS	In U-space airspace only: Common information services Network identification service Geo-awareness service UAS flight authorisation service Traffic information service [weather information conformance monitoring]
Nominal actions	**<u>At strategic level</u>** A. Member States and military authorities promulgate restrictions in the form of permanent or temporary no drone zones: ▪ Outside U-Space airspace ▪ Inside uncontrolled U-space airspace ▪ Inside controlled U-space airspace Military authorities should plan drone geographical zones with restricted access inside military controlled airspace (e.g. a military CTR).			

	Member states and military authorities ensure that the Common Information Service providers are aware of static U-Space airspace configuration. **<u>At pre-tactical level</u>** 1. Military authorities (NAOC, Squadron planning cell…) should define and reserve additional restrictions in the form of No Drone Zones (e.g. for training missions involving Army helicopters) or military constraints, inside uncontrolled U-space airspace and military controlled U-space airspace 1. Military authorities (NAOC, Squadron planning cell…) plan the activation of temporary No Drone Zones defined at strategic level inside uncontrolled U-Space airspace and military controlled U-Space airspace,. 2. Through an AMC (joint civil/military cell), military authorities should ensure that the Common Information Service provider is notified in a timely and effective manner of static and planned UAS geographical zones restricted or prohibited. 3. The CISP disseminates the U-space airspace configuration. 4. The Drone Operator submits an UAS Flight authorisation request to its USSP. 5. The USSP checks the request for UAS flight authorisation against U-space airspace restrictions and temporary airspace limitations. The USSP may introduce changes to the authorisation during any phase of the flight and, in such a case, informs the Drone Operator about them. The USSP ensures that authorised drone operations are free of intersection in space and time with manned aircraft and any other notified UAS flight authorisation within the same portion of U-space airspace

TABLE 13: UC1.1 – CONTEXT OF ASM

The following diagram illustrates this nominal flow of actions and the interactions between the different actors of the Use Case.

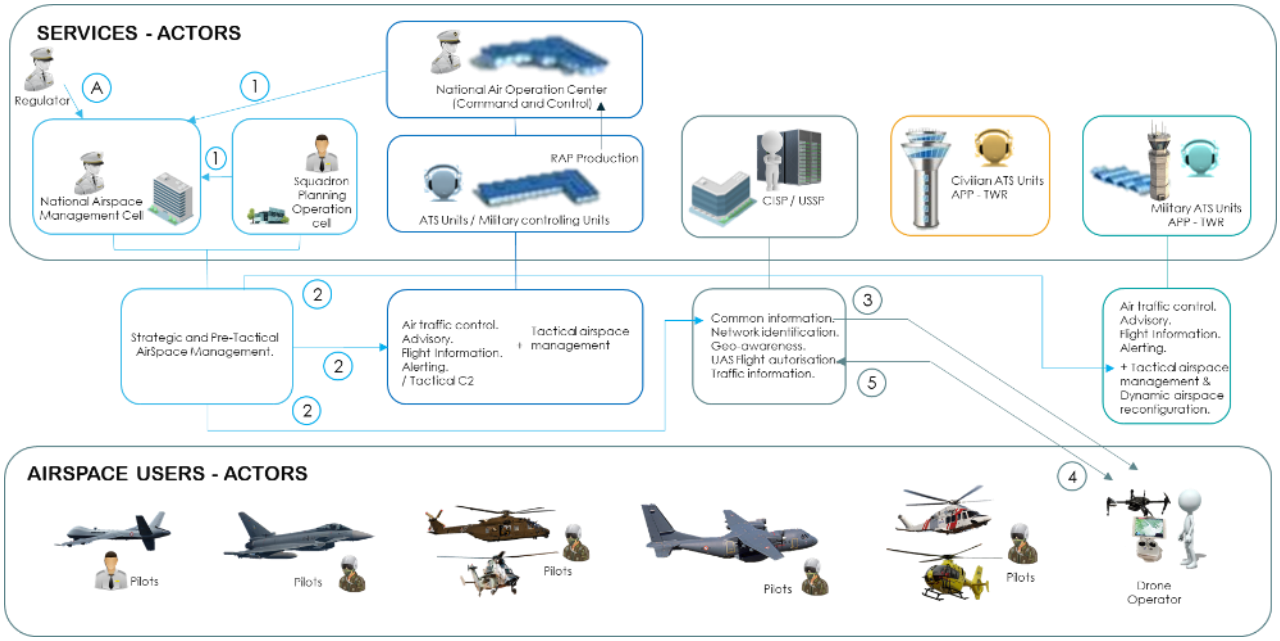


FIGURE 29: UC1 – STRATEGIC AND PRE-TACTICAL ASM

4.1.2.2 - Sub-Use Case UC1.2: tactical low-level airspace management

	Airspace Class	Potential airspace restrictions	Drone activities	U-space services
Inside U-space Airspace Restricted ACCESS	All	R, P, D, NDZ (Permanent or Temporary)	VLOS/BVLOS	In U-space airspace only: Common information services Network identification service Geo-awareness service UAS flight authorisation service Traffic information service [weather information conformance monitoring]
Nominal actions	Inside uncontrolled U-space airspace and inside Military controlled U-space airspace 1. Military, through ATS units/Military controlling units (a) and Military ATS units (b,: ensure that the relevant USSPs and, where applicable, CISPs are notified in a timely and effective manner of the activation, deactivation and temporary limitations of the designated U-space airspace according to the plan defined at pre-tactical level. 2. Military, through ATS units/Military controlling units and Military ATS units, ensure that manned aircraft are free of intersection in space with unmanned activity. 2. USSP provides through the geo-awareness service to the Drone operator : ■ information on the applicable operational conditions and airspace constraints within the U-space airspace; ■ UAS geographical zones, relevant to the U-space airspace; ■ temporary restrictions applicable to airspace use within the U-space airspace. It is possible to note at this point, that it should be possible to plan a training activity (e.g. helicopters) in a safer manner inside U-Space airspace than outside, as processes can be implemented to segregate drone traffic from manned traffic.			

TABLE 14: UC1.2 – CONTEXT OF ASM

The following diagram illustrates this nominal flow of actions and the interactions between the different actors of the Use Case.

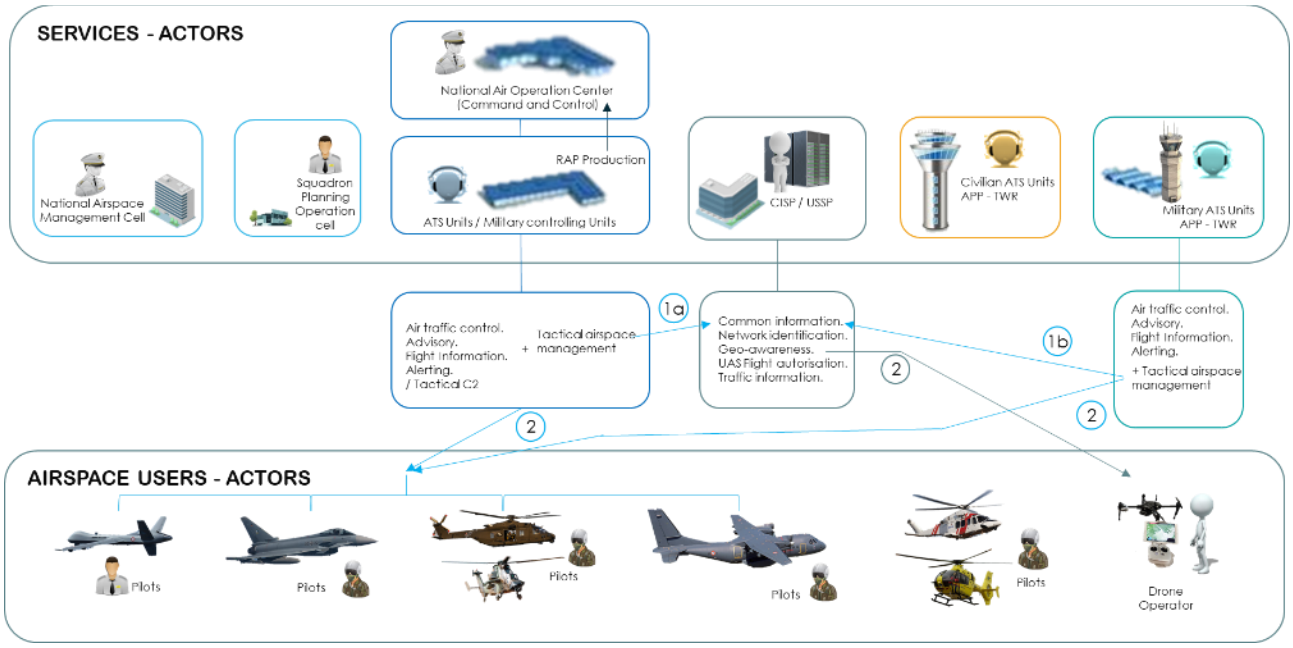


FIGURE 30: UC1 – TACTICAL LOW-LEVEL AIRSPACE MANAGEMENT

4.1.2.3 - Sub-Use Case UC1.3: tactical low-level airspace management – Dynamic Reconfiguration

Due to tactical changes (military mission constraints), non-planned - sudden real-time constraints e.g. security measures, public service operations ...; and sudden adverse weather constraints, e.g. CB activity, ATS Units / Military controlling units (1a, 1b and 1c in Figure 32) shall temporarily limit the area within the designated U-space airspace where UAS operations can take place in order to accommodate short-term changes in manned traffic demand by adjusting the lateral and vertical limits of the U-space airspace.

4.1.2.3.1 - Inside Uncontrolled U-Space airspace

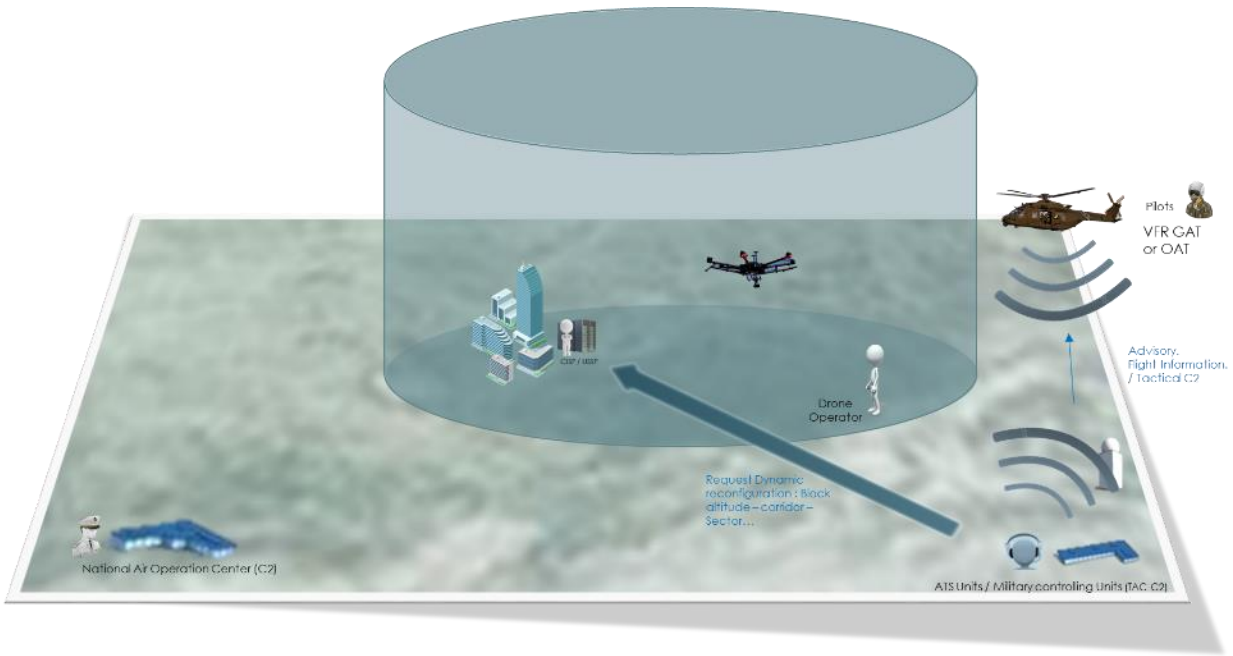


FIGURE 31: UC1 – DYNAMIC RECONFIGURATION INSIDE UNCONTROLLED U-SPACE AIRSPACE

	Airspace Class	Potential airspace restrictions	Drone activities	U-space services
inside U-space Airspace Restricted ACCESS	Uncontrolled: F, G	R, P, D, NDZ (permanent or temporary)	VLOS/BVLOS	In U-space airspace only: Common information services Network identification service Geo-awareness service UAS flight authorisation service Traffic information service [weather information conformance monitoring]
Nominal actions	1. (a) ATS Units / Military controlling units ensure that the relevant U-space service providers and, where applicable, single common information service providers are notified in a timely and effective manner of the activation, deactivation and temporary limitations of the designated U-space airspace. 2. U-space service providers shall dispatch the geo-awareness information in a timely manner to allow contingencies and emergencies to be addressed by UAS operators, 2. A dynamic reconfiguration should be a temporary limitation of the designated U-space airspace, for example in the form of an altitude block (Figure 33), a corridor (Figure 34), or a portion of airspace (Figure 35). 2. An USSP "functionality" to ground all UAS when needed by the military should be defined.			

TABLE 15: UC1.3.1 – CONTEXT OF ASM

The following diagram illustrates this nominal flow of actions and the interactions between the different actors of the use case.

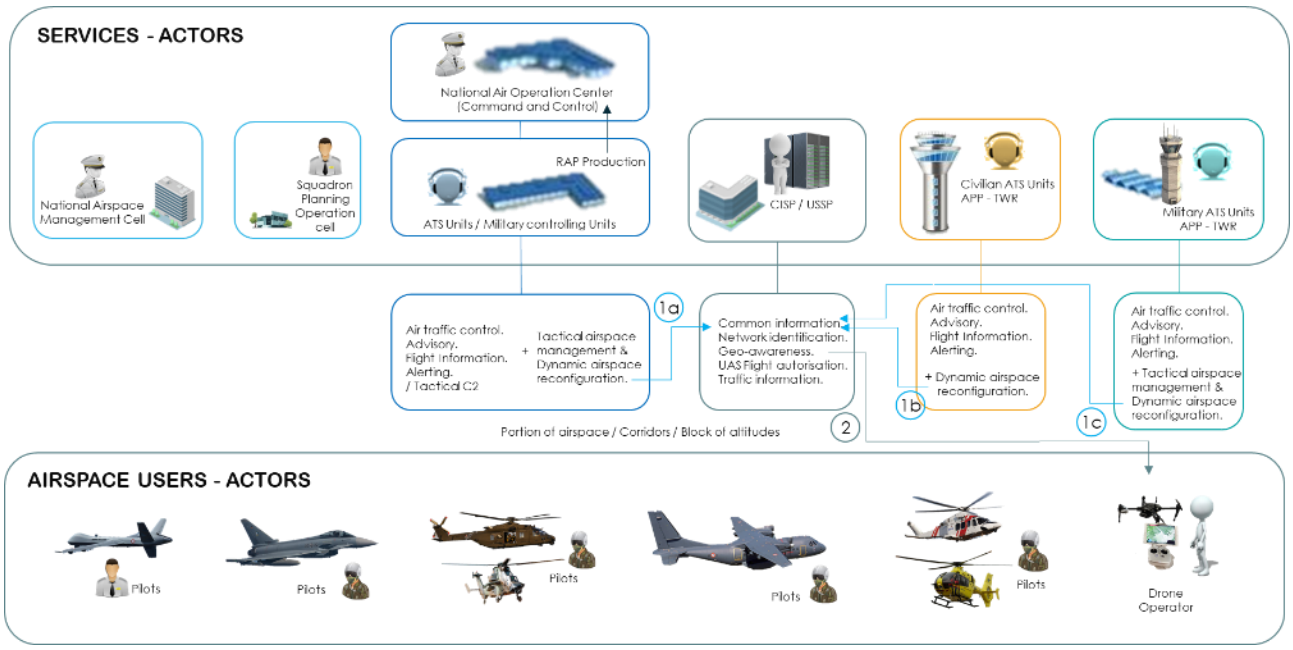


FIGURE 32: UC1 – TACTICAL LEVEL – DYNAMIC RECONFIGURATION

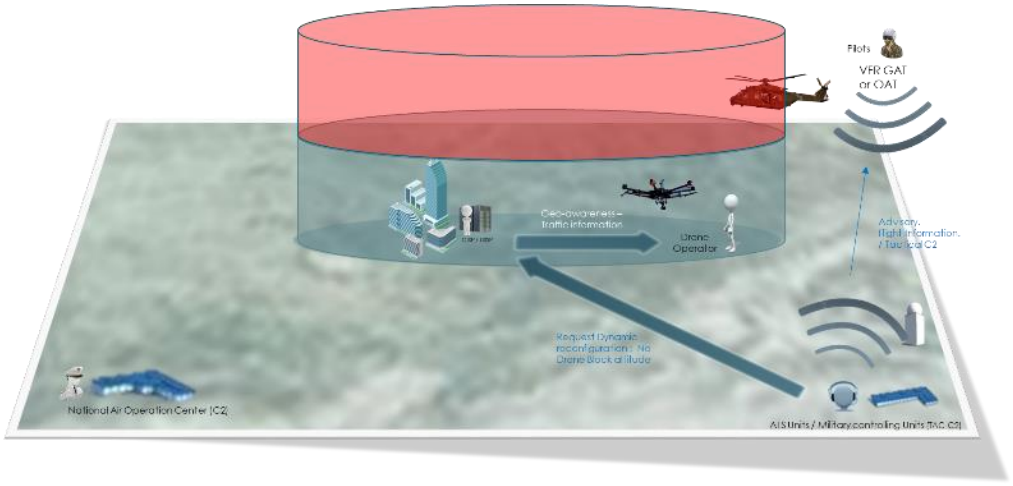


FIGURE 33: UC1 – DYNAMIC RECONFIGURATION – NO DRONE ALTITUDE BLOCK

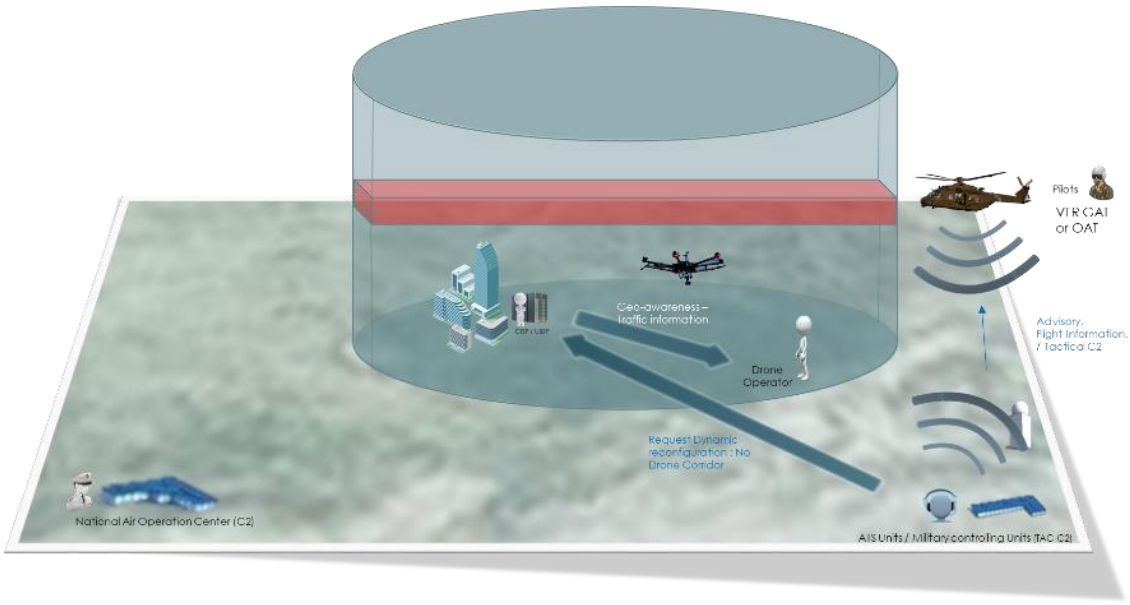


FIGURE 34: UC1 – DYNAMIC RECONFIGURATION – NO DRONE CORRIDOR

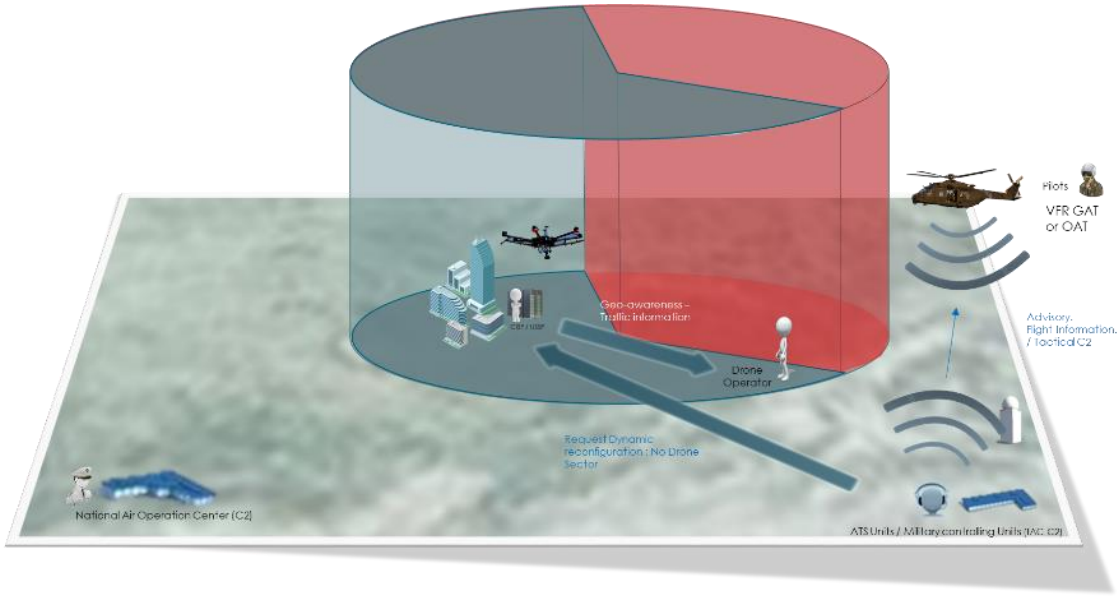


FIGURE 35: UC1 – DYNAMIC RECONFIGURATION – NO DRONE SECTOR

4.1.2.3.2 - Inside Controlled U-Space airspace

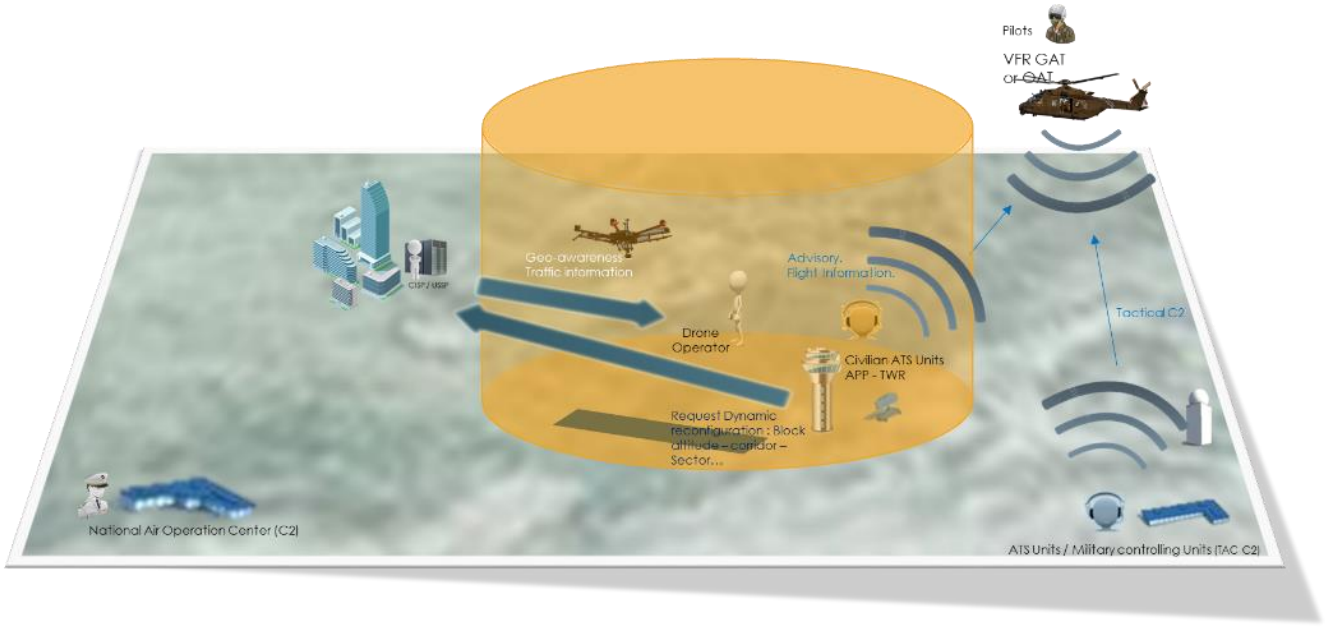


FIGURE 36: UC1 – DYNAMIC RECONFIGURATION INSIDE CONTROLLED U-SPACE AIRSPACE

	Airspace Class	Potential airspace restrictions	Drone activities	U-space services
inside U-space Airspace Restricted ACCESS	Controlled: A,B,C,D,E	R, P, D, NDZ (Permanent or Temporary)	VLOS/BVLOS	In U-space airspace only: Common information services Network identification service Geo-awareness service UAS flight authorisation service Traffic information service [weather information conformance monitoring]
Nominal actions		1. Military (c) or Civilian (b) ATS Units ensure that the relevant USSPs and, where applicable, the CISP are notified in a timely and effective manner of the activation, deactivation and temporary limitations of the designated U-space airspace. 2. USSPs dispatch the geo-awareness information in a timely manner to allow contingencies and emergencies to be addressed by Drone operators, 2. A dynamic reconfiguration should be a temporary limitation of the designated U-space airspace, for example in the form of an altitude block (Figure 38), a corridor (Figure 39) or a portion of airspace (Figure 40). 2. An USSP "functionality" to ground all UAS when needed by the military should be defined.		

TABLE 16: UC1.3.2 – CONTEXT OF ASM

The following diagram illustrates this nominal flow of actions and the interactions between the different actors of the use case.

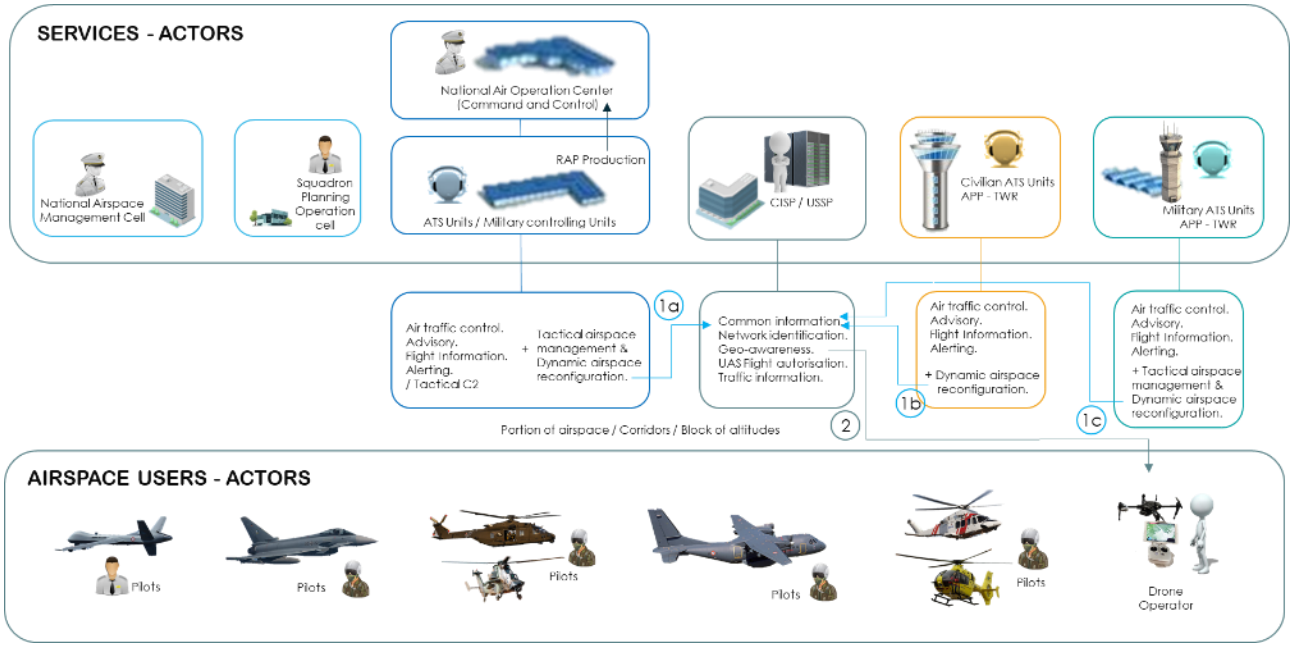


FIGURE 37: UC1 – TACTICAL LEVEL – DYNAMIC RECONFIGURATION

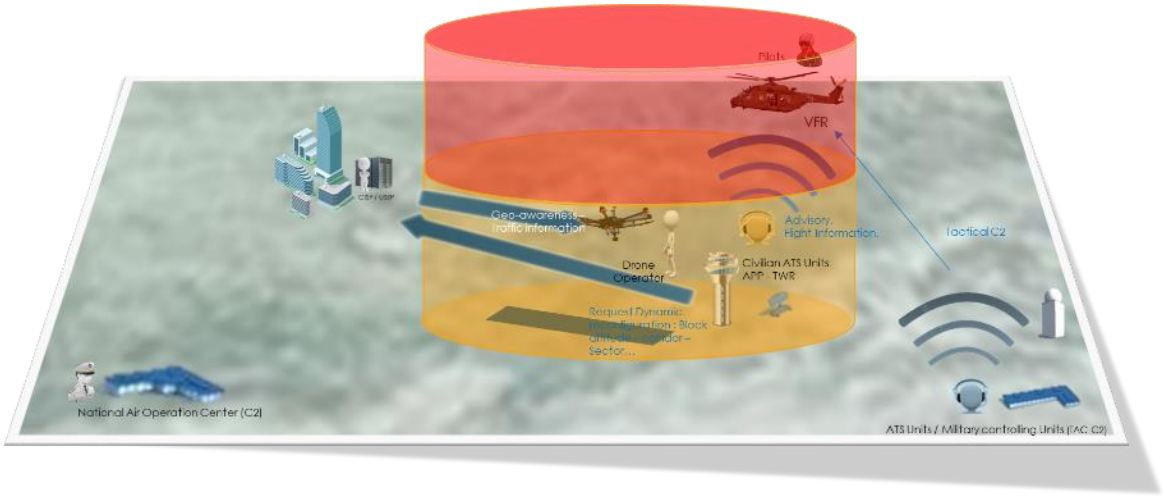


FIGURE 38: UC1 – DYNAMIC RECONFIGURATION – NO DRONE ALTITUDE BLOCK

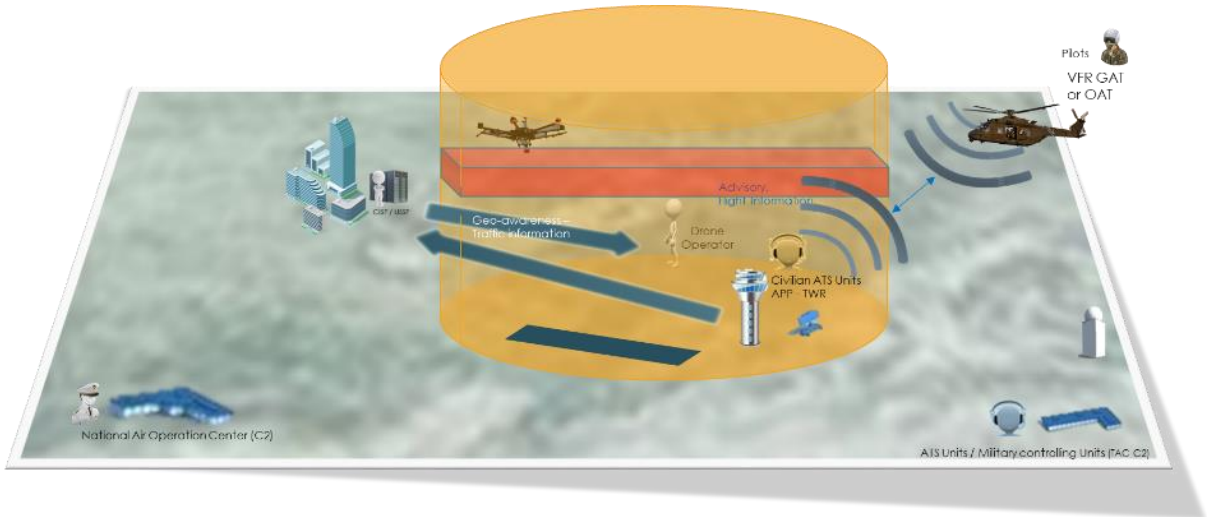


FIGURE 39: UC1 – DYNAMIC RECONFIGURATION – NO DRONE CORRIDOR

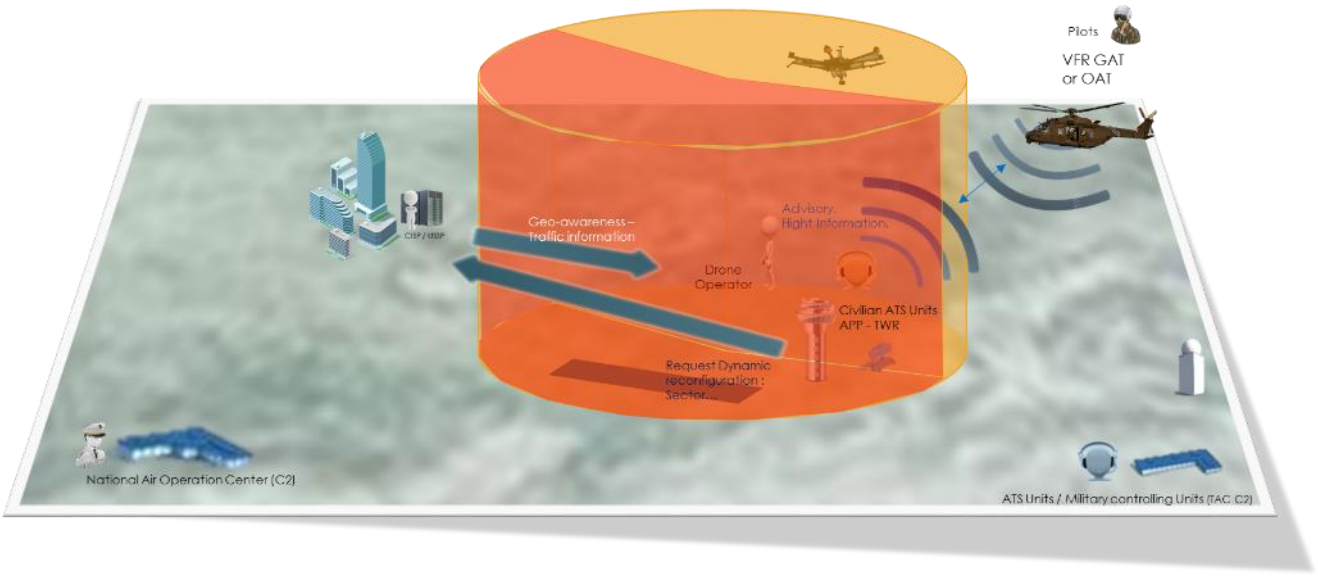


FIGURE 40: UC1 – DYNAMIC RECONFIGURATION – NO DRONE SECTOR

4.2 - Use Case 2: Recognized Air Picture

4.2.1 - Use Case overview

Air Forces of European Member States have been entitled to detect, track and identify to the greatest extent all aerial objects approaching or operating in their respective airspace. The result of these actions is to provide so-called **Recognized Air Pictures (RAP)**.

NATO Member States have implemented functional C2 (Command & Control) structures, processes, networks and systems that are capable to detect, identify and track the air and surface assets of interest. In peacetime, civil aviation, notably through the Air Navigation Service Providers (ANSPs), is collaborating in the enhancement of the RAP by data exchanges (e.g., flight plans).

In case of unauthorised flights within controlled airspace under their responsibility, ATC services are reporting the incident to the appropriate military authorities. The civilian Area Control Centres (ACC) do not have the capability to interrogate uncooperative aircraft or force them to alter their flight path.

In the context of Very Low Level (VLL) airspace, detecting drones in flight is the first challenge in RAP production. It is known that large drones can be detected with legacy radar systems, while low-altitude, slow and small drones require more specialized equipment to distinguish them from a clutter, e.g. leaves and birds.

At tactical level, the Air Surveillance Operators (ASO) from the military Control and Reporting Centres (CRC) are in charge of identifying all aerial objects and are tracking their behaviour inside a defined portion of airspace.

In this Use Case, it is assumed that:

- The military have implemented the appropriate sensors and C2 network, as described in the Joint Air Power Competence Centre (JAPCC) document "A Comprehensive Approach to Countering Unmanned". [51] [Part 3 Unmanned Aircraft System Threat Vectors paragraph "General Threats from Unmanned Aircraft Systems" / part 7 Defensive Counter- Air Operations]
- In the CRC organisation, it is assumed that ASOs are in charge of providing the drone RAP in a dedicated portion of airspace, and more specifically in the entire VLL area in the three different types of zones presented in Figure 41.

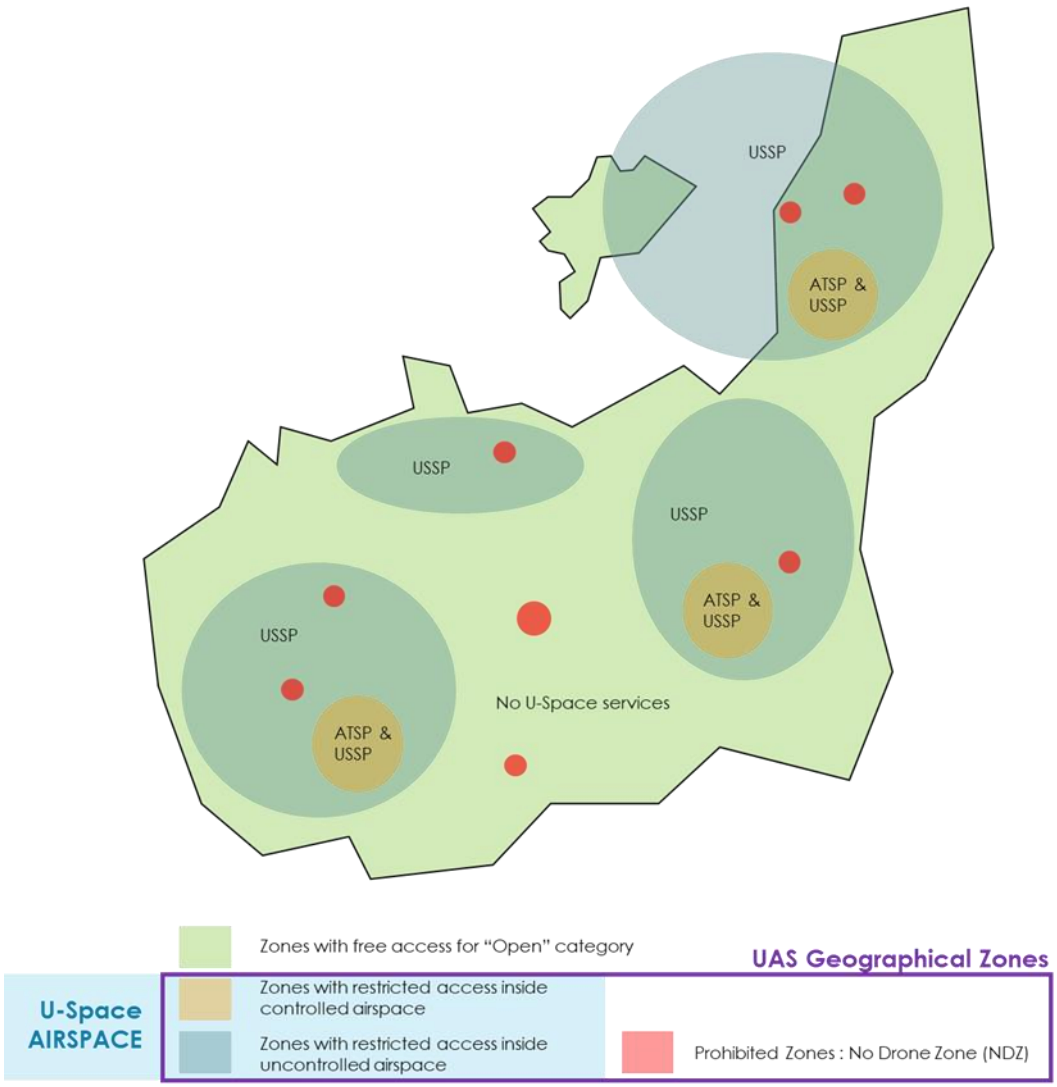


FIGURE 41: UC2 - GEOGRAPHICAL SCOPE

Use Case 2 is divided into three sub-Use Cases, depending on the context in which they occur, as the three operational contexts described in the introduction to this section 4 - are relevant for the Use Case:

- Outside U-space airspace (sub-Use Case 2.1 in 4.2.2.1 -);
- Inside uncontrolled U-space airspace (sub-Use Cases 2.2 in 4.2.2.2 -);
- Inside controlled U-space airspace (sub-Use Cases 2.3 in 4.2.2.3 -).

The overall view, showing different scenarios is depicted in Figure 42 below.

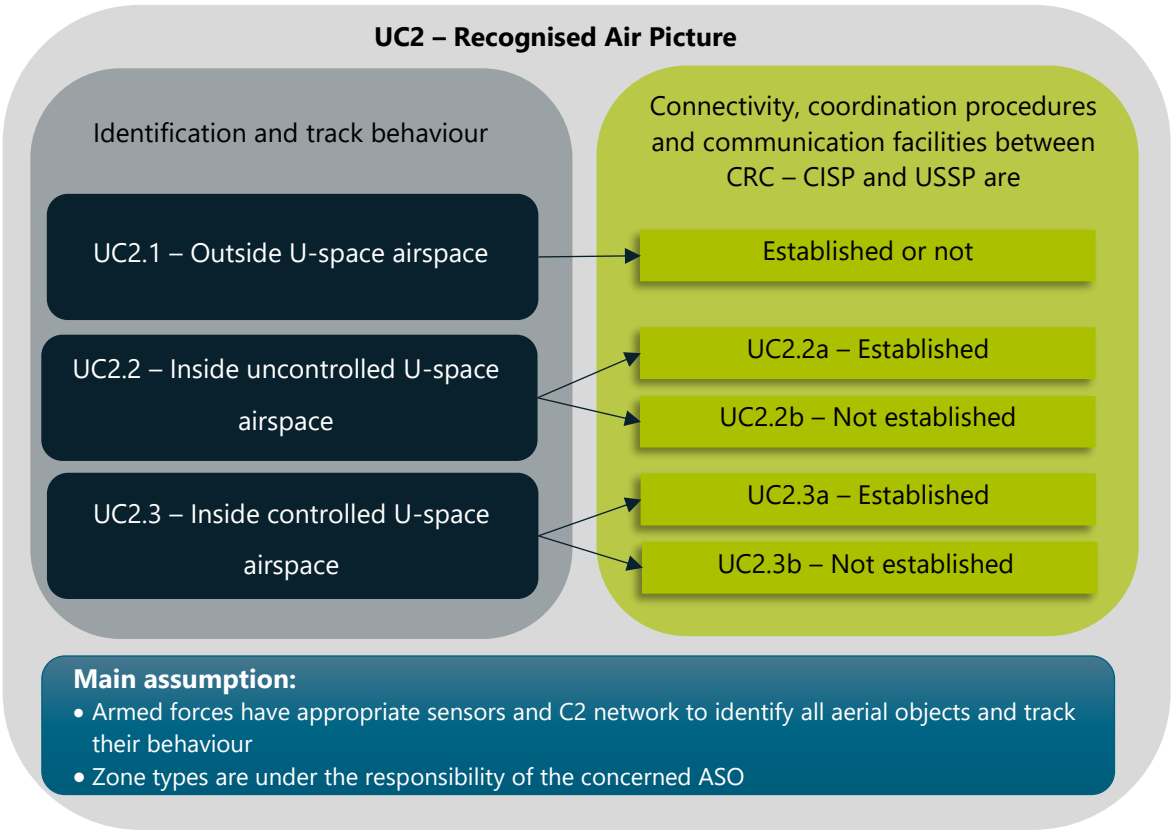


FIGURE 42: UC2 – RECOGNISED AIR PICTURE OVERVIEW

■ Actors (individuals and organisations)

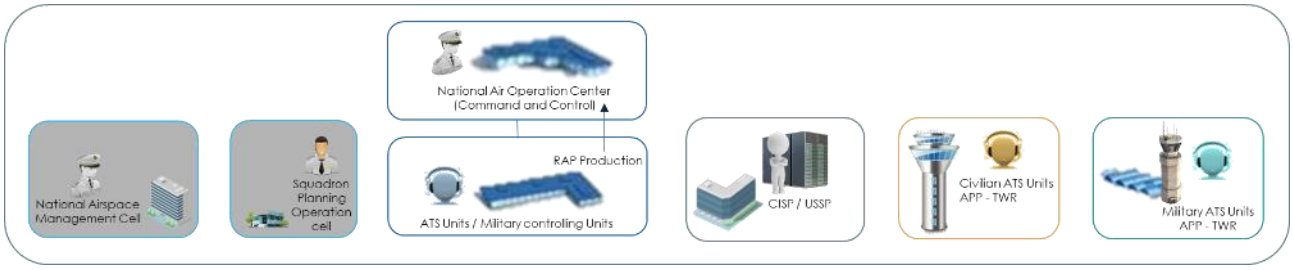


FIGURE 43: UC2 – ACTORS

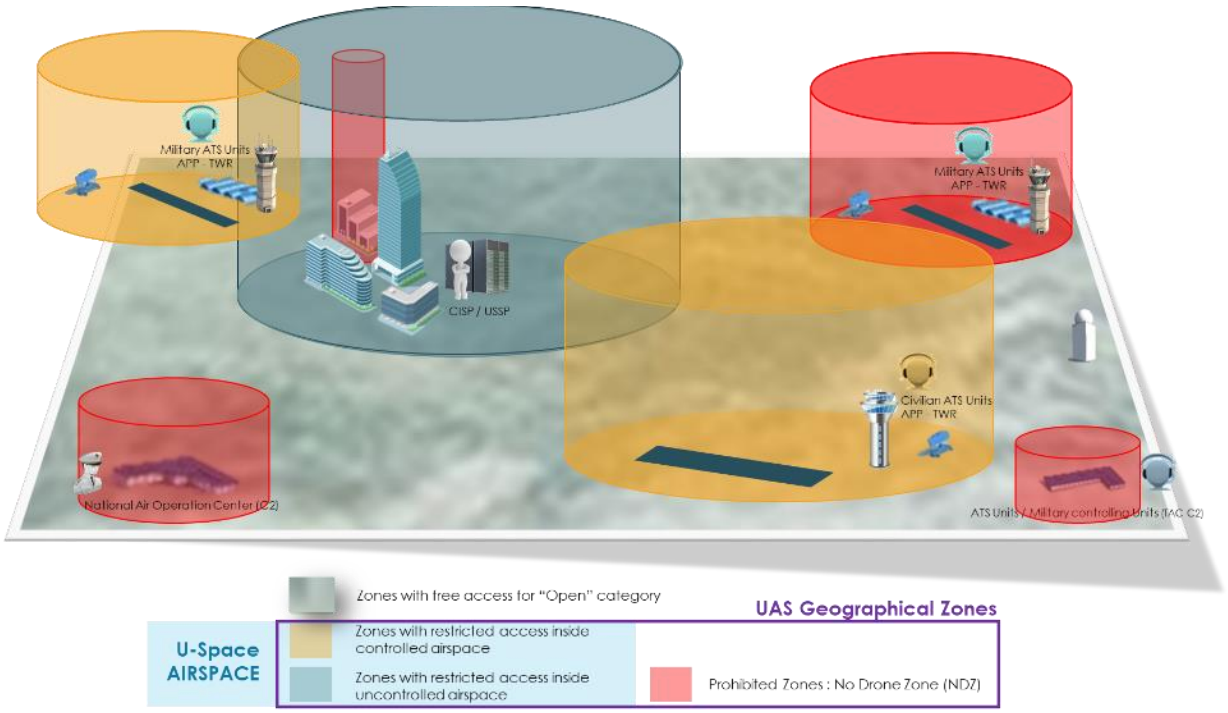


FIGURE 44: UC2 – ACTORS ASSOCIATED TO UAS GEOGRAPHICAL ZONES

- CRC Air Surveillance Operator (ASO)
- Drone Operator
- Air Traffic Controller (ATCO)
- U-space Service Provider (USSP)
- Common Information Service Provider (CISP)
- Air Traffic Service Provider (ATSP)

- General assumptions
  - It is considered that the CRC ASO knows where drone geographical zones are located (e.g. via publication by the national AIS or directly displayed on the ASO position thanks to a U-space service);
  - Outside the U-space airspace, the access of drones to VLL uncontrolled airspace is free if they operate in the VLOS 'open' category. They are not provided any U-space service.
- Event initiating the Use Case
  - A drone is detected in the VLL airspace by a CRC.

4.2.2 - Nominal flow of actions

4.2.2.1 - Sub-Use Case UC2.1: Identification outside U-space airspace

Outside U-space Airspace FREE ACCESS	Airspace Class	Potential airspace restrictions	Drone activities	U-space services
	F,G	R, P, D, NDZ	VLOS	None
Nominal actions	■ The **ASO is unable** to identify the detected track, unless a specific military surveillance system is available; ■ The ASO focuses on the track behaviour and escalates to a higher level any prohibited or restricted entry for decision-making.			

TABLE 17: UC2.1 - CONTEXT OF RAP PRODUCTION

4.2.2.2 - Sub-Use Cases UC2.2: Identification and track behaviour inside uncontrolled U-space airspace

OPTION UC2.2A: ESTABLISHED MILITARY COOPERATION WITH USSP

In this sub-Use Case, it is assumed that:

- The CRC systems and the CISP/USSP systems are connected;
- Coordination procedures are defined between operation centres;
- Communication facilities are established between ASOs and the USSP.

U-space Airspace Restricted ACCESS	Airspace Class	Potential airspace restrictions	Drone activities	U-space services
	F, G	R, P, D areas NDZ Dynamic reconfiguration	VLOS/BVLOS	Common information services Network identification service Geo-awareness service UAS flight authorisation service Traffic information service [weather information conformance monitoring]
Nominal actions	■ The **ASO is able** to correlate the detected track, or track exchange, to the drone identity **(3)** using information obtained via the **Network identification (2)** and **UAS flight authorisation (1)** services provided by the USSP, thanks to automated data exchanges between systems; ■ The ASO focuses on the track behaviour and escalates to a higher level any prohibited or restricted entry for decision-making; ■ Military authorities are also able to envisage implementing a systematic Flight Information tool on drone positions aiming at automatically correlating tracks to the drone identity;			

	■ The **USSP can report** to the Air C2 centre any incident and/or unsafe situation.

TABLE 18: UC2.2A – CONTEXT OF RAP PRODUCTION

The following diagram illustrates this nominal flow of actions and the interactions between the different actors of the use case.

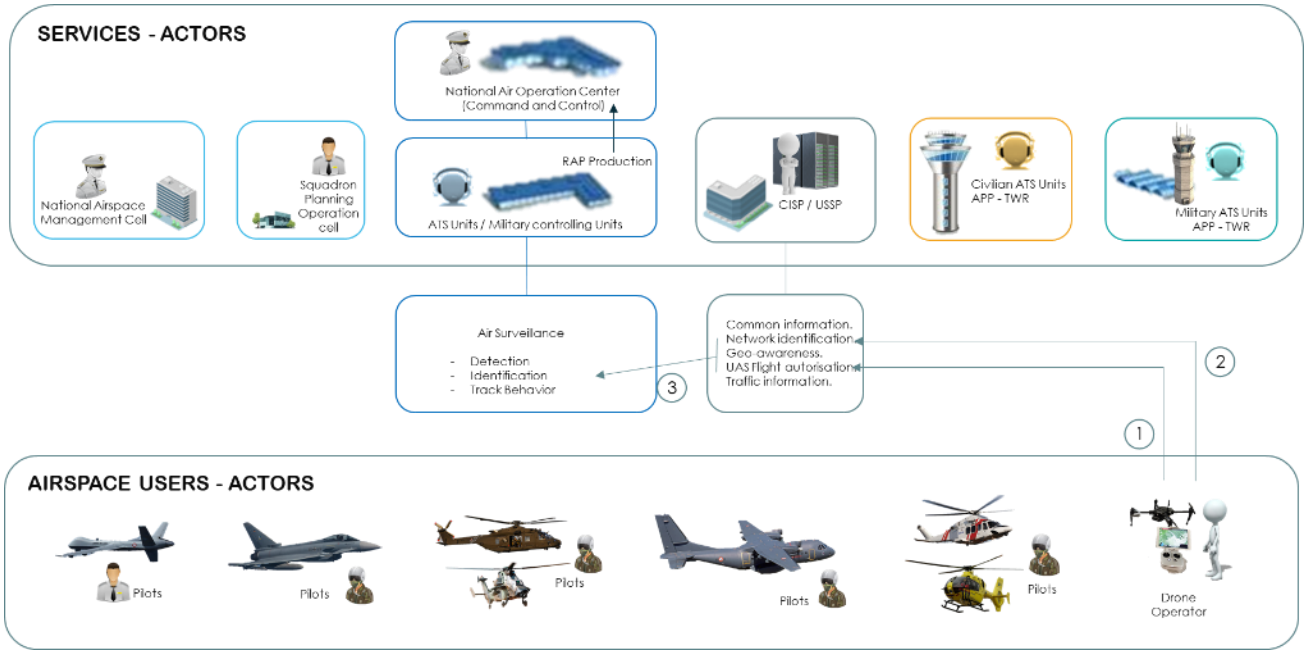


FIGURE 45: UC2.2A – RAP

OPTION UC2.2B: NO ESTABLISHED MILITARY COOPERATION WITH THE USSP

In this sub-Use Case, it is assumed that:

- The CRC systems and the CISP/USSP systems are not connected;
- Coordination procedures are not defined between operation centres;
- Communication facilities are not established between ASOs and the USSP.

U-space Airspace Restricted ACCESS	Airspace Class	Potential airspace restrictions	Drone activities	U-space services
	F, G	R, P, D areas NDZ	VLOS/BVLOS	None
Nominal actions	■ The **ASO is unable** to perform an identification of the detected track, unless a specific military surveillance system (not based on U-space) is available and/or if the systems can automatically exchange data on a specific network; ■ The ASO focuses on track the behaviour and escalates to a higher level any prohibited or restricted entry for decision-making.			

TABLE 19: UC2.2B - CONTEXT OF OPERATION

4.2.2.3 - Sub-Use Cases UC2.3: Identification inside controlled U-space airspace

OPTION UC2.3A: ESTABLISHED MILITARY COOPERATION WITH USSP

In addition to existing coordination between the CRC and the ATSP, in this sub-Use Case it is assumed that:

- The CRC systems and the CISP/USSP systems are connected;
- Coordination procedures are defined between operation centres[16];
- Communication facilities are established between ASOs and the USSP.

	Airspace Class	Potential airspace restrictions	Drone activities	U-space services
U-space Airspace Restricted ACCESS	A, B, C, D, E	R, P, D areas NDZ Dynamic reconfiguration	VLOS/BVLOS	Common information services Geo-awareness service UAS flight authorisation service Network identification service Traffic information service [weather information conformance monitoring]
Nominal actions	■ The **ASO is able** to correlate the detected track, or track exchange, to the drone identity **(3)** using information obtained via the **Network identification (2)** and **UAS flight authorisation (1)** services provided by the USSP, thanks to automated data exchanges between systems; ■ The ASO focuses on the track behaviour and escalates to a higher level any prohibited or restricted entry for decision-making; ■ Military authorities are also able to envisage implementing a systematic Flight Information tool on drone positions aiming at automatically correlating tracks to the drone identity; ■ The **USSP can report** to the Air C2 centre any incident and/or unsafe situation.			

TABLE 20: UC2.3A – CONTEXT OF RAP PRODUCTION

[16] *System coordination will have to be defined locally, as USSPs and the ATSP/military control unit context may differ from one MS to another.*

The following diagram illustrates this nominal flow of actions and the interactions between the different actors of the use case.

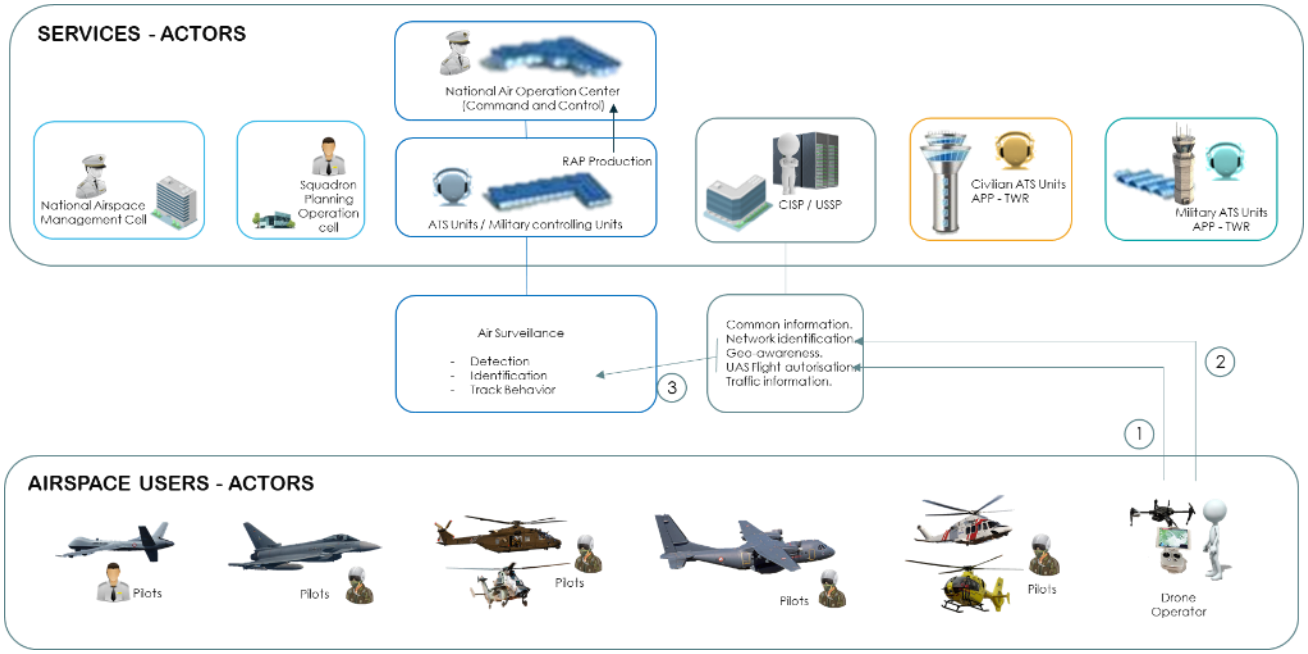


FIGURE 46: UC2.3A – RAP

OPTION UC2.3B: MILITARY COOPERATION WITH USSP NOT ESTABLISHED

In this sub-Use Case it is assumed that:

- The CRC systems and the CISP/USSP systems are not connected;
- Coordination procedures are not defined between operation centres;
- Communication facilities are not established between ASOs and the USSP.

	Airspace Class	Potential airspace restrictions	Drone activities	U-space services
U-space Airspace Restricted ACCESS	A, B, C, D, E	R, P, D areas NDZ	VLOS/BVLOS	None
Nominal actions	■ **ASO is unable** to do identification on track detection, unless a dedicated military surveillance system is implemented and/or if the systems can automatically exchange data on a specific network; ■ ATC reports to the Air C2 centre any incident and/or unsafe situation.			

TABLE 21: UC2.3B - CONTEXT OF RAP PRODUCTION

Although the Use Case takes place in controlled airspace, it shows that the ASO does not have any additional means to perform his tasks with U-space than in uncontrolled airspace (cf. 4.2.2.1 -).

4.3 - Use Case 3: Air Policing mission (QRA)

4.3.1 - Use Case overview

When an incident such as a loss of radio communication is identified in the State airspace, the relevant civil and military authorities of the concerned State scramble an Air Policing mission to intercept the suspected aircraft following close civil-military coordination. The QRA is composed of one or more armed fighter aircraft or helicopter(s), depending on the speed of the aircraft to be intercepted.

The military Control and Reporting Centres (CRCs) and Command and Control (C2) centres support such missions at national level. In parallel, the national military authorities report to the NATO CAOCs (Combined Air Operation Centre) based on a 24/7 air picture, mainly via ground-to-ground data exchanges between the systems.

In this Use Case, it is assumed that:

- The military have implemented the appropriate sensors and C2 network, as described in the Joint Air Power Competence Center (JAPCC) document "A Comprehensive Approach to Countering Unmanned". [51] [Part 3 Unmanned Aircraft System Threat Vectors paragraph "General Threats from Unmanned Aircraft Systems" / part 7 Defensive Counter- Air Operations];
- In the CRC organisation, it is assumed that the Weapon Controller is in charge of the QRA mission control (tasks and safety) in accordance with the national Regulation and in conformity with the NATO aligned standard procedures.

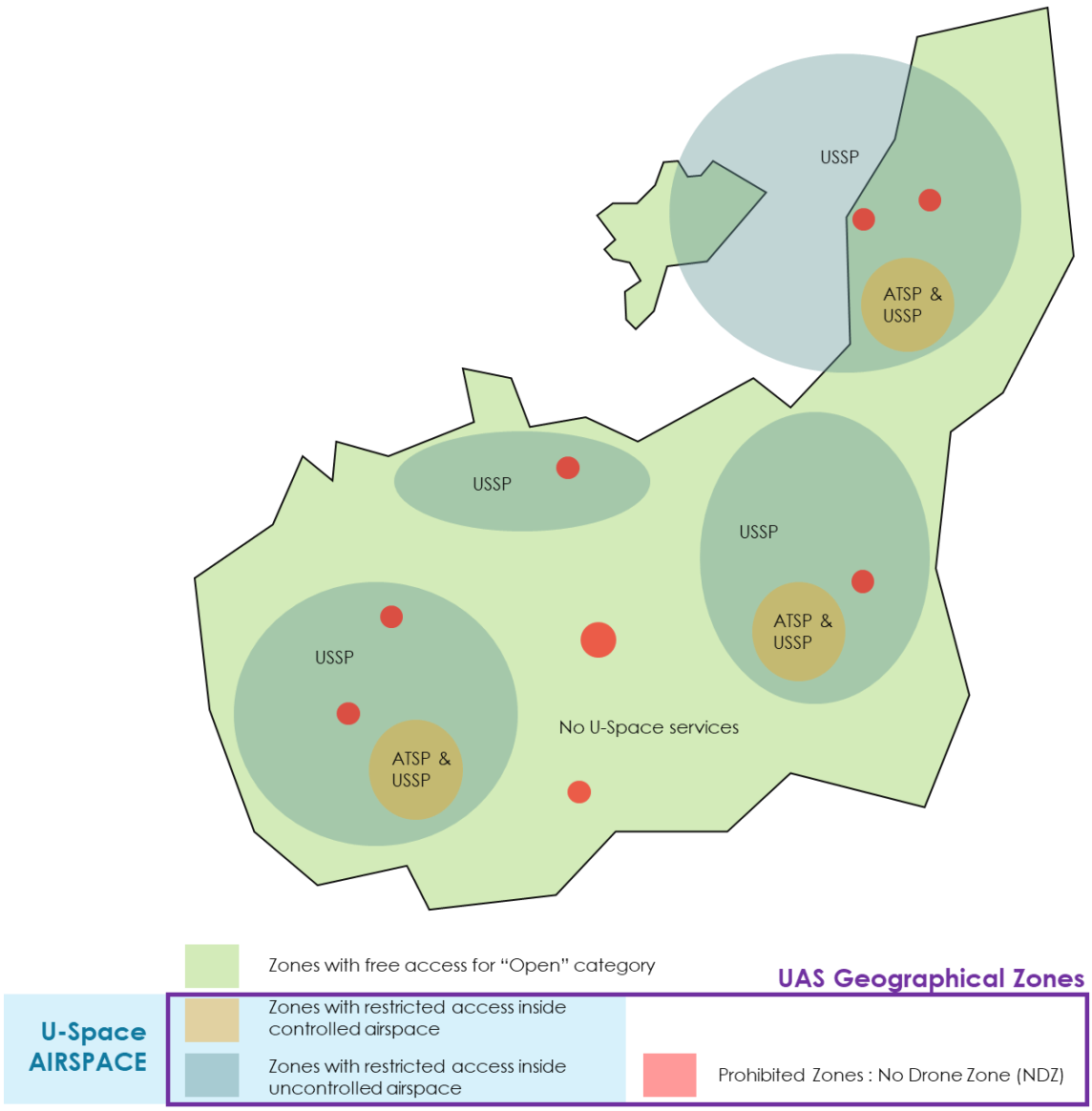


FIGURE 47: UC3 – GEOGRAPHICAL SCOPE

The Quick Reaction Alert Interceptor (QRA(I)) takes off to investigate unclear or potentially unsafe situations to visually identify unknown target aircraft. The interception or course of action may take place in both controlled and uncontrolled airspace, from High – Very High to Low – Very Low Level.

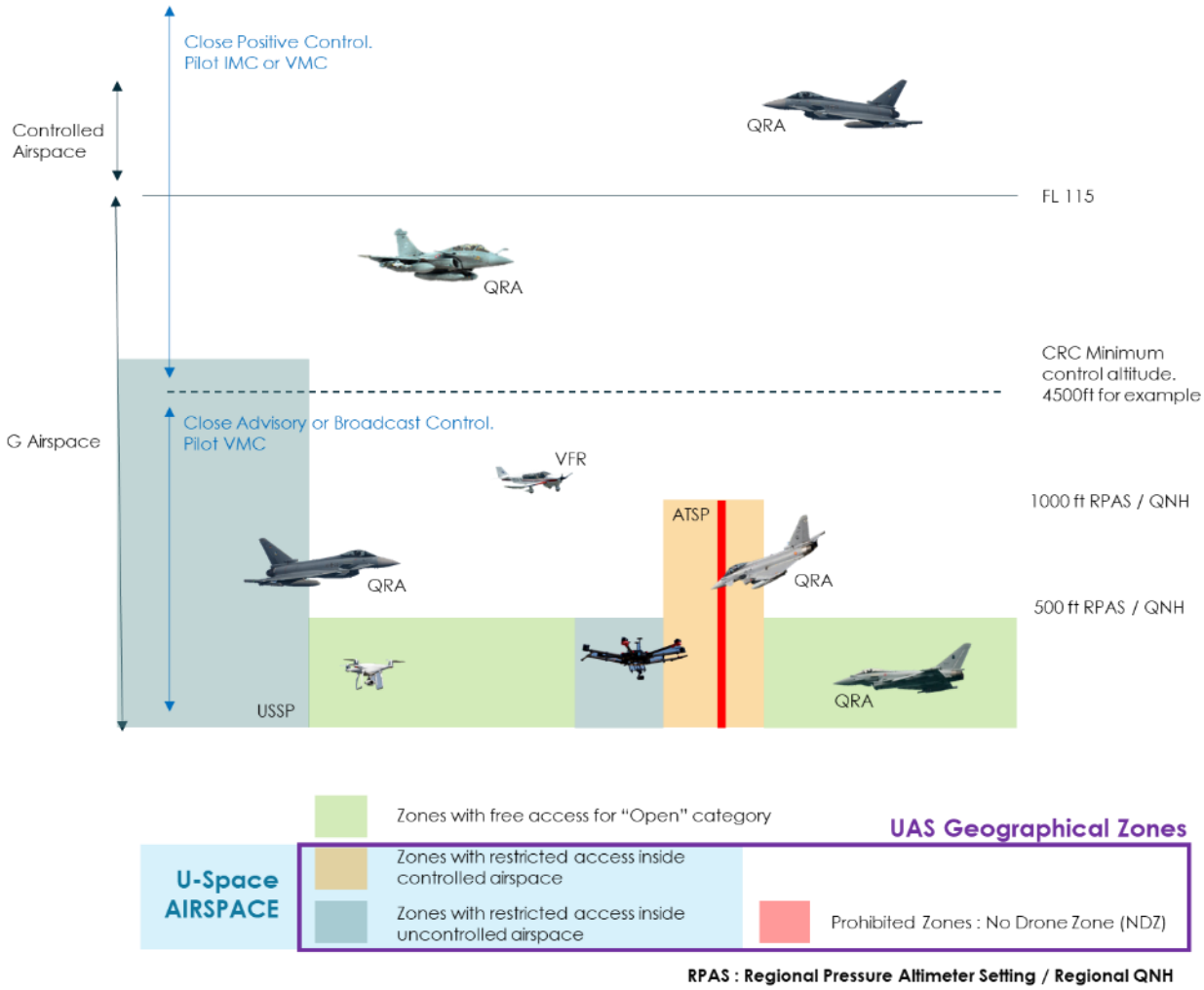


FIGURE 48: UC3 – AIRSPACE STRUCTURE

As recognized in the Single European Sky Regulation, the military mission effectiveness and access to airspace have to be guaranteed.

At Very Low Level (VLL), military aircraft can operate in drone free access zones and U-space airspaces. This means both outside and within the drone geographical zones, as defined in the U-space Regulation (cf. 2.3.2.5 -).

Use Case 3 is divided into three sub-Use Cases, depending on the context in which they occur, as the three operational contexts described in the introduction to this section 4 - are relevant for the Use Case

- Outside U-space airspace (sub-Use Case 3.1 in 4.3.2.1 -);
- Inside uncontrolled U-space airspace (sub-Use Cases 3.2 in 4.3.2.2 -);
- Inside controlled U-space airspace (sub-Use Cases 3.3 in 4.3.2.3 -).

The overall view, showing different scenarios is depicted in Figure 49 below.

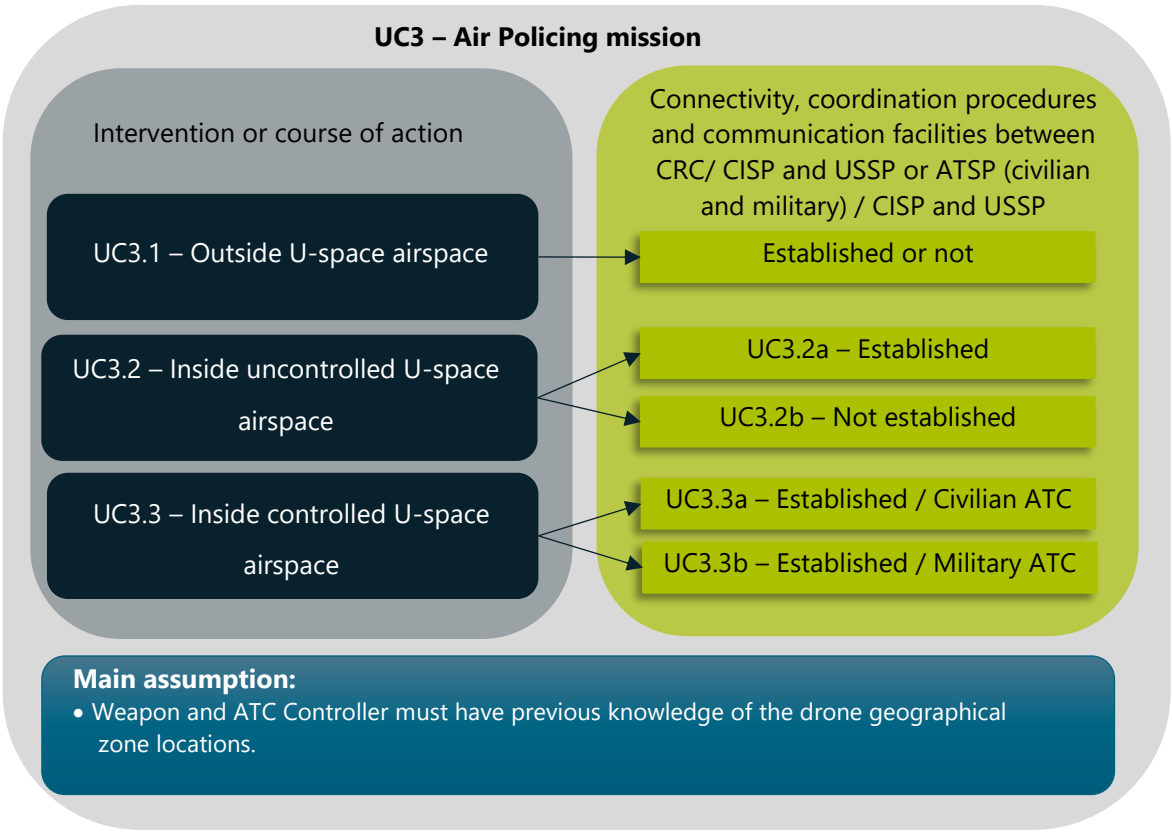


FIGURE 49: UC3 – AIR POLICING MISSION OVERVIEW

- Actors (individuals and organisations)

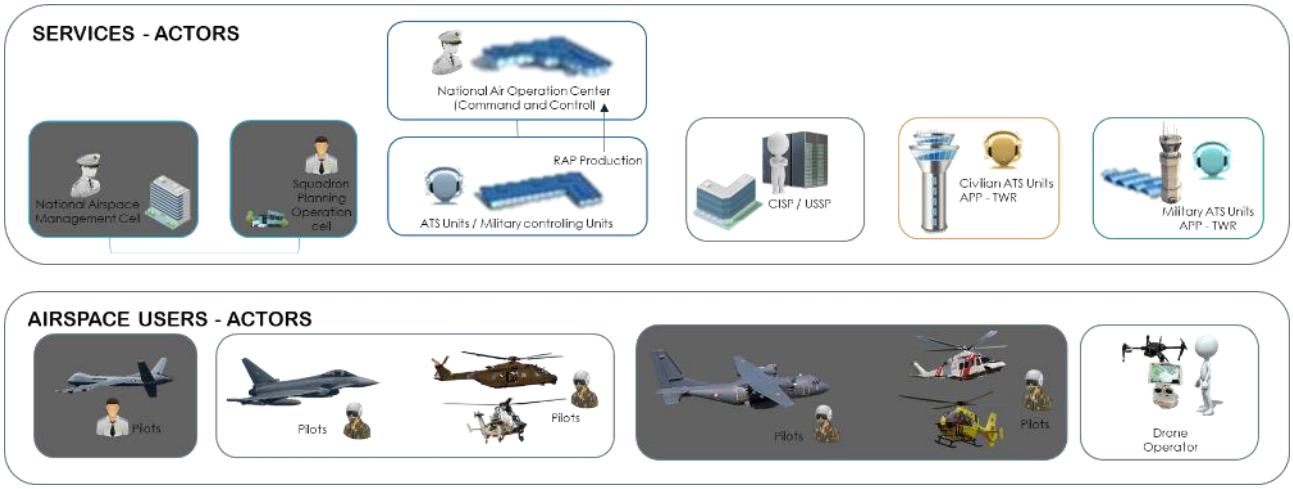


FIGURE 50: UC3 - ACTORS

- Military Air Traffic Controller (ATCO)
- Weapon Controller
- QRA interceptor pilot(s)
- Drone Operator
- Civilian Air Traffic Controller (ATCO)
- U-space Service Provider (USSP)
- Common Information Service Provider (CISP)
- Military Control and Reporting Centre (CRCs)
- Command and Control (C2) centre
- NATO Combined Air Operation Centre (CAOC)

- Military control agency
- Tactical control agency
- ATS units / Military controlling units

- General assumptions
  - It is considered that the Weapon Controller knows where drone geographical zones are located (e.g. via publication by the national AIS or directly displayed on the Weapon Controller position thanks to a U-space service);
  - Outside the U-space airspace, the access of drones to VLL uncontrolled airspace is free if they operate in the VLOS 'open' category. They are not provided any U-space service.
- Event initiating the Use Case
  - A non-cooperative aircraft is flying in the airspace of a Member State.

4.3.2 - Nominal flow of actions

4.3.2.1 - Sub-Use Case UC3.1: Interception or course of action outside U-space airspace

<table>
<tr><td rowspan="4">outside U-space Airspace

FREE ACCESS</td><td>Airspace Class</td><td>Flight Rules MIL a/c</td><td>Potential airspace restrictions</td><td>Air mission control/ safety</td><td>Drone activities</td><td>U-space services</td><td>Dynamic NDZ</td></tr>
<tr><td rowspan="3">F, G</td><td>Visual flight ≥500ft or Operational flight <500ft</td><td rowspan="3">R, P, D areas</td><td rowspan="3">TAC C2: Broadcast or close advisory control/ Pilot : see and avoid</td><td rowspan="3">VLOS</td><td rowspan="3">None</td><td rowspan="3">None</td></tr>
<tr><td>Flight conditions</td></tr>
<tr><td>VMC</td></tr>
<tr><td>Nominal actions</td><td colspan="7">■ The QRA interceptor pilot (Fighter or helicopter) flies under VFR OAT (Operational Air Traffic) or GAT (General Air Traffic) flight above 500ft[17] or under operational flight below 500ft (depending on national regulations), to intercept the target aircraft;
■ Below the minimum control altitude (as MRVA: Minimum Radar Vectoring Altitude) of the ATS Unit / Military control unit, the Weapon Controller provides close advisory or broadcast control. Tactical/target information is passed to enable the QRA interceptor pilot to accomplish the assigned task;
■ The ATS Unit / Military control unit, when possible, provides adequate warnings about hazards and carries out coordination with the managers of areas (civilian ATCOs, other military ATCOs) interfering with the intercept flight path;
■ The QRA interceptor pilot is responsible for navigation and collision avoidance by applying the see-and-avoid principle;
■ The Drone Operator is responsible for collision avoidance with all aircraft;
■ The information on drone traffic could be provided by the military Weapon Controller (cf. RAP Use Case in 4.2 -) if military sensors cover this area (limited SA).</td></tr>
</table>

TABLE 22: UC3.1 – CONTEXT OF OPERATION

Note: In this airspace, defined as type X volumes in CORUS-XUAM, the benefit of the connectivity with the U-space should provide a certain freedom of action by sending a short term restriction request to the USSP. In

[17] *If the QRA interceptor is an helicopter, this threshold may around 170 ft*

the CORUS-XUAM Concept of Operations, short term restrictions are communicated to drone operators through the Emergency Management service:

"If the flight has an U-plan, the Emergency management service will warn the pilot when a geo-fence-with-immediate-effect has been created which affects the current flight." [23]

4.3.2.2 - Sub Use-Cases UC3.2: Interception or course of action inside uncontrolled U-space airspace

OPTION UC3.2A: ESTABLISHED MILITARY COOPERATION WITH USSP

In this sub-Use Case, it is assumed that:

- The CRC systems and the CISP/USSP systems are connected;
- Coordination procedures are defined between operation centres;
- Communication facilities are established between Weapon Controllers and the USSP.

<table>
<tr><th></th><th>Airspace Class</th><th>Flight Rules MIL a/c</th><th>Potential airspace restrictions</th><th>Air mission control/ safety</th><th>Drone activities</th><th>U-space services</th><th>Dynamic NDZ</th></tr>
<tr><td rowspan="3">U-space Airspace

Restricted ACCESS</td><td rowspan="3">F, G</td><td>Visual flight ≥500ft or Operational flight <500ft</td><td rowspan="3">R, P, D areas

NDZ</td><td rowspan="3">TAC C2: Broadcast or close advisory control/ Pilot : see and avoid</td><td rowspan="3">VLOS/ BVLOS</td><td rowspan="3">Common information

Geo-awareness

UAS flight authorisation

Network identification

Traffic information

[weather information

conformance monitoring]</td><td rowspan="3">Requested by military</td></tr>
<tr><td>Flight conditions</td></tr>
<tr><td>VMC</td></tr>
<tr><td>Nominal actions</td><td colspan="7">

The QRA interceptor pilot (fighter or helicopter) flies under VFR OAT (Operational Air Traffic) or GAT (General Air Traffic) flight above 500ft/170ft or under operational flight below 500ft/170ft (depending on national regulations), to intercept the target aircraft;
Below the minimum control altitude (as MRVA: Minimum Radar Vectoring Altitude) of the ATS Unit / Military control unit, the Weapon Controller provides close advisory or broadcast control. Tactical/target information is passed to enable the QRA interceptor pilot to accomplish the assigned task;
The ATS Unit / Military control unit, when possible, provides adequate warnings about hazards;
The connectivity, coordination procedures and interoperable communication between the ATS Unit / Military control unit and USSP/CISP could allow achieving higher levels of safety;
Military authorities could request defined dynamic U-space airspace restrictions (Figure 51) to conduct QRA operations in a safe and efficient manner. (See UC 1)

Dynamic airspace reconfiguration means temporary modification of the U-space airspace in order to accommodate short-term requests from airspace users, by adjusting the geographical limits of this U-Space airspace;
ATS Unit / Military control unit can request to temporarily limit the area within the designated U-space airspace where drone operations can take place in order to accommodate the request;

</td></tr>
</table>

	▸ ATS Unit / Military control unit ensures that the relevant U-space service providers and, where applicable, common information service providers, are notified in a timely and effective manner of the activation, deactivation and temporary limitations of the designated U-space airspace. USSP adapt Geo-awareness service to the airspace configuration; ▸ A dynamic reconfiguration should be a temporary limitation of the designated U-space airspace, in the form of altitude block, corridor, portion of airspace; ▸ An USSP "functionality" to ground all UAS when needed by the military should be defined. ■ The **network identification service (1 in Figure 52)** provides the Weapon Controller with full situational awareness of drone activity. The Weapon Controller could provide traffic information **(2 in Figure 52)** on drones to the QRA(I) pilot; ■ The correlation between drone tracks and their **flight authorisations (1 in Figure 52)** allows the Weapon Controller to extrapolate the future flight path of drone traffic; ■ The USSP **traffic information service (4 in Figure 52)** provided to Drone Operators contains information on any other conspicuous air traffic that may be in proximity with the position or intended route of their drones.

TABLE 23: UC3.2A - CONTEXT OF OPERATION

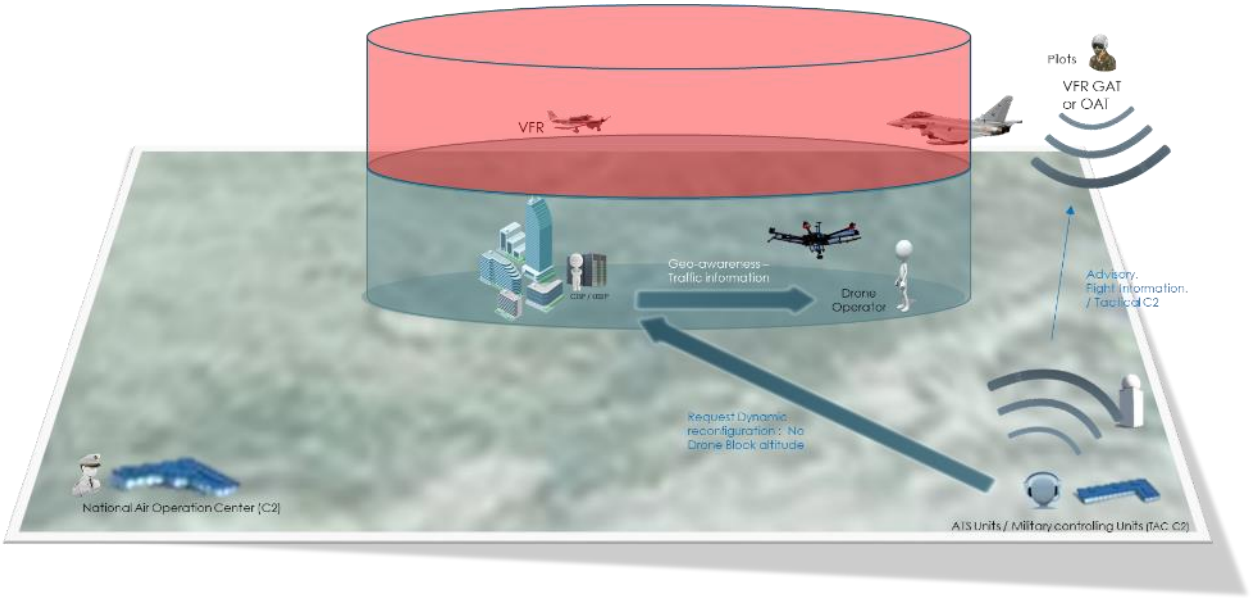


FIGURE 51: UC3 – DYNAMIC RECONFIGURATION INSIDE UNCONTROLLED U-SPACE AIRSPACE

The following diagram illustrates this nominal flow of actions and the interactions between the different actors of the use case.

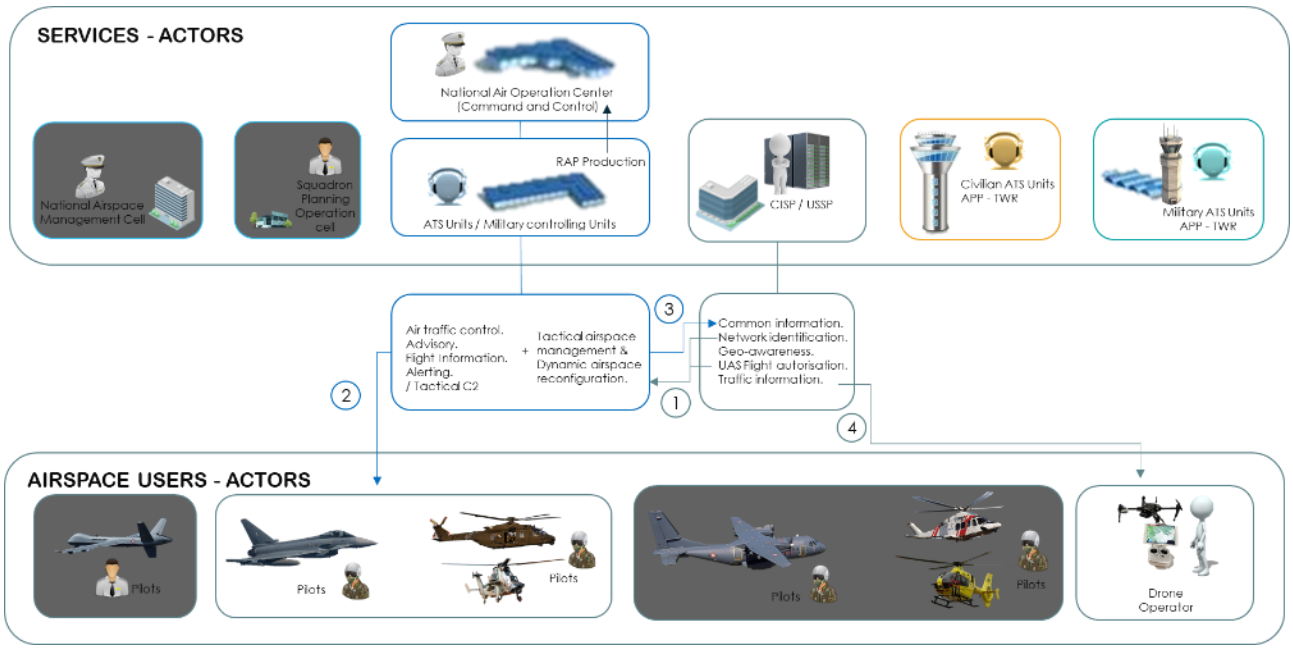


FIGURE 52: UC3 – QRA INSIDE UNCONTROLLED U-SPACE AIRSPACE

OPTION UC3.2B: MILITARY COOPERATION WITH USSP NOT ESTABLISHED

In this sub-Use Case, it is assumed that:

- The CRC systems and the CISP/USSP systems are not connected;
- Coordination procedures are not defined between operation centres;
- Communication facilities are not established between Weapon Controllers and the USSP.

	Airspace Class	Flight Rules MIL a/c	Potential airspace restrictions	Air mission control/ safety	Drone activities	U-space services	Dynamic NDZ
U-space airspace Restricted ACCESS	F, G	Visual flight ≥500ft or Operational flight <500ft Flight conditions VMC	R, P, D areas NDZ	TAC C2: Broadcast or close advisory control/ Pilot : see and avoid	VLOS/ BVLOS	None	None
Nominal actions	■ The QRA interceptor pilot (fighter or helicopter) flies under VFR OAT (Operational Air Traffic) or GAT (General Air Traffic) flight above 500ft/170ft or under operational flight below 500ft/170ft, to intercept the target aircraft; ■ Below the minimum control altitude (as MRVA: Minimum Radar Vectoring Altitude) of the ATS Unit / Military control unit, the Weapon Controller provides close advisory or broadcast control. Tactical/target information is passed to enable the aircraft pilot to accomplish the assigned task; ■ ATS Unit / Military control unit, when possible, provides adequate warnings about hazards; ■ Military actors have no awareness of drone activities and U-space services available in this uncontrolled, restricted access drone geographical zone;						

	■ Unplanned or conscious entry of a military aircraft in the uncontrolled, restricted access drone geographical zone is a risk, which the military should assess before entering those areas. To mitigate such a risk, it is important to receive information on potential activities in the considered area (e.g. through the military surveillance systems); ■ (optional[18]) The military Weapon Controller (cf. RAP Use Case in 4.2 -) provides information on drone traffic if military sensors cover this area (limited SA).

TABLE 24: UC3.2B – CONTEXT OF OPERATION

Note: The U-space regulation IR 2021/664 [12] highlights the need to know the position of manned aircraft in the U-space concerned:

"In order to allow unmanned aircraft to safely operate alongside manned aircraft in U-space airspace, rules providing for effective signalling of the presence of manned aircraft by means of surveillance technologies are necessary. (…) The traffic information service shall include information about manned aircraft and UAS traffic shared by other U-space service providers and relevant air traffic service units. The traffic information service shall provide information about other known air traffic and shall:

(a) include the position, time of report as well as speed, heading or direction and emergency status of aircraft, when known;

(b) be updated at a frequency that the competent authority has determined.

The Strategic Research and Innovation Agenda (SRIA) highlights that: *"Research is required to understand how different modes of separation provision enable interoperable ATM and U-space services to co-exist, considering the diversity of aircraft performance characteristics and detect-and-avoid capabilities"* and *"Different solutions for separation management for all types of vehicles in all types of airspace (including airborne detect and avoid (DAA) as well as ground-based and hybrid solutions) should also be considered."* [26]

4.3.2.3 - Sub-Use Cases UC3.3: Interception or course of action inside controlled U-space airspace

OPTION UC3.3A: ESTABLISHED CIVILIAN ATSP COOPERATION WITH USSP, AIRSPACE UNDER CIVILIAN ATC

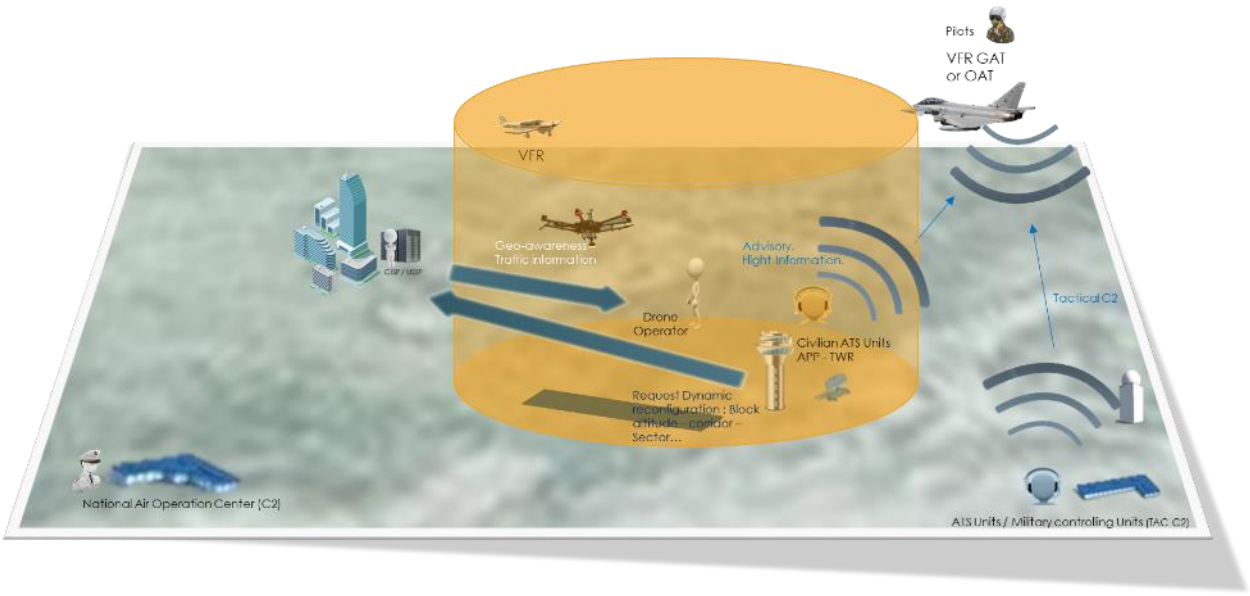


FIGURE 53: CIVILIAN CONTROLLED AIRSPACE

In addition to existing coordination between the CRC and the civilian ATS unit, in this sub-Use Case, it is assumed that:

---

[18] *If the military have appropriate sensors and C2 network to allow proper detection of drones*

- The civilian ATS unit systems and the CISP/USSP systems are connected;
- Coordination procedures are defined between operation centres[16];
- Communication facilities are established between the civilian ATSP and USSP.

<table>
<tr><th></th><th>Airspace Class</th><th>Flight Rules MIL a/c</th><th>Potential airspace restrictions</th><th>Air mission control/ safety</th><th>Drone activities</th><th>U-space services</th><th>ATSP</th></tr>
<tr><td rowspan="3">U-space Airspace

Restricted ACCESS</td><td rowspan="3">A, B, C, D, E</td><td>Visual flight ≥500ft or Operational flight <500ft</td><td rowspan="3">R, P, D areas

NDZ</td><td rowspan="3">TAC C2: Broadcast or close advisory control/ ATC</td><td rowspan="3">VLOS/ BVLOS</td><td rowspan="3">Common information services

Geo-awareness

UAS flight authorisation

Network identification

Traffic information

[weather information

conformance monitoring]</td><td rowspan="3">Traffic information/ Dynamic airspace reconfiguration</td></tr>
<tr><td>Flight conditions</td></tr>
<tr><td>VMC</td></tr>
<tr><td>Nominal actions</td><td colspan="7">

The QRA interceptor pilot (fighter or helicopter) flies under VFR OAT (Operational Air Traffic) or GAT (General Air Traffic) flight above 500ft/170ft or under operational flight below 500ft/170ft (depending on national regulations), to intercept the target aircraft;
Below the minimum control altitude (as MRVA: Minimum Radar Vectoring Altitude) of the ATS Unit / Military control unit, the Weapon Controller provides close advisory or broadcast control. Tactical/target information is passed to enable the QRA interceptor pilot to accomplish the assigned task;
The ATS Unit / Military control unit manages the coordination with the civilian ATCO (APP);
The QRA interceptor pilot remains on tactical frequency with the ATS Unit / Military control unit and establishes a two-way communication with the civilian ATCO on the second radio set;
Inside controlled airspace, the civilian ATCO should be able to request defined dynamic U-space airspace restrictions (Figure 54) to enable such operations in a safe and efficient manner (See UC1).

Dynamic airspace reconfiguration means temporary modification of the U-space airspace in order to accommodate short-term requests from airspace users, by adjusting the geographical limits of this U-space airspace;
The civilian ATCO (APP) can request to temporarily limit the area within the designated U-space airspace where drone operations can take place in order to accommodate the request;
The civilian ATS unit (APP) ensures that the relevant U-space service providers and, where applicable, common information service providers, are notified in a timely and effective manner of the activation, deactivation and temporary limitations of the designated U-space airspace. USSP adapt Geo-awareness service to the airspace configuration;
A dynamic reconfiguration should be a temporary limitation of the designated U-space airspace, in the form of altitude block, corridor, portion of airspace;
An USSP “functionality” to ground all UAS when needed by the military should be defined

</td></tr>
</table>

	■ Inside controlled airspace, the civilian ATCO provides traffic information **(2 in Figure 55)** to the QRA pilot on manned and unmanned [shared by the USSP **(1 in Figure 55)**] activities. He facilitates the trajectory desired by the QRA interceptor pilot. The weapon controller assumes tactical C2 **(3 in Figure 55)**. Traffic information can be provided to Drones Operators through the USSP **Traffic information service (4 in Figure 55)**.

TABLE 25: UC3.3A - CONTEXT OF OPERATION

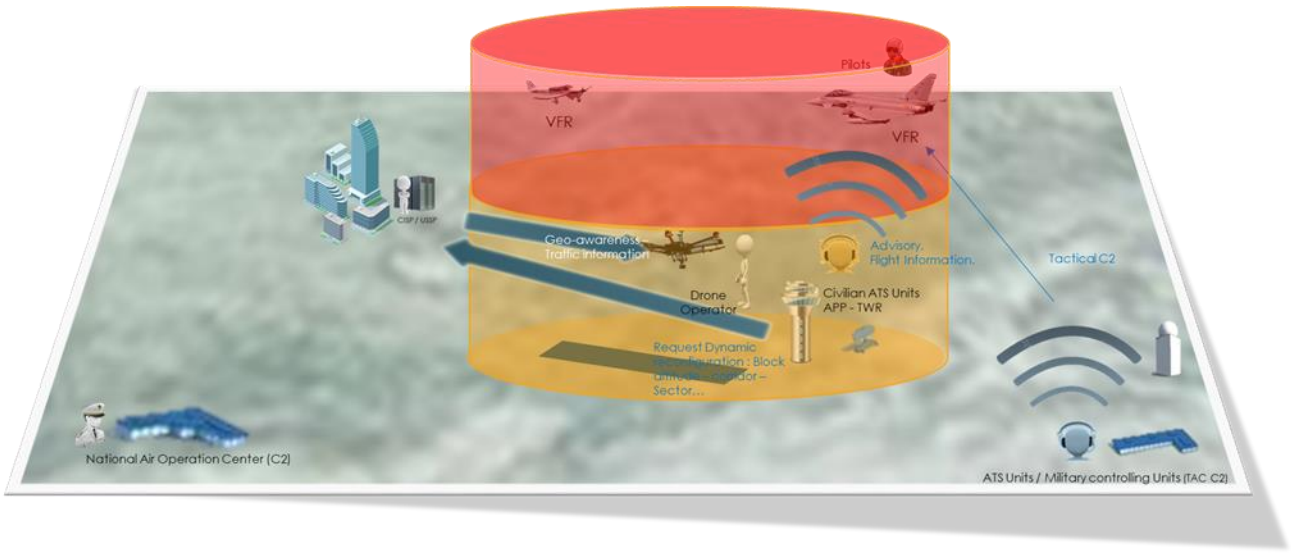


FIGURE 54: UC3 – DYNAMIC RECONFIGURATION INSIDE CIVILIAN CONTROLLED U-SPACE AIRSPACE

The following diagram illustrates this nominal flow of actions and the interactions between the different actors of the use case.

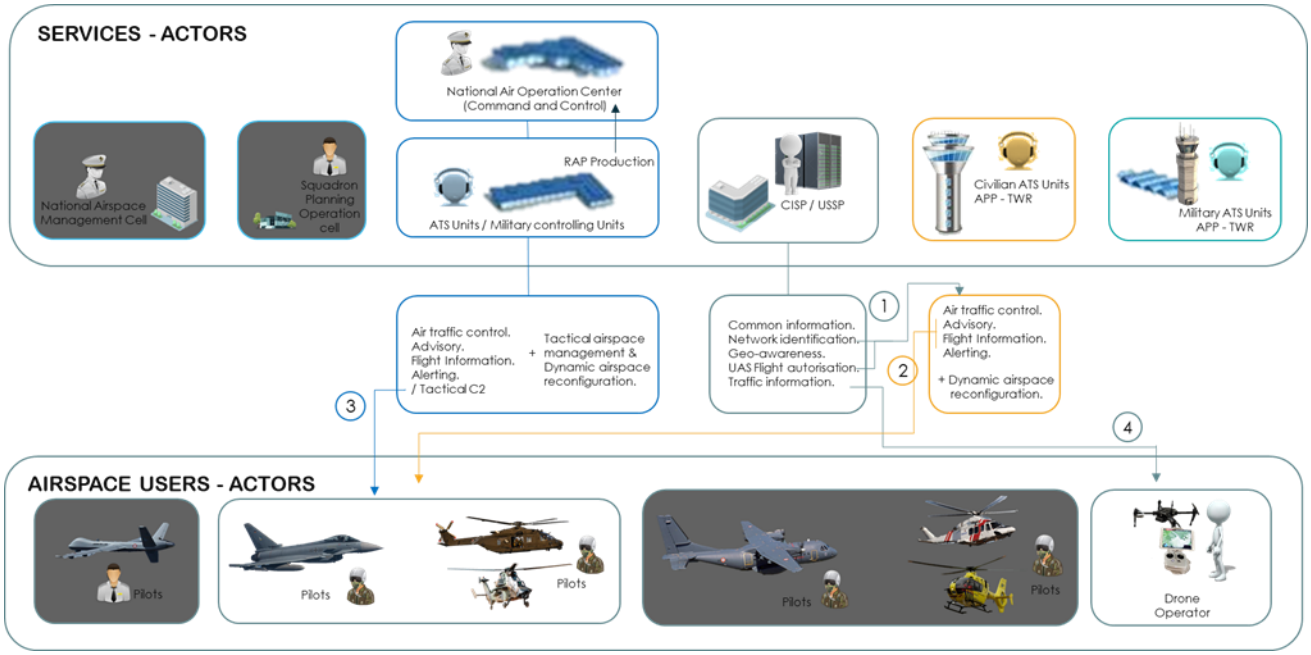


FIGURE 55: UC3 – QRA INSIDE CIVILIAN CONTROLLED U-SPACE AIRSPACE

OPTION UC3.3B: ESTABLISHED MILITARY COOPERATION WITH USSP, AIRSPACE UNDER MILITARY ATC

In this sub-Use Case, the Member State has defined a military CTR as part of the U-space airspace. Thus, in line with the requirements of the EASA U-space Regulation, the systems connectivity methods between provider(s) of the Common Information Services, the USSP and the military Air Traffic Service Provider (e.g. in a CTR) is established through interoperable communication protocols.

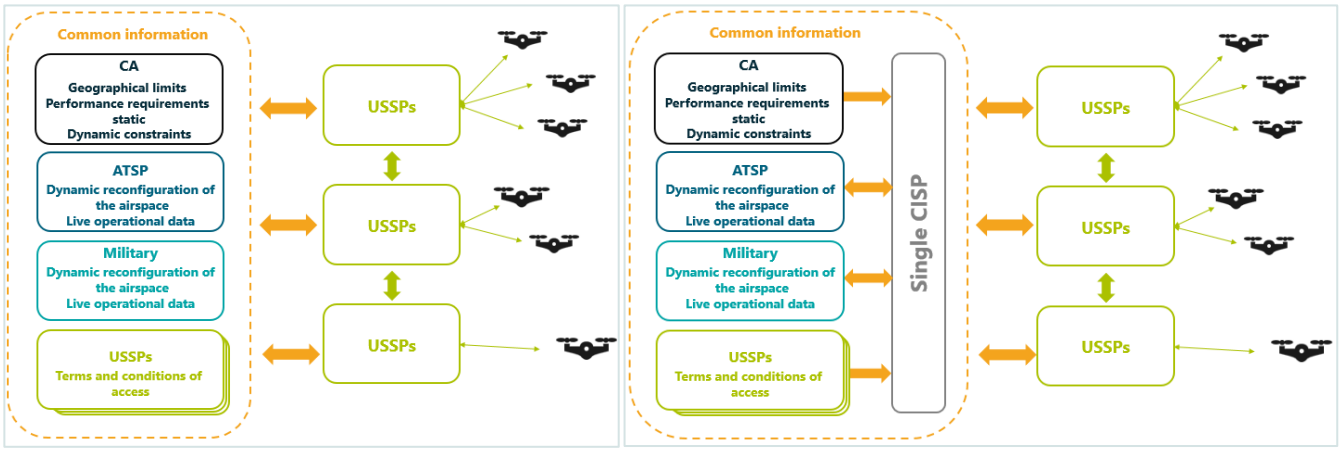


FIGURE 56: POSSIBLE INFORMATION EXCHANGE MODELS BETWEEN A MILITARY ATSU AND USSPS

In this portion of airspace, the relevant military Air Traffic Service Unit (ATSU) has to share continuously with the USSP information on manned aircraft, in particular regarding manned aircraft known or believed to be in a state of emergency, including being subjected to unlawful interference.

The traffic information about manned aircraft provided by the USSP to the Drone Operator has to be shared by the relevant ATSUs.

The military ATSU has to apply dynamic reconfiguration of the U-space airspace in order to make sure that manned aircraft and drone traffic remain segregated, as expected by the U-space Regulation.

The Weapon Controller has the knowledge of the geographical locations of U-space airspace, which could be directly displayed on the military control working position. All information data has to be exchanged between the systems.

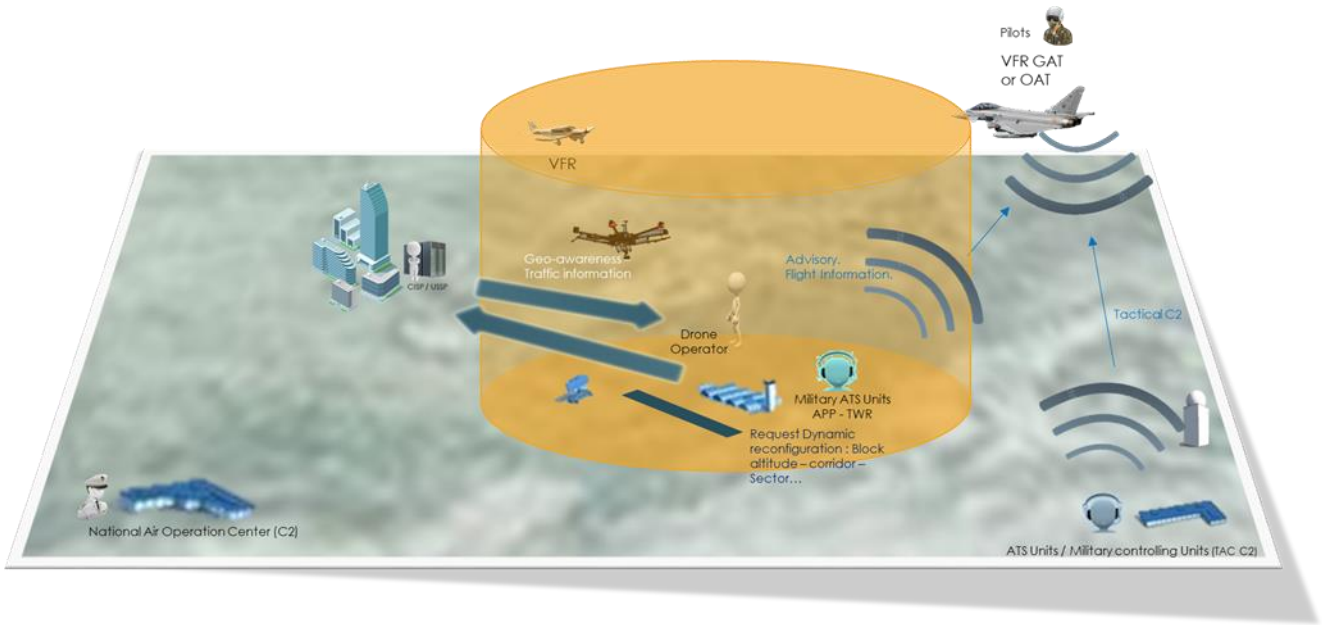


FIGURE 57: MILITARY CONTROLLED AIRSPACE

<table>
<tr><td rowspan="2">U-space Airspace

Restricted ACCESS</td><td>Airspace Class</td><td>Flight Rules MIL a/c</td><td>Potential airspace restrictions</td><td>Air mission control/ safety</td><td>Drone activities</td><td>U-space services</td><td>ATSP</td></tr>
<tr><td>A, B, C, D, E</td><td>Visual flight ≥500ft or Operational flight <500ft
Flight conditions
VMC</td><td>R, P, D areas

NDZ</td><td>TAC C2: Broadcast or close advisory control/ ATC</td><td>VLOS/ BVLOS</td><td>Common information services
Network identification
Geo-awareness
UAS flight authorisation
Traffic information
[weather information
conformance monitoring]</td><td>Traffic information/ Dynamic airspace reconfiguration</td></tr>
<tr><td>Nominal actions</td><td colspan="7">

The QRA interceptor pilot (fighter or helicopter) flies under VFR OAT (Operational Air Traffic) or GAT (General Air Traffic) flight above 500ft/170ft or under operational flight below 500ft/170ft, to intercept the target aircraft;
The Weapon Controller provides close advisory or broadcast control. Tactical/target information is passed to enable the QRA interceptor pilot to accomplish the assigned task;
The ATS Unit / Military control unit manages coordination with the military ATCO (APP);
The QRA interceptor pilot remains on tactical frequency with the ATS Unit / Military control unit and establishes a two ways communication with the military ATCO (APP) on the second radio set;
Inside controlled airspace, the military ATCO (APP) should be able to request defined dynamic U-space airspace restrictions (Figure 58) to enable such operations in a safe and efficient manner (see UC1);

Dynamic airspace reconfiguration means temporary modification of the U-space airspace in order to accommodate short-term requests from airspace users, by adjusting the geographical limits of this U-space airspace;
The Military ATCO (APP) temporarily limits the area within the designated U-space airspace where drone operations can take place in order to accommodate the request;
The military ATS unit (APP) ensures that the relevant U-space service providers and, where applicable, common information service providers, are notified in a timely and effective manner of the activation, deactivation and temporary limitations of the designated U-space airspace. USSP adapt Geo-awareness service to the airspace configuration;
A dynamic reconfiguration should be a temporary limitation of the designated U-space airspace, in the form of altitude block, corridor, portion of airspace;
An USSP “functionality” to ground all UAS when needed by the military should be defined.

Inside controlled airspace, the military ATCO provides traffic information (2 in Figure 59) to the QRA pilot on manned and unmanned [shared by USSP (1 in Figure 59)] activities. He facilitates the trajectory desired by the QRA interceptor pilot. The weapon controller assume tactical C2 (3 in Figure 59).
The Drone Operator is alerted to the proximity with the QRA interceptor through the Traffic information service (4 in Figure 59).

</td></tr>
</table>

TABLE 26: UC3.3B - CONTEXT OF OPERATION

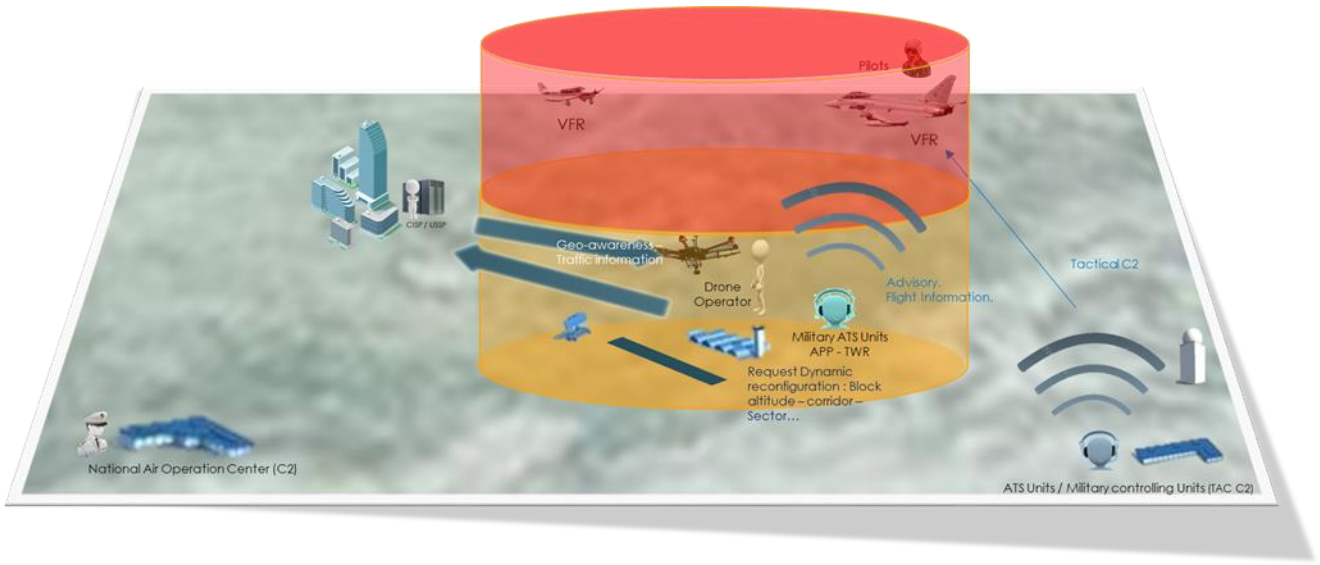


FIGURE 58: UC3 – DYNAMIC RECONFIGURATION INSIDE MILITARY CONTROLLED U-SPACE AIRSPACE

The following diagram illustrates this nominal flow of actions and the interactions between the different actors of the use case.

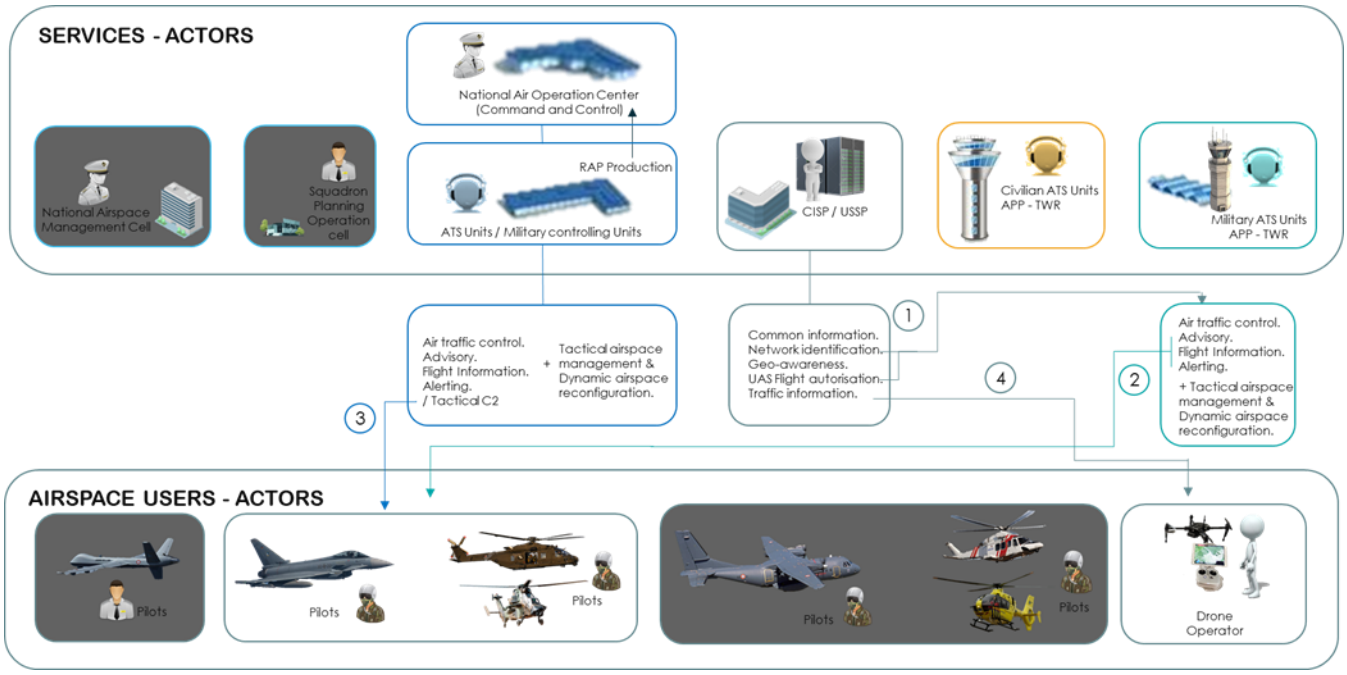


FIGURE 59: UC3 – QRA INSIDE MILITARY CONTROLLED U-SPACE AIRSPACE

4.4 - Use Case 4: Search and Rescue (SAR)

4.4.1 - Use Case overview

The Search and Rescue is an activity with the aim at saving human lives. In many countries, the military is responsible for conducting SAR operations. However, non-military air assets can be used, and even got a leading role. The aircraft types involved are mainly helicopters and multi-engine aircraft, which during actual SAR emergencies will require priority handling and unrestricted access to appropriate airspace.

SAR operations are usually conducted at low altitudes; but some aircraft are occasionally used at medium altitudes as airborne relay units or airborne on-scene coordinator.

SAR operations have practices and procedures, which are based on ICAO Annexes but the responsibilities of civilian and military authorities in SAR operations are not harmonised across Member States.

The military or civil SAR mission coordinator (SMC) is assigned to coordinate the overall SAR response and has two primary concerns regarding the tactical or real-time management of the airspace:

- Gaining access to controlled airspace within the vicinity of the scene of SAR operations;
- Establishing a safe airspace for operation, in controlled or uncontrolled airspace, as needed, with the local ATSU (Air Traffic Service Unit) and the appropriate airspace authority where appropriate.

- SAR scenario

Following a loss of radio and radar contact with an airliner, the Air Traffic Service Provider (ATSP) concerned sends a distress phase (DETRESFA) to the Rescue Coordination Centre (RCC).

The regional CRC is in charge of providing primary radar data on the flight path of the aircraft concerned, including the latitude-longitude coordinates and altitude of the last known position.

In Europe, the RCC is in charge to scramble SAR helicopters inbound the accident area. A possible scenario is:

- The accident zone is straddled between a free access U-space airspace and a restricted one;
- Helicopter(s) take(s) off to join the area under VFR. A CRC Tactical Controller (TAC C2), or an Air Traffic Controller (ATCO) of Military Controlling Unit or ATS Unit depending on national regulations, provides them broadcast control or advisory service, which includes traffic information;

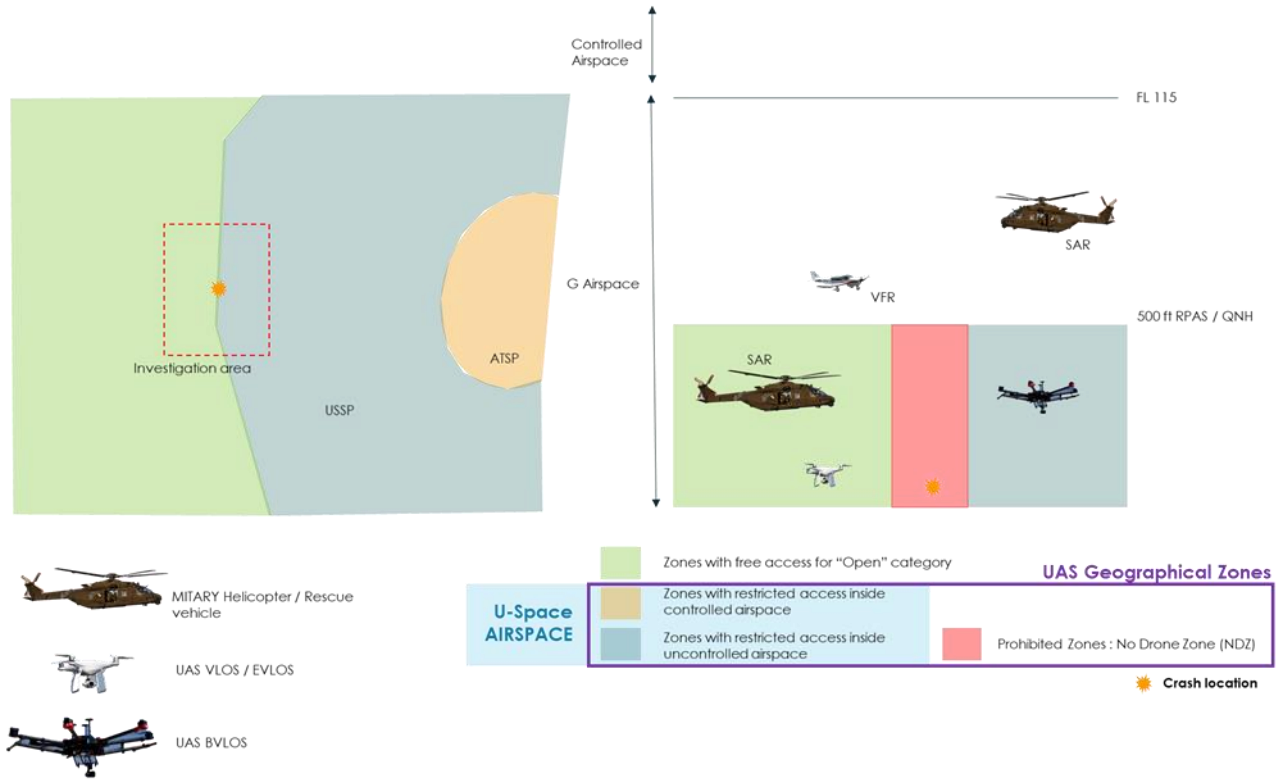


FIGURE 60: UC4 – GEOGRAPHICAL SCOPE AND AIRSPACE STRUCTURE

Use Case 4 is divided into two sub-Use Cases, depending on the context in which they occur, as only two of the three operational contexts described in the introduction to this section 4 - are relevant for the Use Case:

- Outside U-space airspace (sub-use Case 4.1 in 4.4.2.1 -);
- Inside uncontrolled U-space airspace (sub-use Case 4.2 in 0).

The overall view, showing different scenarios is depicted in Figure 61 below.

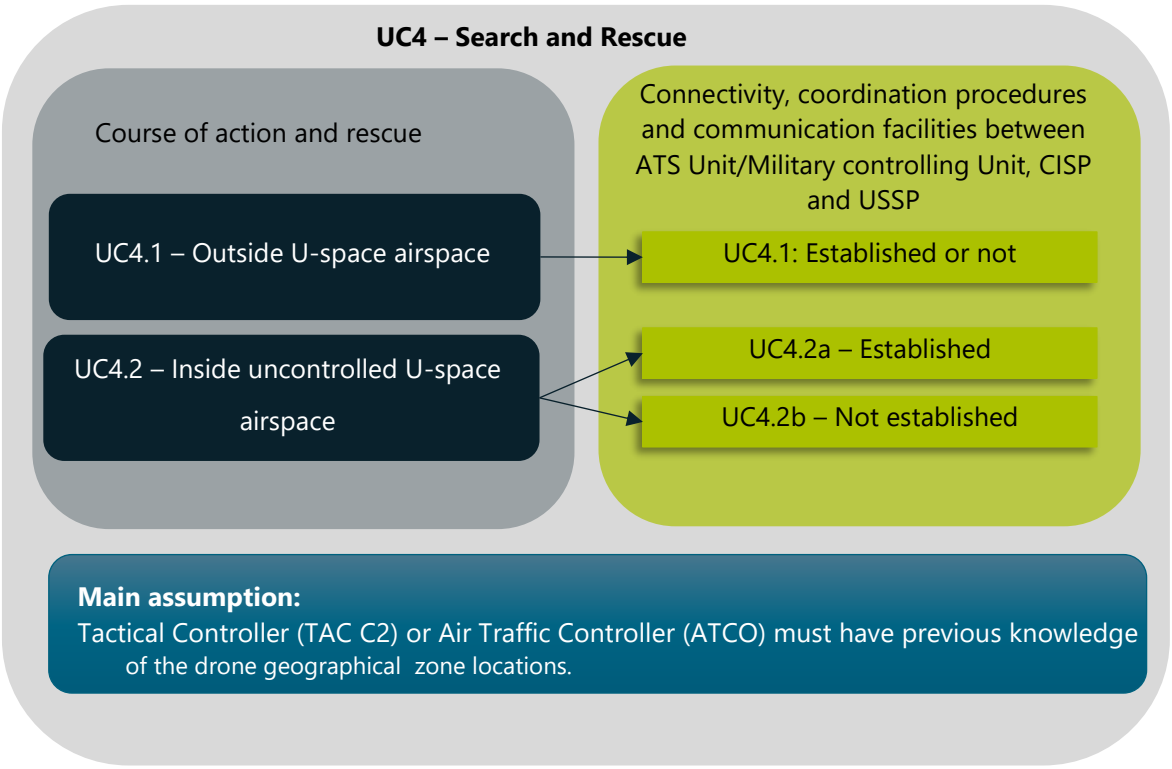


FIGURE 61: UC4 – SEARCH AND RESCUE OVERVIEW

- Actors

FIGURE 62: UC4 – ACTORS

- SAR Mission Coordinator (SMC)
- Air Traffic Controller (ATCO)
- Tactical Controller (TAC C2)
- SAR helicopter pilot(s)
- Drone Operator
- U-space Service Provider (USSP)
- Common Information Service Provider (CISP)
- Rescue Coordination Centre (RCC)
- ATS Unit / Military control unit

- General assumptions
  - It is considered that the Air Traffic Controller (ATCO) or Tactical Controller (TAC C2) knows where drone geographical zones are located (e.g. via publication by the national AIS or directly displayed on the controller working position thanks to a U-space service). All information data has to be exchanged between the systems.
- Event initiating the Use Case
  - An aircraft crashes close to a U-space airspace.

4.4.2 - Nominal flow of actions

4.4.2.1 - Sub-Use Case UC4.1: Course of action and rescue outside U-space airspace

<table>
<tr><td rowspan="4">outside U-space Airspace

FREE ACCESS</td><td>Airspace Class</td><td>Flight Rules MIL a/c</td><td>Potential airspace restrictions</td><td>Air mission control/ safety</td><td>Drone activities</td><td>U-space services</td><td>Dynamic NDZ</td></tr>
<tr><td rowspan="3">F, G</td><td>Visual flight ≥170ft* or Operational flight <170ft*</td><td rowspan="3">R, P, D areas</td><td rowspan="3">TAC C2: Broadcast control/ Pilot : see and avoid</td><td rowspan="3">VLOS</td><td rowspan="3">None</td><td rowspan="3">None</td></tr>
<tr><td>Flight conditions</td></tr>
<tr><td>VMC</td></tr>
<tr><td>Nominal actions</td><td colspan="7">■ To join the searching area, the SAR helicopter pilot flies under VFR OAT (Operational Air Traffic) or GAT (General Air Traffic) flight above 170ft (*depending on national regulations) or under operational flight below;
■ Below the minimum control altitude (as MRVA : Minimum Radar Vectoring Altitude) of the ATS Unit / Military control unit, the Tactical Controller (TAC C2) or Air Traffic Controller (ATCO) provides broadcast control or advisory service. Tactical information is passed to enable the helicopter pilot to accomplish the assigned task;
■ The ATS Unit / Military control unit, when possible, provides adequate warnings about hazards and carries out coordination with the managers of areas (civilian ATCOs, other military ATCOs) interfering with the search holding flight path;
■ The SAR helicopter pilot is responsible for navigation and collision avoidance by applying the see-and-avoid principle;
■ The Drone Operator is responsible for the avoidance of collision with all aircraft;
■ The information on drone traffic could be provided by the military Tactical Controller (TAC C2) (cf. RAP Use Case in 4.2 -) if military sensors cover this area (limited SA).</td></tr>
</table>

TABLE 27: UC4.1 - CONTEXT OF OPERATION

Note: In this airspace, defined as type X volumes in CORUS-XUAM, the benefit of the connectivity with the U-space should provide a certain freedom of action by sending a short term restriction request to the USSP. In the CORUS-XUAM Concept of Operations, short term restrictions are communicated to drone operators through the Emergency Management service:

"If the flight has an U-plan, the Emergency management service will warn the pilot when a geo-fence-with-immediate-effect has been created which affects the current flight." [23]

4.4.2.2 - Sub-Use Cases UC4.2: Course of action and Rescue inside uncontrolled U-space airspace

OPTION UC4.2A: ESTABLISHED MILITARY COOPERATION WITH USSP

In this sub-Use Case, it is assumed that:

- The ATS Unit / Military control unit systems and the CISP/USSP systems are connected;
- Coordination procedures are defined between operation centres;
- Communication facilities are established between Tactical Controller/Air Traffic Controller and the USSP.

	Airspace Class	Flight Rules MIL a/c	Potential airspace restrictions	Air mission control/ safety	Drone activities	U-space services	Dynamic NDZ
U-space Airspace Restricted ACCESS	F, G	Visual flight ≥170ft* or Operational flight <170ft* Flight conditions VMC	R, P, D areas	TAC C2-ATCO: Broadcast control-Advisory service / Pilot : see and avoid	VLOS/ BVLOS	Common information services Geo-awareness UAS flight authorisation Network identification Traffic information [weather information conformance monitoring]	Requested by military

Nominal actions

- To join the searching area, the SAR helicopter pilot flies under VFR OAT (Operational Air Traffic) or GAT (General Air Traffic) flight above 170ft (*depending on national regulations) or under operational flight below;
- Below the minimum control altitude (as MRVA : Minimum Radar Vectoring Altitude) of the ATS Unit / Military control unit , the Tactical Controller (TAC C2) or Air Traffic Controller (ATCO) provides broadcast control or advisory service. Tactical information is passed to enable the SAR helicopter pilot to accomplish the assigned task;
- The ATS Unit / Military control unit, when possible, provides adequate warnings about hazards;
- The connectivity, coordination procedures and interoperable communication between the ATS Unit / Military control unit and USSP/CISP could enhance SAR mission efficiency and achieve higher levels of safety;
- ATS Unit / Military control unit could request defined dynamic U-space airspace restrictions (Figure 63) to conduct SAR operations in a safe and efficient manner (See UC 1):
  - Dynamic airspace reconfiguration means temporary modification of the U-space airspace in order to accommodate short-term requests from airspace users, by adjusting the geographical limits of this U-Space airspace;
  - ATS Unit / Military control unit can request to temporarily limit the area within the designated U-space airspace (1 in Figure 64) where drone operations can take place in order to accommodate the request;
  - ATS Unit / Military control unit ensures that the relevant U-space service providers and, where applicable, common information service providers, are notified (1 in Figure 64) in a timely and effective manner of the activation, deactivation and temporary limitations of the designated U-space airspace. USSP adapt Geo-awareness service (3 in Figure 64) to the airspace configuration;
  - A dynamic reconfiguration should be a temporary limitation of the designated U-space airspace, in the form of altitude block, corridor, portion of airspace;

	▸ An USSP "functionality" to ground all UAS when needed by the military should be defined. ■ The **network identification service (2 in Figure 64)** provides the TAC C2/ATCO with full situational awareness of drone activity. The TAC C2/ATCO could provide traffic information on drones to the SAR helicopter pilot; ■ The correlation between drone tracks and their **flight authorisations (2 in Figure 64)** allows the TAC C2/ATCO to extrapolate the future flight path of drone traffic; ■ The USSP **traffic information service (4 in Figure 64)** provided to Drone Operators contains information on any other conspicuous air traffic that may be in proximity with the position or intended route of their drones.

TABLE 28: UC4.2A – CONTEXT OF OPERATION

These potential benefits of dynamic airspace configuration during SAR operations are illustrated in Figure 63.

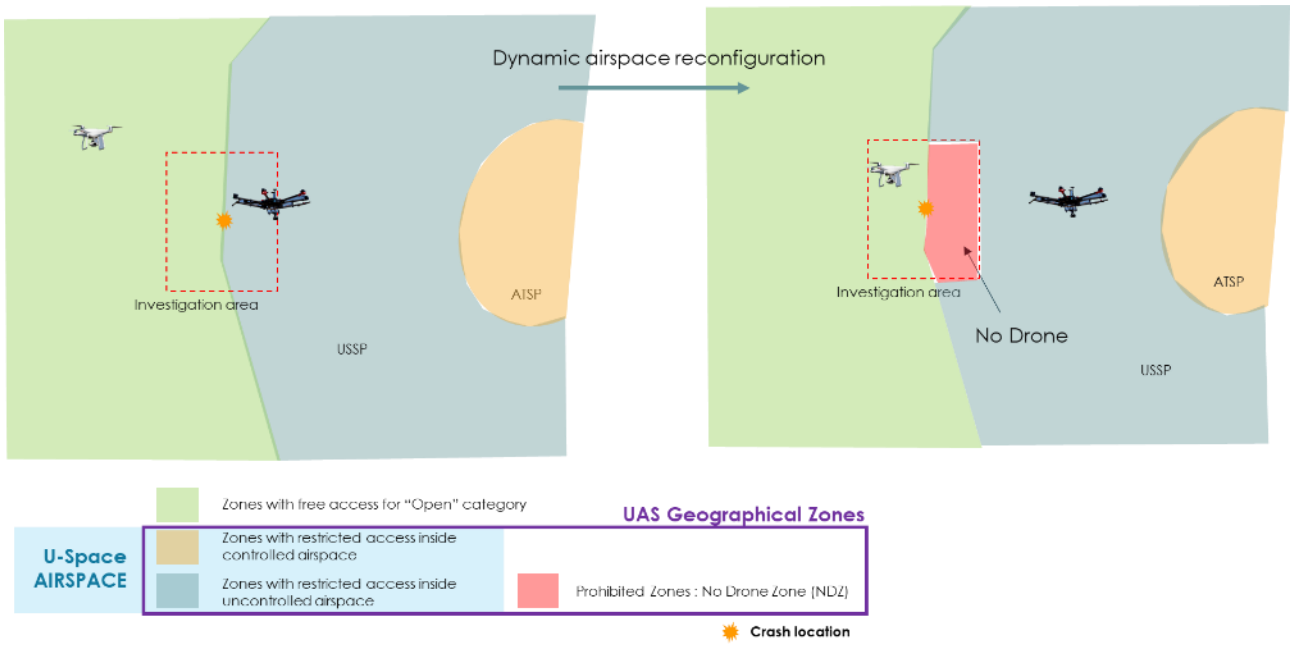


FIGURE 63: DYNAMIC AIRSPACE RECONFIGURATION DURING SAR OPERATIONS

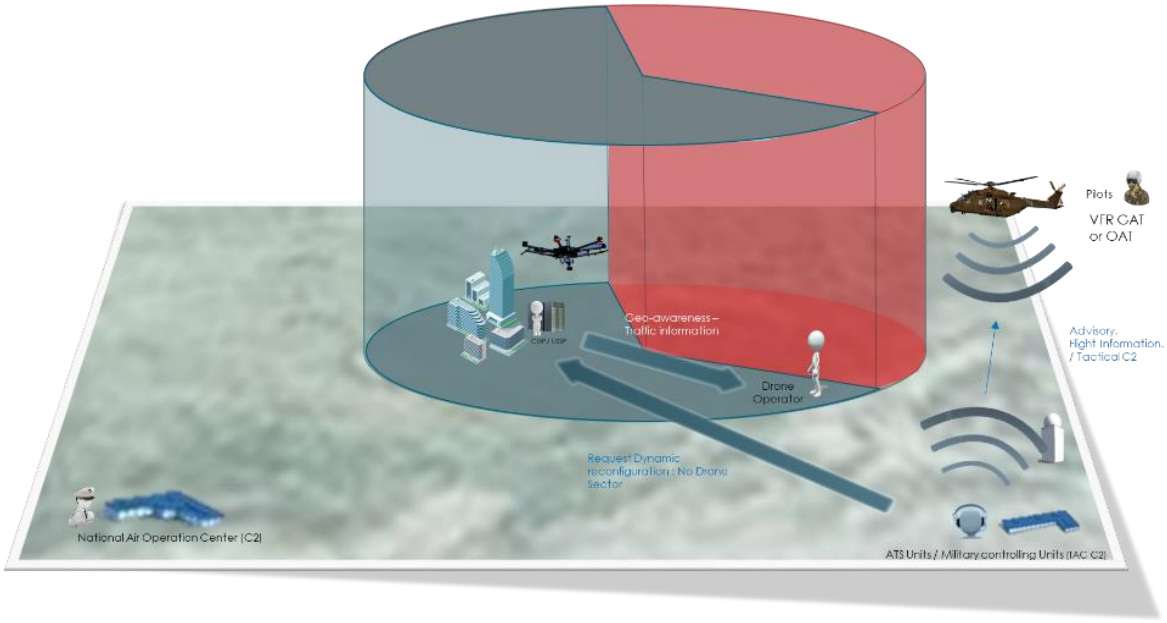


FIGURE 64: DYNAMIC AIRSPACE RECONFIGURATION PROCESS

The following diagram illustrates this nominal flow of actions and the interactions between the different actors of the use case.

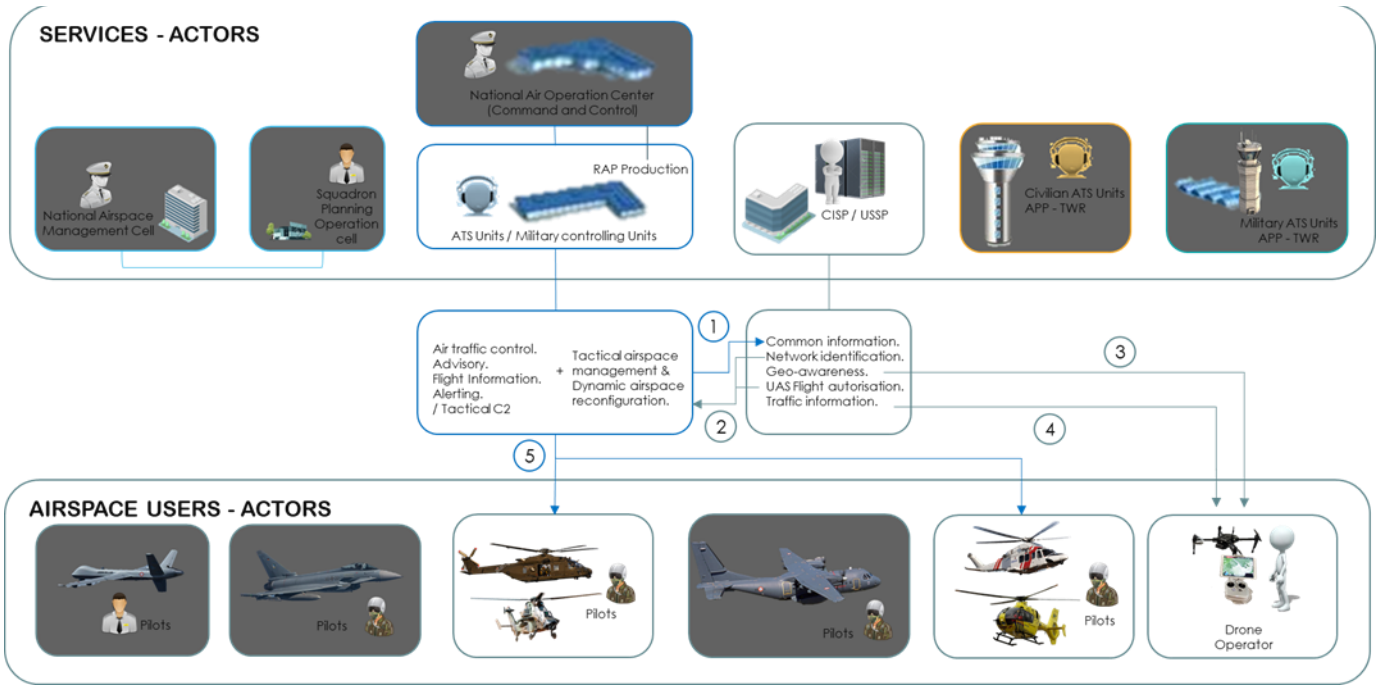


FIGURE 65: UC4 – SAR INSIDE UNCONTROLLED U-SPACE AIRSPACE

When the crash is found, the SAR helicopter pilot lands near the plane wreckage. The precise location is reported to the ground rescue services so that HEMS (Helicopter Emergency Medical Service) helicopters can take off from a nearby city to carry out MEDEVAC (cf. Use Case 6 in 4.7 -).

OPTION UC4.2B: MILITARY COOPERATION WITH USSP NOT ESTABLISHED

In this sub-Use Case, it is assumed that:

- The ATS Unit / Military control unit systems and the CISP/USSP systems are not connected;
- Coordination procedures are not defined between operation centres[16];
- Communication facilities are not established between Tactical Controller (TAC C2) and the USSP.

	Airspace Class	Flight Rules MIL a/c	Potential airspace restrictions	Air mission control/ safety	Drone activities	U-space services	Dynamic NDZ
U-space Airspace Restricted ACCESS	F, G	Visual flight ≥170ft* or Operational flight <170ft* Flight conditions VMC	R, P, D areas NDZ	TAC C2-ATCO: Broadcast control-Advisory service / Pilot : see and avoid	VLOS/ BVLOS	None	None
Nominal actions	■ To join the searching area, the SAR helicopter pilot flies under VFR OAT (Operational Air Traffic) or GAT (General Air Traffic)flight above 170ft (*depending on national regulations) or under operational flight below; ■ Below the minimum control altitude of (as MRVA : Minimum Radar Vectoring Altitude) of the ATS Unit / Military control unit, the Tactical Controller (TAC C2) or Air Traffic Controller						

	(ATCO) provides broadcast control or advisory service. Tactical information is passed to enable the SAR helicopter pilot to accomplish the assigned task; ■ The ATS Unit / Military control unit, when possible, provides adequate warnings about hazards; ■ SAR actors have no awareness of drone activities[19] and U-space services available in this uncontrolled restricted access drone geographical zone. The mitigation actions relies only on specific military systems to detect the drones that are aiming to avoid the concerned areas; ■ Unplanned or conscious entry of a SAR aircraft in the uncontrolled, restricted access drone geographical zone is a risk, which Rescue Mission commander should assess before entering those areas. To mitigate such a risk, it is important to receive information on potential activities in the considered area (e.g. through the military surveillance systems); ■ (optional) The military TAC C2 (cf. RAP Use Case in 4.2 -) provides information on drone traffic if military sensors cover this area (limited SA).

TABLE 29: UC4.2B - CONTEXT OF OPERATION

Note: The U-space regulation IR 2021/664 [12] highlights the need to know the position of manned aircraft in the U-space concerned:

"In order to allow unmanned aircraft to safely operate alongside manned aircraft in U-space airspace, rules providing for effective signalling of the presence of manned aircraft by means of surveillance technologies are necessary. (…) The traffic information service shall include information about manned aircraft and UAS traffic shared by other U-space service providers and relevant air traffic service units. The traffic information service shall provide information about other known air traffic and shall:

(a) include the position, time of report as well as speed, heading or direction and emergency status of aircraft, when known;

(b) be updated at a frequency that the competent authority has determined.

The Strategic Research and Innovation Agenda (SRIA) highlights that: *"Research is required to understand how different modes of separation provision enable interoperable ATM and U-space services to co-exist, considering the diversity of aircraft performance characteristics and detect-and-avoid capabilities"* and *"Different solutions for separation management for all types of vehicles in all types of airspace (including airborne detect and avoid (DAA) as well as ground-based and hybrid solutions) should also be considered."* [26]

[19] *ATS Unit / Military control unit supporting SAR actors are however aware of drone geographical zones, through their publication by the national AIS.*

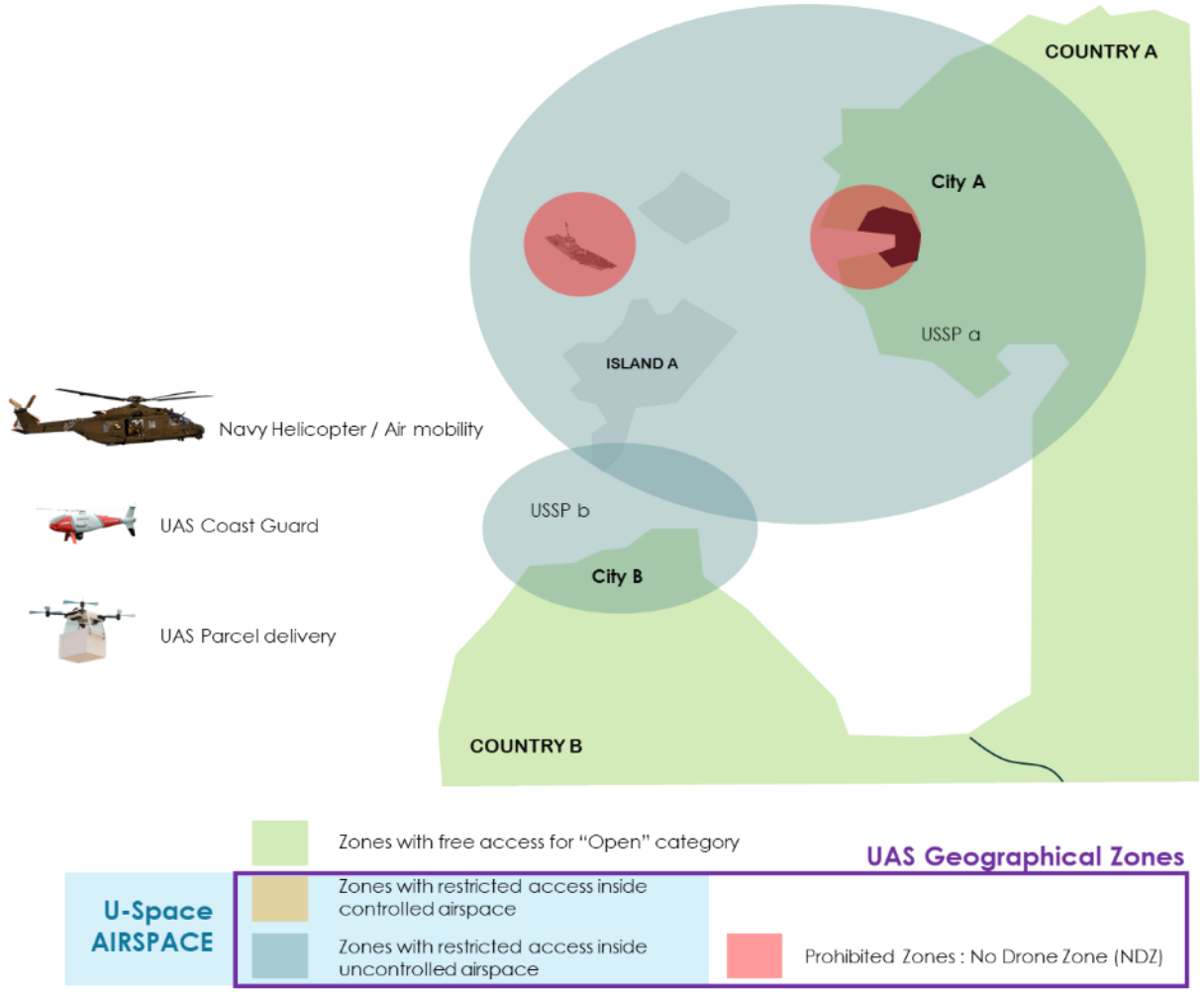
4.5 - Use Case 5: Maritime environment: Air mobility between warship and harbour

4.5.1 - Use Case overview

The maritime environment is not often considered in the Single European Sky, except when dealing with the Flexible Use of Airspace. Many military missions are carried out in this complex environment mixing missions at sea and in the air. The interaction between both air and maritime domains has therefore to be managed in the most possible coordinated way.

- Maritime environment scenario

Joint military forces are performing air mobility and landing missions involving helicopter and fighter assets flying between the harbour and a warship off city A. In a U-space context, these operations have to be planned, and all the different airspace users, including Drone operators shall be informed about the temporary airspace structure.



.

FIGURE 66: UC5 - GEOGRAPHICAL SCOPE

In the figure above, the harbour is located inside uncontrolled airspace within a drone restricted access zone and is protected by a No Drone Zone (NDZ) up to 1,000ft (ceiling of the drone geographical zone). Potential military traffic surveillance drones can operate between city A and island A, combined with many commercial drone flights between city A, city B and island A. All the traffic is supported by USSP a and USSP b, which are providing the mandatory services detailed in the U-space Regulation. [12]

- A joint military planning mission cell is in charge of planning the missions and creating a NDZ over the warship offshore with a radius of 5NM and up to 500ft. This area will be used during a specific time slot with and is coordinated with the concerned civil aviation authorities and, when relevant, with the USSP (see UC1).

- On the day of the operations, the Joint Forces or the Maritime Control Centre (MCC) coordinates all activities;
- The Tactical Controllers (TAC C2)/Air Traffic Controller (ATCO) provide broadcast control/advisory services, which include flight information.
- A helicopter takes off from the harbour to join the area around the warship under VFR flight at 150ft and performs a stationary flight for winch before returning to the harbour.

The Use Case 5 only takes place inside uncontrolled U-space airspace.

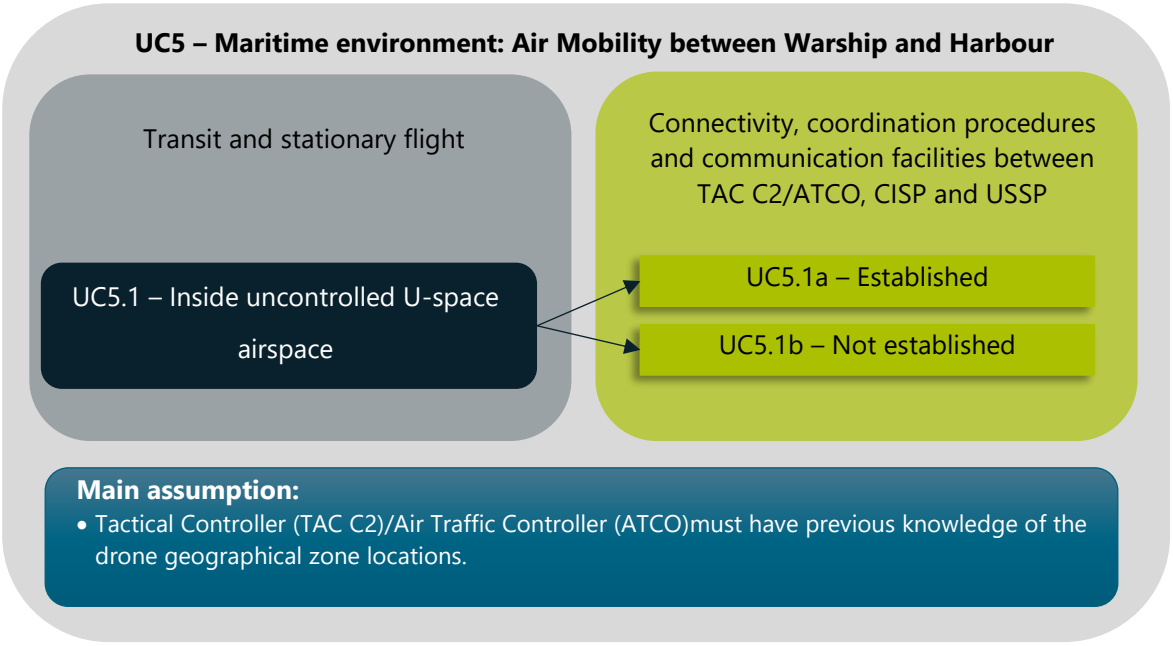


FIGURE 67: UC5 – MARITIME ENVIRONMENT OVERVIEW

- Actors

FIGURE 68: UC5 - ACTORS

- Military Air Traffic Controller (ATCO)
- Tactical Controller (TAC C2)
- Military aircraft pilots
- Drone Operator
- U-space Service Provider (USSP)
- Common Information Service Provider (CISP)

- Military Control and Reporting Centre (CRC)
- Military planning mission cell
- Joint Forces or Maritime Control Centre (MCC)
- National Military Authority

- General assumptions
  - It is considered that the Air Traffic Controller (ATCO) or Tactical Controller (TAC C2) knows where drone geographical zones are located (e.g. via publication by the national AIS or directly displayed on the controller working position thanks to a U-space service). All information data has to be exchanged between the systems.
- Event initiating the Use Case
  - The military helicopter takes off.

4.5.2 - Nominal flow of actions

4.5.2.1 - Sub-Use Cases UC5.1: Transit and stationary flight inside uncontrolled U-space airspace

OPTION-USE CASE UC5.1A: ESTABLISHED MILITARY COOPERATION WITH USSP

In this sub-Use Case, it is assumed that

- ATS Unit / Military control unit systems and the CISP/USSP systems are connected;
- Coordination procedures are defined between operation centres[16];
- Communication facilities are established.

<table>
<tr><td rowspan="4">U-space Airspace

Restricted ACCESS</td><td>Airspace Class</td><td>Flight Rules MIL a/c</td><td>Potential airspace restrictions</td><td>Air mission control/ safety</td><td>Drone activities</td><td>U-space services</td><td>Dynamic NDZ</td></tr>
<tr><td rowspan="3">F, G</td><td>Visual flight ≥170ft* or Operational flight <170ft*</td><td rowspan="3">R, P, D areas

NDZ</td><td rowspan="3">TAC C2-ATCO: Broadcast control-Advisory service/ Pilot : see and avoid</td><td rowspan="3">VLOS/ BVLOS</td><td rowspan="3">Common information services

Geo-awareness

UAS flight authorisation

Network identification

Traffic information

[weather information

conformance monitoring]</td><td rowspan="3">Requested by military</td></tr>
<tr><td>Flight conditions</td></tr>
<tr><td>VMC</td></tr>
<tr><td>Nominal actions</td><td colspan="7">■ The military helicopter pilot flies to the designated area under VFR OAT (Operational Air Traffic) or GAT (General Air Traffic) flight above 170ft (*depending on national regulations) or under operational flight below;
■ Below the minimum control altitude (as MRVA : Minimum Radar Vectoring Altitude) of the ATS Unit / Military control unit, the Tactical Controller (TAC C2) or Air Traffic Controller (ATCO) provides broadcast control or advisory service, including flight information (potential hazards). Tactical information is passed to enable the military helicopter pilot to accomplish the assigned task;
■ The connectivity, coordination procedures and interoperable communication between the TAC C2 and USSP/CISP could help achieving higher levels of safety;</td></tr>
</table>

	■ ATS Unit / Military control unit could request defined dynamic U-space airspace restrictions (Figure 70) to conduct their operations in a safe and efficient manner (see UC 1). The TAC C2/ATCO should request dynamic airspace reconfiguration to protect transit between harbour and warship and to protect stationary flight over warship if not planned, at least the day before the operations; ▸ Dynamic airspace reconfiguration means temporary modification of the U-space airspace in order to accommodate short-term requests from airspace users, by adjusting the geographical limits of this U-Space airspace.(Figure 70); ▸ ATS Unit / Military control unit can request to temporarily limit the area within the designated U-space airspace (6 in Figure 71) where drone operations can take place in order to accommodate the request; ▸ ATS Unit / Military control unit ensures that the relevant U-space service providers and, where applicable, common information service providers, are notified (6 in Figure 71) in a timely and effective manner of the activation, deactivation and temporary limitations of the designated U-space airspace. USSP adapt Geo-awareness service (7 in Figure 71) to the airspace configuration; ▸ A dynamic reconfiguration should be a temporary limitation of the designated U-space airspace, in the form of altitude block, corridor, portion of airspace; ▸ An USSP "functionality" to ground all UAS when needed by the military should be defined ■ The **network identification service (8 in Figure 71)** provides the TAC C2/ATCO with full situational awareness of drone activity. The TAC C2/ATCO could provide traffic information **(10 in Figure 71)** on drones to the helicopter pilot; ■ The correlation between drone tracks and their **flight authorisations (8 in Figure 71)** allows TAC C2/ATCO to extrapolate the future flight path of drone traffic; ■ The USSP **traffic information service (9 in Figure 71)** provided to Drone Operators contains information on any other conspicuous air traffic that may be in proximity with the position or intended route of their drones.

TABLE 30: UC5.1A - CONTEXT OF OPERATION

The following diagrams illustrate this nominal flow of actions and the interactions between the different actors of the use case.

Before the mission:

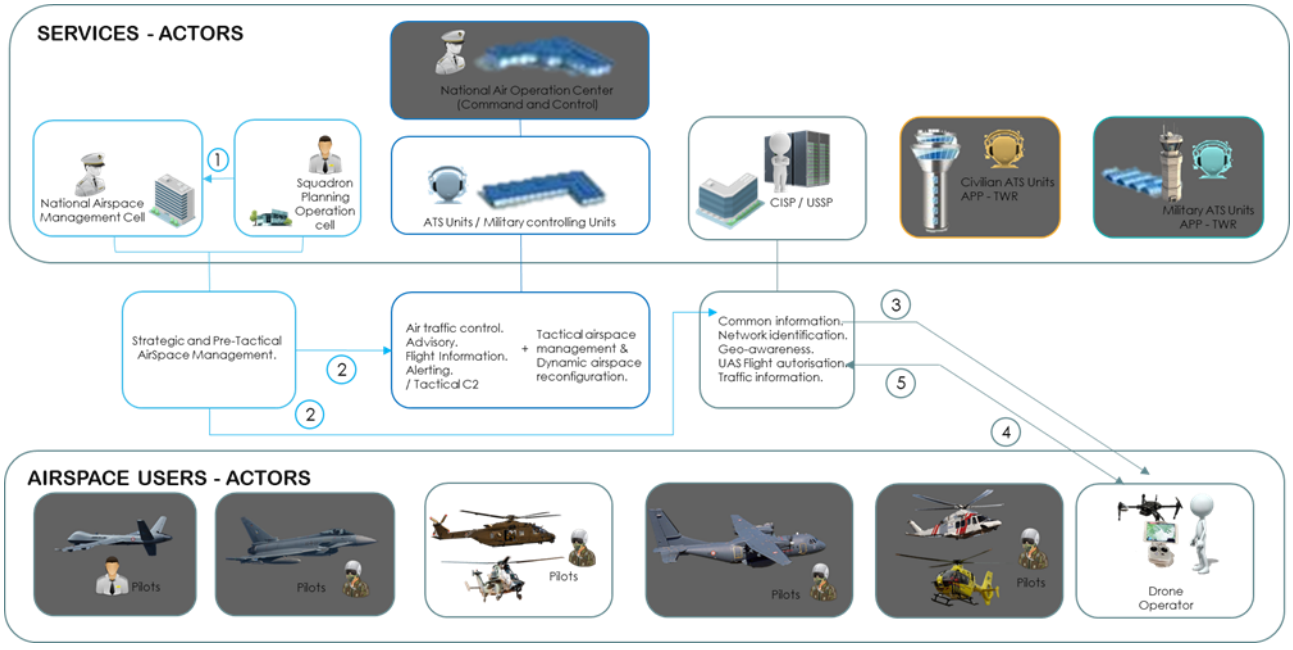


FIGURE 69: MARITIME ENVIRONMENT INSIDE UNCONTROLLED U-SPACE AIRSPACE, PRE-TACTICAL LOW-LEVEL AIRSPACE MANAGEMENT; WARSHIP NO DRONE ZONE

During the mission:

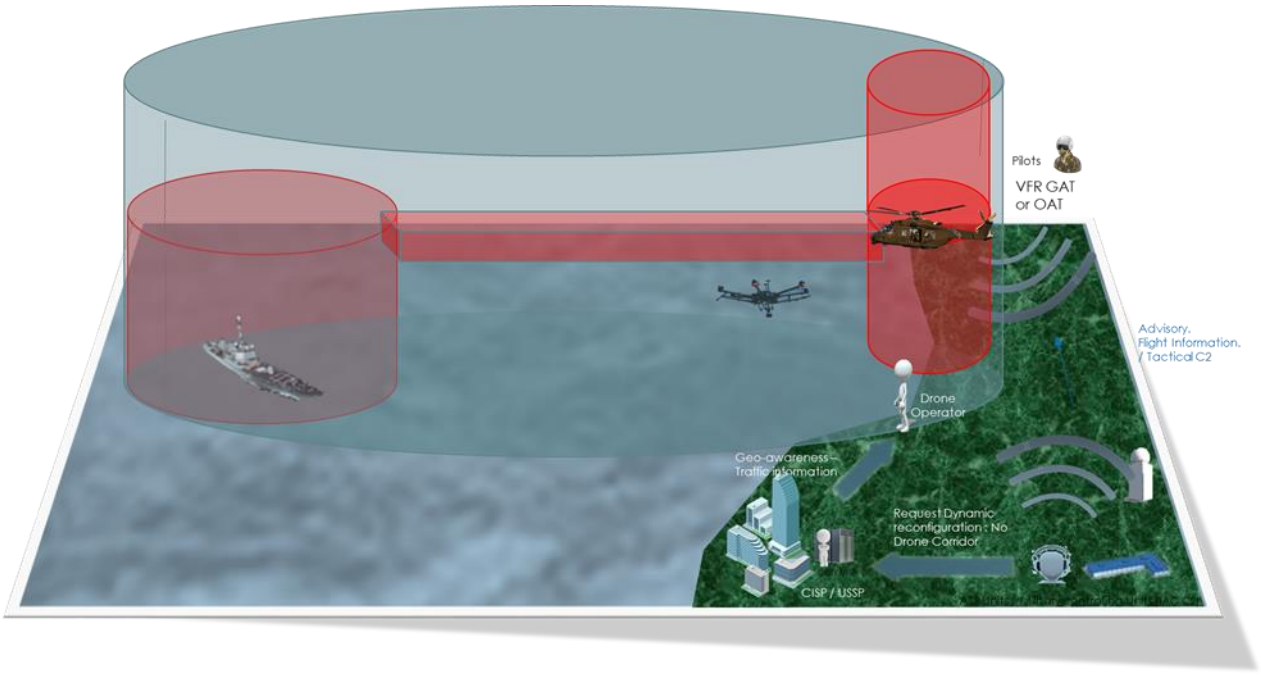


FIGURE 70: DYNAMIC AIRSPACE RECONFIGURATION

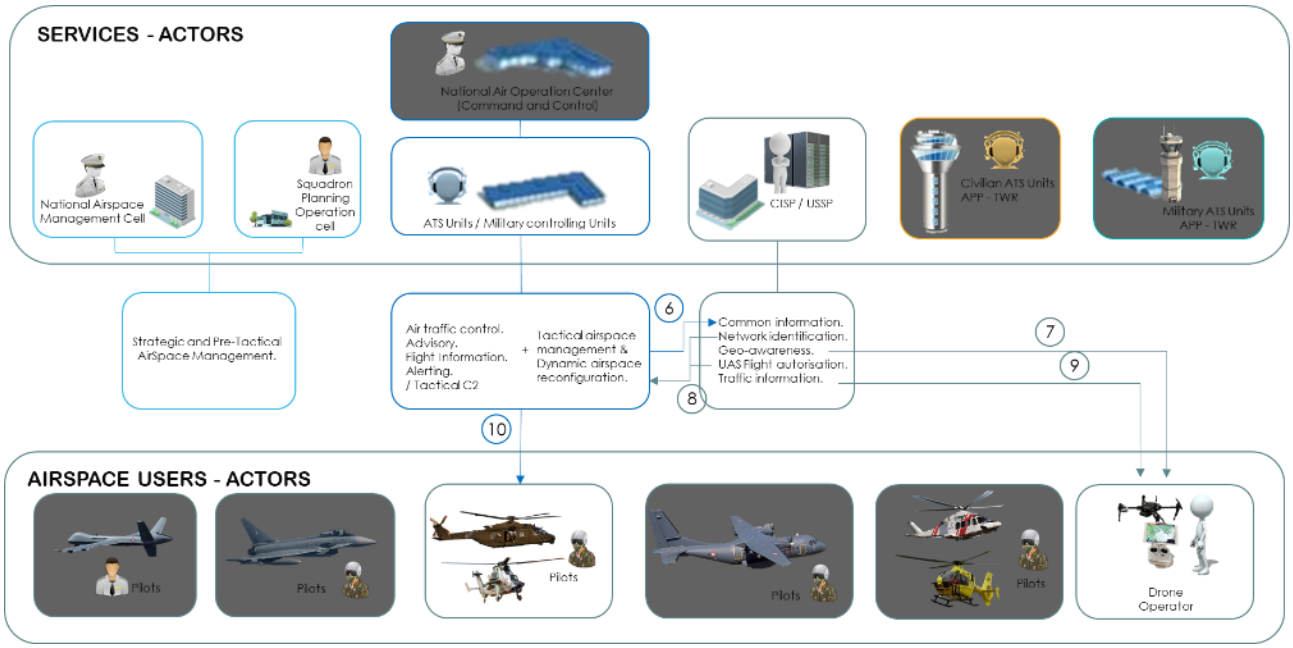


FIGURE 71: UC5 – MARITIME ENVIRONMENT INSIDE UNCONTROLLED U-SPACE AIRSPACE

OPTION-USE CASE UC5.1B: MILITARY COOPERATION WITH USSP NOT ESTABLISHED

In this sub-Use Case, it is assumed that:

- The ATS Unit / Military control unit systems and the CISP/USSP systems are not connected;
- Coordination procedures are not defined between operation centres;
- Communication facilities are not established between Tactical Controller (TAC C2)/Air Traffic Controller (ATCO) and the USSP.

	Airspace Class	Flight Rules MIL a/c	Potential airspace restrictions	Air mission control/ safety	Drone activities	U-space services	Dynamic NDZ
U-space Airspace Restricted ACCESS	F, G	Visual flight ≥170ft* or Operational flight <170ft* Flight conditions VMC	R, P, D areas NDZ	TAC C2-ATCO: Broadcast control-Advisory service / Pilot : see and avoid	VLOS/ BVLOS	None	None
Nominal actions	■ The military helicopter pilot flies to the designated area under VFR OAT (Operational Air Traffic) or GAT (General Air Traffic)flight above 170ft (*depending on national regulations) or under operational flight below; ■ Below the minimum control altitude of the (as MRVA : Minimum Radar Vectoring Altitude) of the ATS Unit / Military control unit, the Tactical Controller (TAC C2) or Air Traffic Controller (ATCO) provides broadcast control or advisory service, including flight information (potential hazards). Tactical information is passed to enable the military helicopter pilot to accomplish the assigned task; ■ Military actors have no awareness of drone activities and U-space services available in this uncontrolled restricted access drone geographical zone. The mitigation actions relies only on specific military systems to detect the drones that are aiming to avoid the concerned areas; ■ Unplanned or conscious entry of a military aircraft in the uncontrolled, restricted access drone geographical zone is a risk, which the military should assess before entering those areas. To mitigate such a risk, it is important to receive information on potential activities in the considered area (e.g. through the military surveillance systems); ■ (optional) The military TAC C2 (cf. RAP Use Case in 4.2 -) provides information on drone traffic if military sensors cover this area (limited SA).						

TABLE 31: UC5.1B - CONTEXT OF OPERATION

Note: The U-space regulation IR 2021/664 [12] highlights the need to know the position of manned aircraft in the U-space concerned:

"In order to allow unmanned aircraft to safely operate alongside manned aircraft in U-space airspace, rules providing for effective signalling of the presence of manned aircraft by means of surveillance technologies are necessary. (…) The traffic information service shall include information about manned aircraft and UAS traffic shared by other U-space service providers and relevant air traffic service units. The traffic information service shall provide information about other known air traffic and shall:

(a) include the position, time of report as well as speed, heading or direction and emergency status of aircraft, when known;

(b) be updated at a frequency that the competent authority has determined.

The Strategic Research and Innovation Agenda (SRIA) highlights that: *"Research is required to understand how different modes of separation provision enable interoperable ATM and U-space services to co-exist, considering*

the diversity of aircraft performance characteristics and detect-and-avoid capabilities" and *"Different solutions for separation management for all types of vehicles in all types of airspace (including airborne detect and avoid (DAA) as well as ground-based and hybrid solutions) should also be considered."* [26]

4.6 - Use Case 6: Large force training mission: Personnel Recovery (PR)

4.6.1 - Use Case overview

This Use Case is based on a military training scenario aiming to recover a military crew and/or civilians from a non-friendly territory. Such a mission is also called Combat Search and Rescue (CSAR). CSAR missions are sometimes combined with SAR missions (cf. Use Case 3 in 4.4 -).

The objective of Combat Search and Rescue is to carry out a Personnel Recovery (PR) training mission involving fighters, helicopters (rescue vehicle) and a MALE drone from different armed forces. A realistic scenario is supported by army attack helicopters and fighter aircraft against opponents.

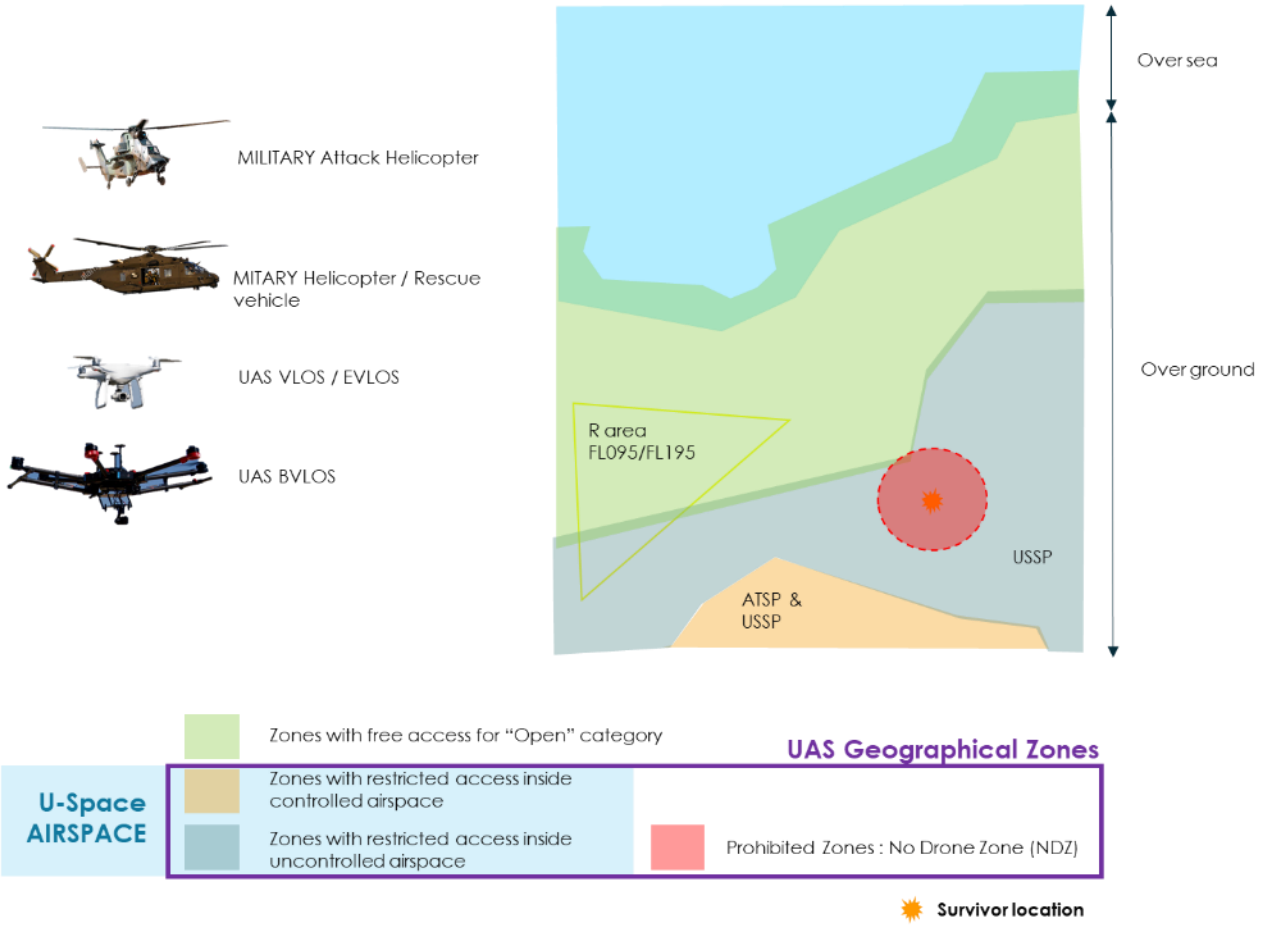


FIGURE 72: UC5 - GEOGRAPHICAL SCOPE

- Training PR mission scenario

A significant number of air assets participating to the Joint Personnel Recovery (JPR) operation. A MALE drone operated within segregated areas and all manned aircraft in uncontrolled airspace (class G).

The survivor is in an uncontrolled airspace within a drone restricted access zone. Thus, the helicopters will firstly transit through an uncontrolled airspace outside the U-space airspace before recovering the survivor in an uncontrolled airspace within a drone restricted access zone. In order to ensure flight safety, the helicopters will fly at different altitudes (QNH) and the fighters will operate above the U-space between 500ft and FL115 for safety and deconfliction considerations.

The day before the operation, the CSAR planning mission cell, jointly with the national Airspace Management Cell[20] and the CISP, designs and plans a NDZ for the whole duration of the operation. This NDZ corresponding

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[20] *The Airspace Management Cell is a joint civil-military cell responsible for the day to day management and temporary allocation of national or sub-regional airspace under the jurisdiction of one or more ECAC state(s)*

to the restricted area over the survivor's location where the MALE drone will operate (e.g. an area with a radius of 10NM, from ground up to 500ft Above Sea level - ASL)) (see UC1).

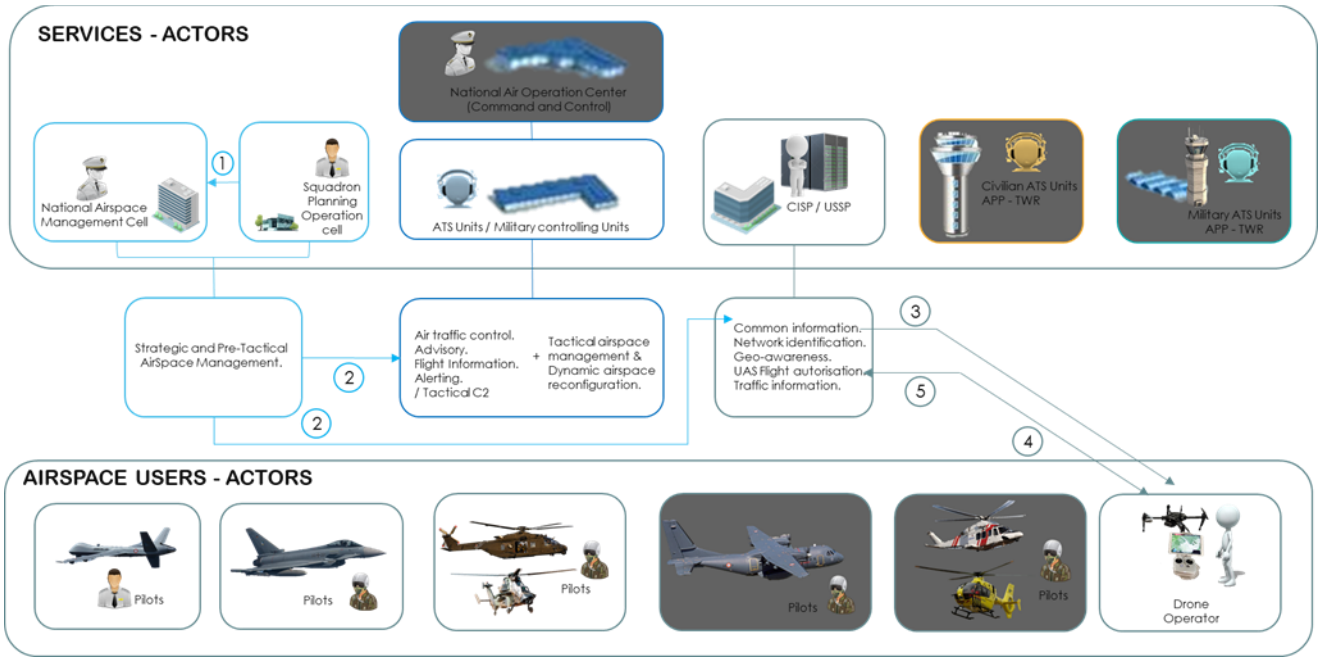

FIGURE 73: USE CASE 6 – TRAINING OPERATION INSIDE UNCONTROLLED U-SPACE AIRSPACE. PRE-TACTICAL LOW-LEVEL AIRSPACE MANAGEMENT; SURVIVOR NO DRONE ZONE

On the day of operation:

- Helicopters and fighters take off to join the training uncontrolled area under GAT VFR flight or Tactical OAT Type V flight. The military Control and Reporting Centre (CRC) provides the tactical control to the assets;
- The MALE drone takes off to join area under IFR type of flight in non-segregated areas, or under segregated OAT flight according to Member States organisations. The air traffic or the tactical controller provides control services. The MALE drone starts its mission and stay "on station" at 12,000ft above the training area. It should be noted that the drone pilot establishes communication with the rescue mission commander (rescue vehicle leader);
- A manned aircraft constantly overflies the survivor's location.

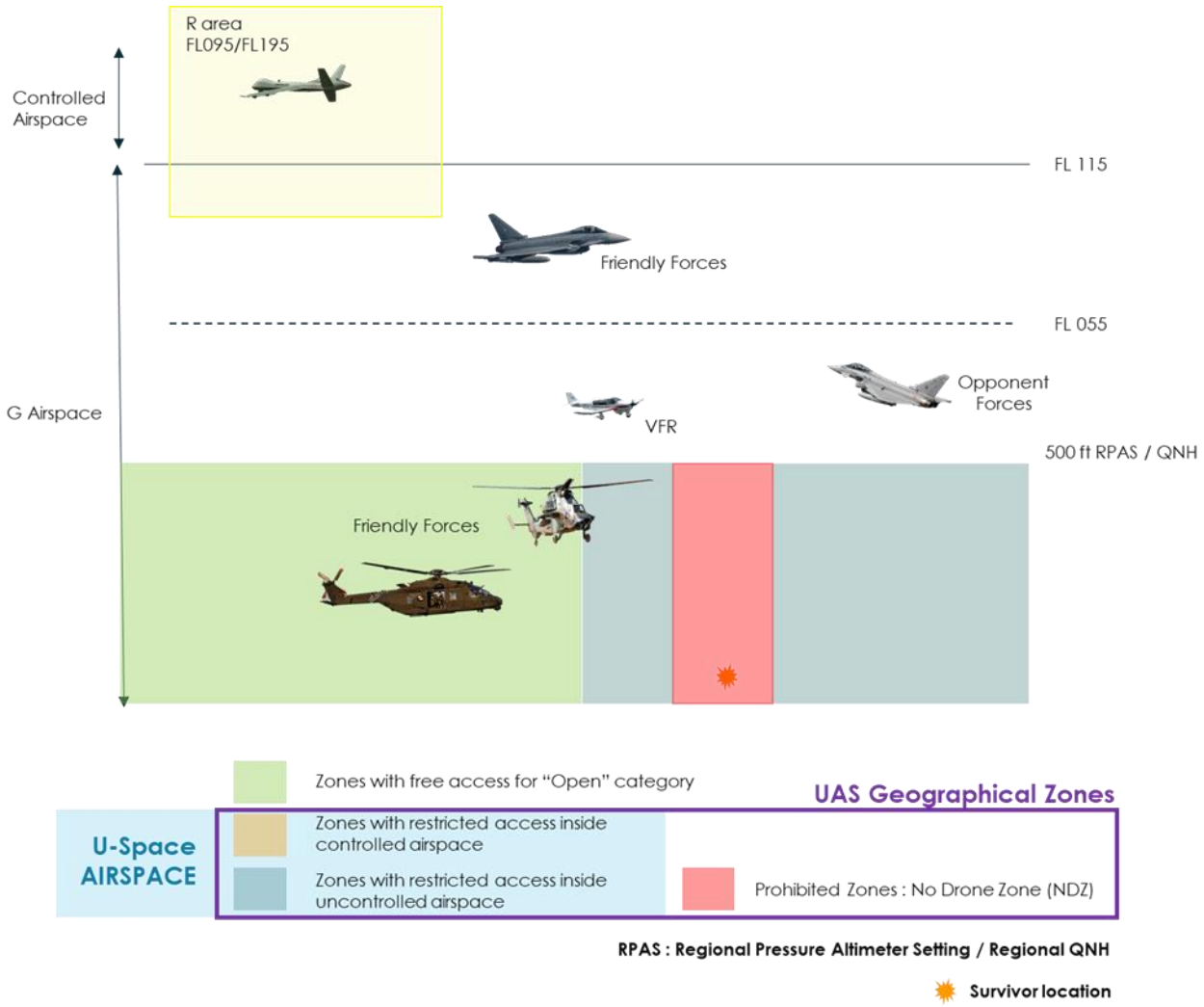

FIGURE 74: UC6 - AIRSPACE STRUCTURE

Use Case 6 is divided into two sub-Use Cases, depending on the context in which they occur, as only two of the three operational contexts described in the introduction to this section 4 - are relevant for the Use Case:

- Outside U-space airspace (sub-Use Case 6.1 in 4.6.2.1 -);
- Inside uncontrolled U-space airspace (sub-Use Case 6.2 in 4.6.2.2 -).

The overall view, showing different scenarios is depicted in Figure 75 below.

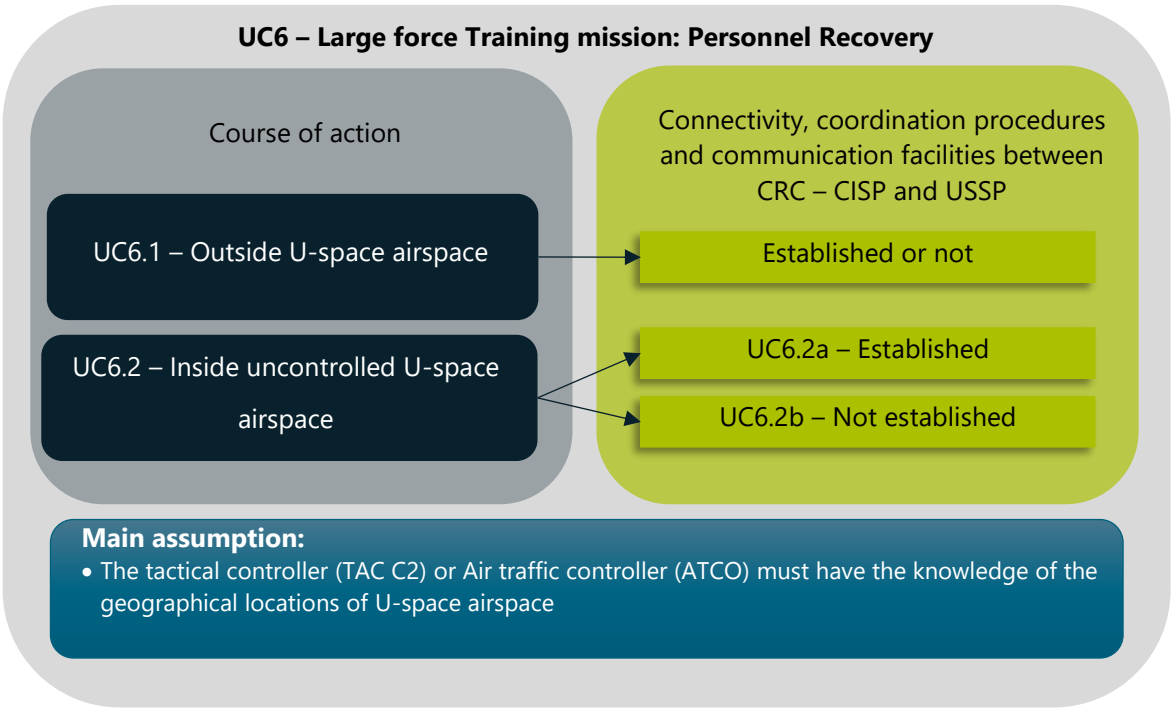

FIGURE 75: UC5 – LARGE FORCE TRAINING MISSION OVERVIEW

- Actors

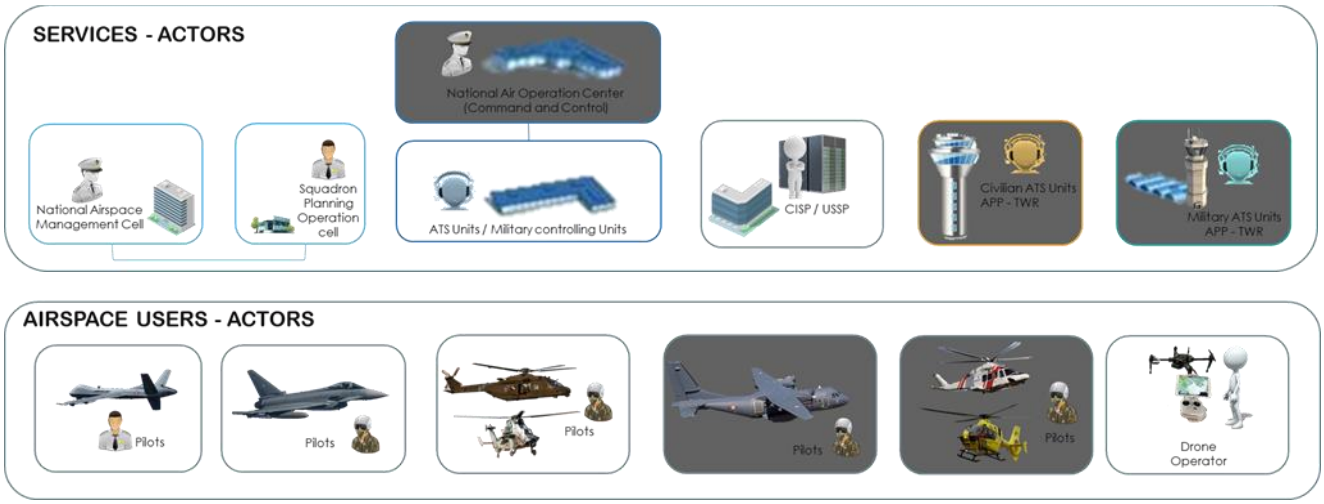

FIGURE 76: UC6 – ACTORS

- (Military) Air Traffic Controller (ATCO)
- Tactical Controller (TAC C2)
- Helicopter/fighter pilot(s)
- MALE drone pilot
- Drone Operator
- Rescue mission commander
- U-space Service Provider (USSP)
- Common Information Service Provider (CISP)
- ATS Units / Military controlling Units
- Command and Control (C2) centre
- National Military Authority

- CSAR planning mission cell
- National Airspace Management Cell (AMC)

- General assumptions
  - It is considered that the Air Traffic Controller (ATCO) or Tactical Controller (TAC C2) knows where drone geographical zones are located (e.g. via publication by the national AIS or directly displayed on the controller working position thanks to a U-space service). All information data has to be exchanged between the systems.
- Event initiating the Use Case
  - Decision to initiate the training operation.

4.6.2 - Nominal flow of actions

4.6.2.1 - Sub-Use Case UC6.1: Course of action outside U-space airspace

	Airspace Class	Flight Rules MIL a/c	Potential airspace restrictions	Air mission control/ safety	Drone activities	U-space services	Dynamic NDZ
outside U-space Airspace FREE ACCESS	F, G	Visual flight ≥170ft* or Operational flight <170ft* Flight conditions VMC	R, P, D areas	TAC C2-ATCO: Broadcast control-Advisory service / Pilot : see and avoid	VLOS	None	None
Nominal actions	- To operate over the recovery area, helicopters fly under VFR OAT (Operational Air Traffic) or GAT (General Air Traffic) flight above 170ft (depending on national regulations) or under operational flight below; Fighter pilots fly under VFR OAT or GAT above U-Space airspace; - Below the minimum control altitude (as MRVA : Minimum Radar Vectoring Altitude) of the ATS Unit / Military control unit , the Tactical Controller (TAC C2) or Air Traffic Controller (ATCO) provides broadcast control or Advisory service. Tactical information is passed to enable the helicopter and aircraft pilots to accomplish the assigned task; - The ATS Unit / Military control unit, when possible, provides adequate warnings about hazards and carries out coordination with the managers of areas (civilian and or military) interfering with the training operation; - The military helicopter and aircraft pilots are responsible for navigation and collision avoidance by applying the see-and-avoid principle; - The Drone Operators are responsible for the avoidance of collision with all aircraft and drones; - The information on drone traffic could be provided by the military TAC C2 (cf. RAP Use Case in 4.2 -) if military sensors cover this area (limited SA).						

TABLE 32: UC6.1 – CONTEXT OF OPERATION

Note: In this airspace, defined as type X volumes in CORUS-XUAM, the benefit of the connectivity with the U-space should provide a certain freedom of action by sending a short term restriction request to the USSP. In the CORUS-XUAM Concept of Operations, short term restrictions are communicated to drone operators through the Emergency Management service:

"If the flight has an U-plan, the Emergency management service will warn the pilot when a geo-fence-with-immediate-effect has been created which affects the current flight." [23]

4.6.2.2 - Sub-Uses Case UC6.2: Course of action and recovery inside uncontrolled U-space airspace

OPTION UC6.2A: ESTABLISHED MILITARY COOPERATION WITH USSP

In this sub-Use Case, it is assumed that:

- The ATS Unit / Military control unit systems and the CISP/USSP systems are connected;
- Coordination procedures are defined between operation centres;
- Communication facilities are established between Tactical Controller (TAC C2)/Air Traffic Controller (ATCO) and the USSP.

	Airspace Class	Flight Rules MIL a/c	Potential airspace restrictions	Air mission control/ safety	Drone activities	U-space services	Dynamic NDZ
U-space Airspace Restricted ACCESS	F, G	Visual flight ≥170ft* or Operational flight <170ft* Flight conditions VMC	R, P, D areas NDZ	TAC C2-ATCO: Broadcast control-Advisory service / Pilot : see and avoid	VLOS/ BVLOS	Common information services Geo-awareness UAS flight authorisation Network identification Traffic information [weather information conformance monitoring]	Requested by military
Nominal actions	■ To join and operate over the recovery area, the helicopters fly under VFR OAT (Operational Air Traffic) or GAT (General Air Traffic) flight above 170ft (*depending on national regulations) or under operational flight below. Fighter pilots fly under VFR OAT or GAT above U-Space airspace. ■ Below the minimum control altitude (as MRVA (Minimum Radar Vectoring Altitude)) of the ATS Unit / Military control unit, the Tactical Controller (TAC C2) or Air Traffic Controller (ATCO) provides broadcast control. Tactical information is passed to enable the helicopter and fighter pilots to accomplish the assigned task; ■ The ATS Unit / Military control unit, when possible, provides adequate warnings about hazards; ■ The connectivity, coordination procedures and interoperable communication between the TAC C2 and USSP/CISP could help achieving higher levels of safety; ■ ATS Unit / Military control unit could request defined dynamic U-space airspace restrictions (FIG 66) to conduct training operations in a safe and efficient manner. (See UC 1). The TAC C2/ATCO should request dynamic airspace reconfiguration to protect helicopter transits and over survivor location if not planned, at least the day before the operations (At pre-tactical level); ▸ Dynamic airspace reconfiguration means temporary modification of the U-space airspace in order to accommodate short-term requests from airspace users, by adjusting the geographical limits of this U-Space airspace; ▸ ATS Unit / Military control unit can request to temporarily limit the area within the designated U-space airspace (1 in Figure 78) where drone operations can take place in order to accommodate the request;						

	▸ ATS Unit / Military control unit ensures that the relevant U-space service providers and, where applicable, common information service providers, are notified (1 in Figure 78) in a timely and effective manner of the activation, deactivation and temporary limitations of the designated U-space airspace. USSP adapt Geo-awareness service (2 in Figure 78) to the airspace configuration; ▸ A dynamic reconfiguration should be a temporary limitation of the designated U-space airspace, in the form of altitude block, corridor, portion of airspace; ▸ An USSP "functionality" to ground all UAS when needed by the military should be defined ■ The **network identification service (3 in Figure 78)** allows for the TAC C2/ATCO to have full situational awareness of the complete drone activities: traffic information **(5 in Figure 78)** on drone could be provided to the helicopter and fighter pilots; ■ The correlation between drone tracks and their **flight authorisations (3 in Figure 78)** allows the TAC C2/ATCO to extrapolate the future flight path of drone traffic; ■ The USSP **traffic information service (4 in Figure 78)** provided to Drone Operators contains information on any other conspicuous air traffic that may be in proximity with the position or intended route of their drones.

TABLE 33: UC6.2A – CONTEXT OF OPERATION

The following diagrams illustrate this nominal flow of actions and the interactions between the different actors of the use case.

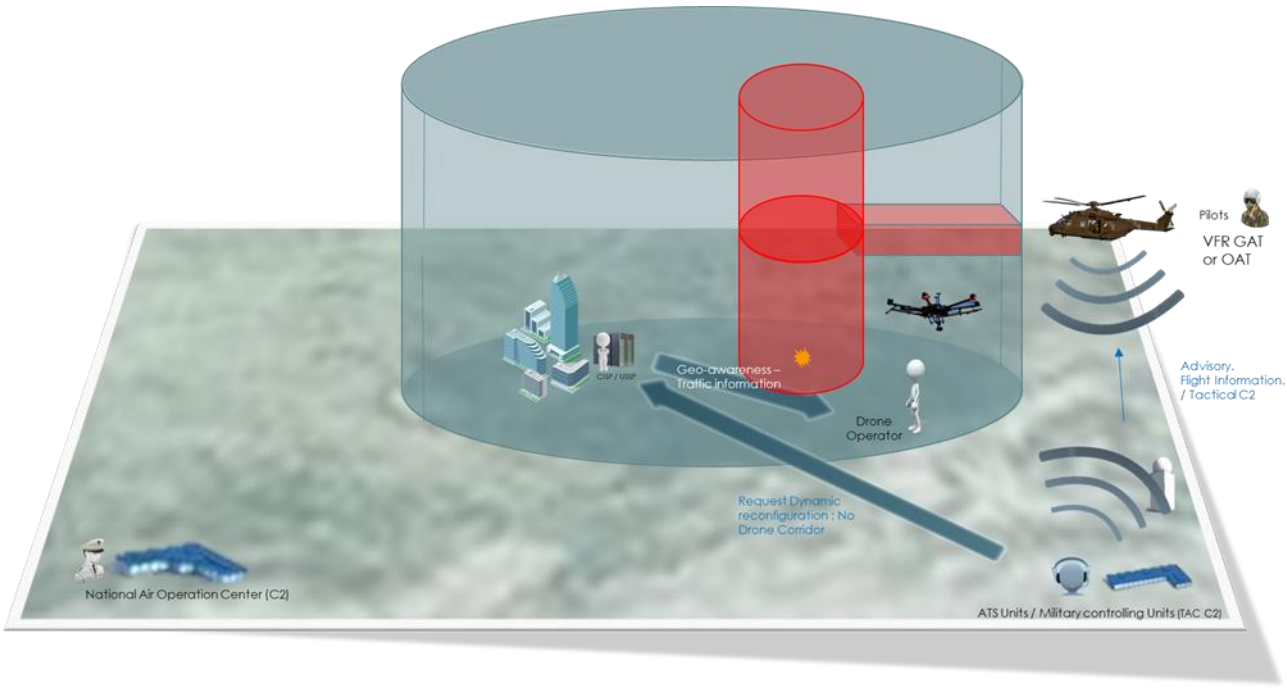

FIGURE 77: DYNAMIC AIRSPACE RECONFIGURATION PROCESS

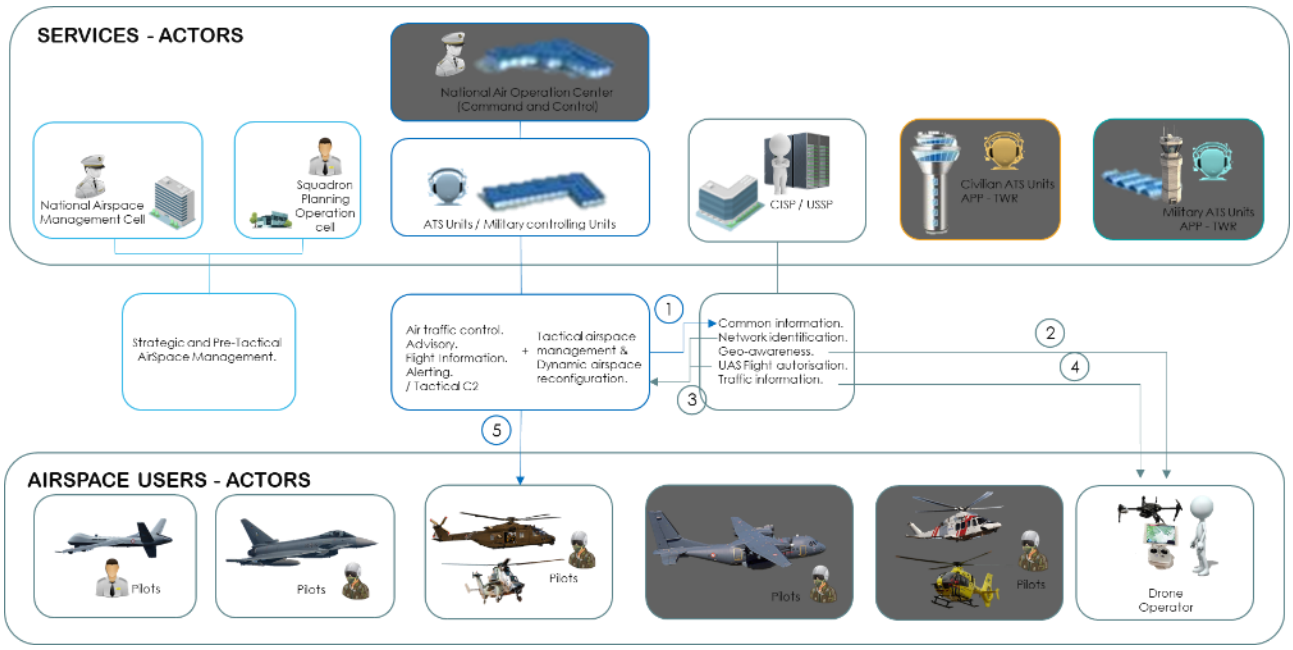

FIGURE 78: UC6 – TRAINING OPERATION INSIDE UNCONTROLLED U-SPACE AIRSPACE

OPTION UC6.2B: MILITARY COOPERATION WITH USSP NOT ESTABLISHED

In this sub-Use Case, it is assumed that:

- The ATS Unit / Military control unit and USSP/CISP systems are not connected;
- Coordination procedures are not defined between operation centres[16];
- Communication facilities are not established between Tactical Controller (TAC C2)/Air Traffic Controller (ATCO) and the USSP.

	Airspace Class	Flight Rules MIL a/c	Potential airspace restrictions	Air mission control/ safety	Drone activities	U-space services	Dynamic NDZ
U-space Airspace Restricted ACCESS	F, G	Visual flight ≥170ft* or Operational flight <170ft* Flight conditions VMC	R, P, D areas NDZ	TAC C2: Broadcast control/ Pilot : see and avoid	VLOS/ BVLOS	None	None
Nominal actions	■ To join and operate over the recovery area, helicopters fly under VFR OAT (Operational Air Traffic) or GAT (General Air Traffic) flight above 170ft (depending on national regulations) or under operational flight below. Fighter pilots fly under VFR OAT or GAT above U-Space airspace; ■ Below the minimum control altitude (as MRVA : Minimum Radar Vectoring Altitude) of the ATS Unit / Military control unit, the Tactical Controller (TAC C2) or Air Traffic Controller (ATCO) provides broadcast control or advisory service. Tactical information is passed to enable the helicopter and aircraft pilots to accomplish the assigned task; ■ The ATS Unit / Military control unit, when possible, provides adequate warnings about hazards;						

	■ Military actors have no awareness of drone activities and U-space services available in this uncontrolled restricted access drone geographical zone. The mitigation actions relies only on specific military systems to detect the drones that are aiming to avoid the concerned areas; ■ Unplanned or conscious entry of a military aircraft in the uncontrolled, restricted access drone geographical zone is a risk, which the military should assess before entering those areas. To mitigate such a risk, it is important to receive information on potential activities in the considered area (e.g. through the military surveillance systems); ■ (optional) The military TAC C2 (cf. RAP Use Case in 4.2 -) provides information on drone traffic if military sensors cover this area (limited SA).

TABLE 34: UC6.2B - CONTEXT OF OPERATION

Note: The U-space regulation IR 2021/664 [12] highlights the need to know the position of manned aircraft in the U-space concerned:

"In order to allow unmanned aircraft to safely operate alongside manned aircraft in U-space airspace, rules providing for effective signalling of the presence of manned aircraft by means of surveillance technologies are necessary. (…) The traffic information service shall include information about manned aircraft and UAS traffic shared by other U-space service providers and relevant air traffic service units. The traffic information service shall provide information about other known air traffic and shall:

(a) include the position, time of report as well as speed, heading or direction and emergency status of aircraft, when known;

(b) be updated at a frequency that the competent authority has determined.

The Strategic Research and Innovation Agenda (SRIA) highlights that: *"Research is required to understand how different modes of separation provision enable interoperable ATM and U-space services to co-exist, considering the diversity of aircraft performance characteristics and detect-and-avoid capabilities"* and *"Different solutions for separation management for all types of vehicles in all types of airspace (including airborne detect and avoid (DAA) as well as ground-based and hybrid solutions) should also be considered."* [26]

4.7 - Use Case 7: Natural disaster relief: MEDEVAC - Airlift

4.7.1 - Use Case overview

This Use Case is based on a catastrophic natural disaster event, where a village or building is no longer accessible by road and rail. Many of the injured people have to be evacuated to the nearest hospital. The village/building has no longer running water, nor power. The national authorities have therefore decided to set up an airlift bridge to the affected place by using civil and/or military helicopters and transport aircraft:

- Helicopter Emergency Medical Service (HEMS) and other helicopters to carry out medical evacuation (MEDEVAC) to the hospital;
- Transport aircraft to carry out airdrop missions of supplies and materials over the village;
- Military helicopters to carry out delivery of equipment and to transport rescue teams.

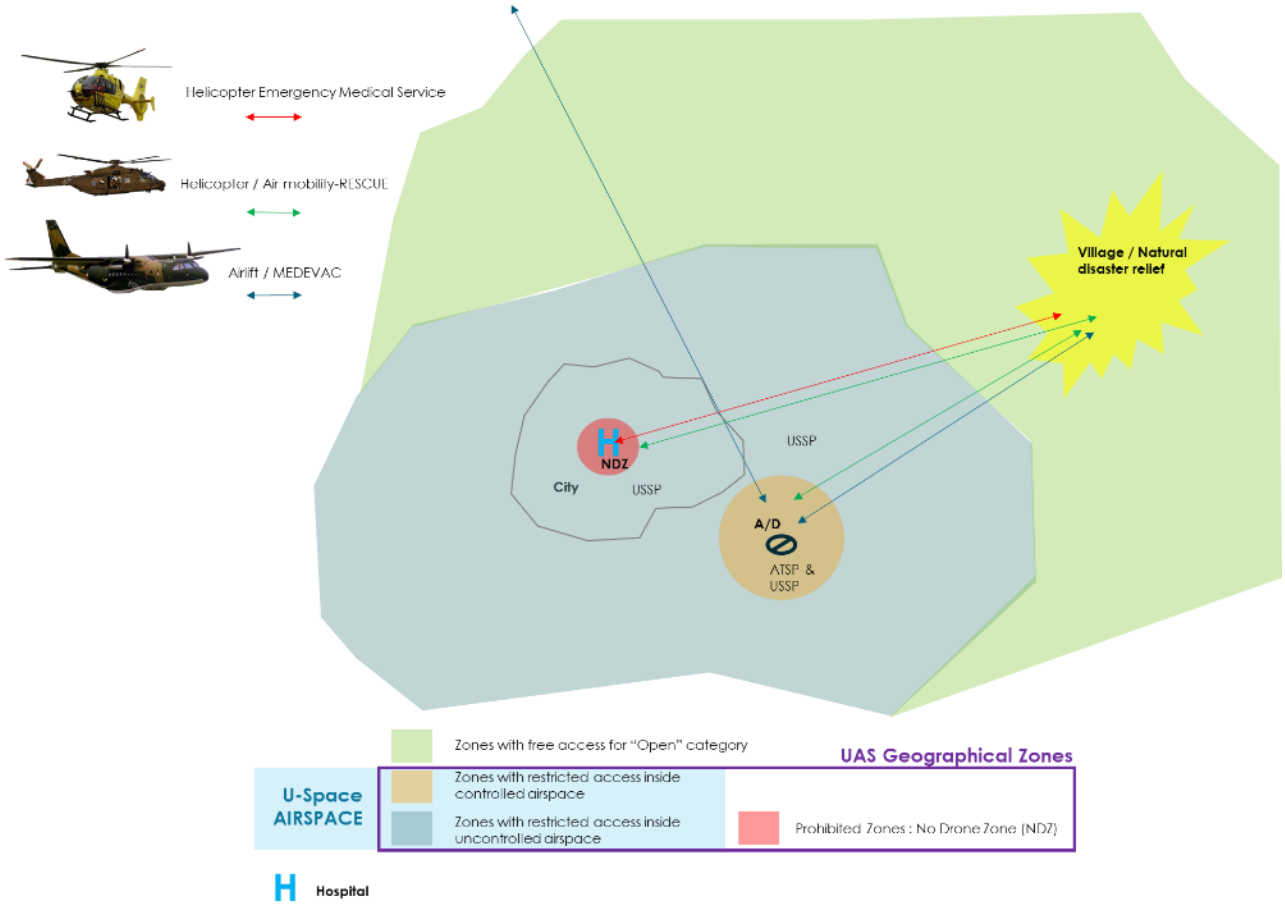

FIGURE 79: UC7 – GEOGRAPHICAL SCOPE

- MEDEVAC/Airlift scenario

The affected place is located below uncontrolled airspace outside a U-space airspace. A drone restricted access zone is defined inside the controlled airspace around the airport. A No Drone Zone (NDZ) protects the city hospital, within a drone restricted access zone that is itself inside uncontrolled airspace.

Use Case 6 is divided into three sub-Use Cases, depending on the context in which they occur, as the three operational contexts described in the introduction to this section 4 - are relevant for the Use Case:

- Outside U-space airspace (sub-Use Case 7.1 in 4.7.2.1 -);
- Inside uncontrolled U-space airspace (sub-Use Case 7.2 in 4.7.2.2 -);
- Inside controlled U-space airspace (sub-Use Case 7.3 in 4.7.2.3 -).

The overall view, showing different scenarios is depicted in Figure 80 below.

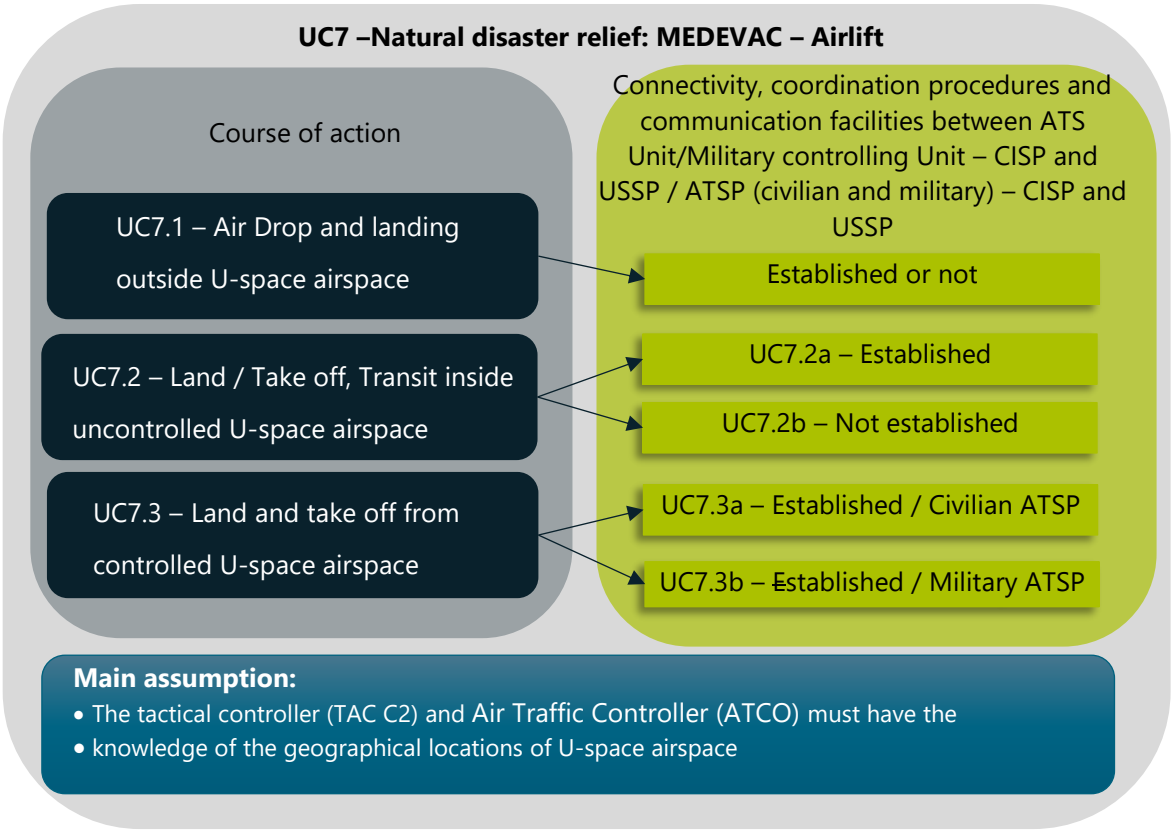

FIGURE 80: UC7 – NATURAL DISASTER RELIEF OVERVIEW

- Actors

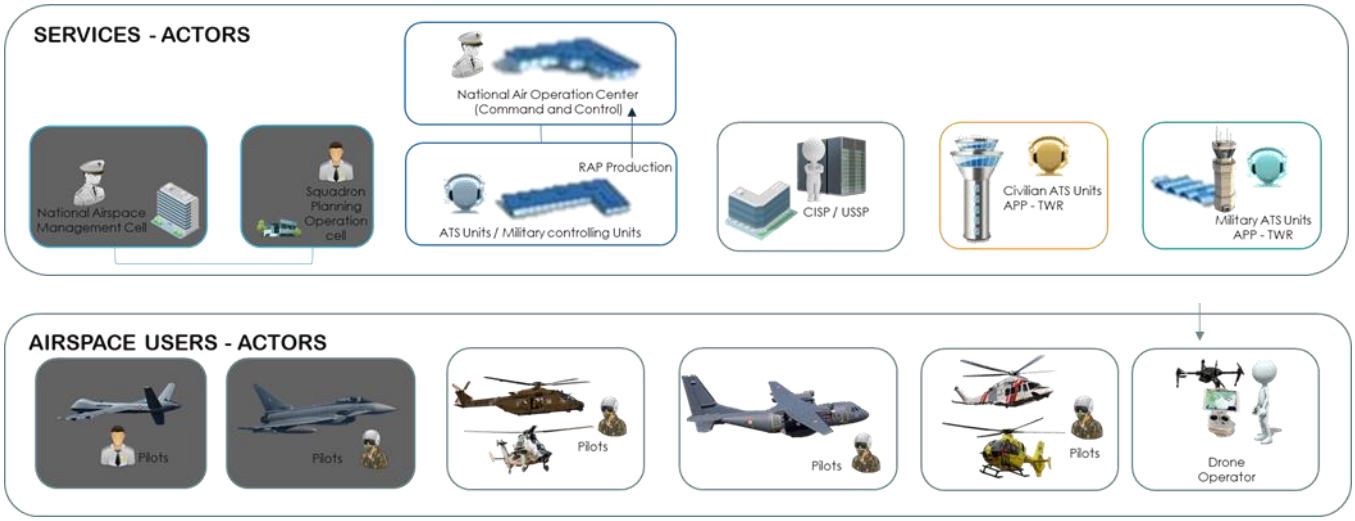

FIGURE 81: UC7 – ACTORS

- Civilian Air Traffic Controller (ATCO)
- Military Air Traffic Controller (ATCO)
- Tactical Controller (TAC C2)
- Military aircraft pilot(s)
- Drone Operator
- U-space Service Provider (USSP)

- Common Information Service Provider (CISP)
- Helicopter Emergency Medical Service (HEMS)
- ATS Unit / Military control unit
- Command and Control (C2) centre
- National Military Authority

- General assumptions
  - It is considered that the Air Traffic Controller (ATCO) or Tactical Controller (TAC C2) knows where drone geographical zones are located (e.g. via publication by the national AIS or directly displayed on the controller working position thanks to a U-space service). All information data has to be exchanged between the systems.
- Event initiating the Use Case
  - Decision to evacuate people located in an area stricken by a natural disaster and not accessible by road or train.

4.7.2 - Nominal flow of actions

4.7.2.1 - Sub-Use Case UC7.1: Air Drop and landing outside U-space airspace

<table>
<tr><td rowspan="4">outside U-space Airspace

FREE ACCESS</td><td>Airspace Class</td><td>Flight Rules MIL a/c</td><td>Potential airspace restrictions</td><td>Air mission control/ safety</td><td>Drone activities</td><td>U-space services</td><td>Dynamic NDZ</td></tr>
<tr><td rowspan="3">F, G</td><td>Visual flight ≥170/330ft* or Operational flight <170/330ft*</td><td rowspan="3">R, P, D areas</td><td rowspan="3">TAC C2-ATCO: Broadcast control-Advisory service / Pilot : see and avoid</td><td rowspan="3">VLOS</td><td rowspan="3">None</td><td rowspan="3">None</td></tr>
<tr><td>Flight conditions</td></tr>
<tr><td>VMC</td></tr>
<tr><td>Nominal actions</td><td colspan="7">■ To transit and operate over the village, helicopter and aircraft pilots fly under VFR OAT (Operational Air Traffic) or GAT (General Air Traffic) flight above 170ft/330ft (*depending on national regulations) or under operational flight below;
■ Below the minimum control altitude (as MRVA : Minimum Radar Vectoring Altitude) of the ATS Unit / Military control unit, the Tactical Controller (TAC C2) or Air Traffic Controller (ATCO) provides broadcast control or advisory service. Tactical information is passed to enable the helicopter and aircraft pilots to accomplish the assigned task;
■ The ATS Unit / Military control unit, when possible, provides adequate warnings about hazards and carries out coordination with the managers of areas (civilian or military) interfering with the transit flight path;
■ The military aircraft pilot is responsible for aircraft navigation and collision avoidance. by applying the see-and-avoid principle;
■ The Drone Operator is responsible for the avoidance of collision with all the aircraft;
■ The information on drone traffic could be provided by the military TAC C2 (cf. RAP Use Case in 4.2 -) if military sensors cover this area (limited SA).</td></tr>
</table>

TABLE 35: UC7.1 - CONTEXT OF OPERATION

Note: In this airspace, defined as type X volumes in CORUS-XUAM, the benefit of the connectivity with the U-space should provide a certain freedom of action by sending a short term restriction request to the USSP. In the CORUS-XUAM Concept of Operations, short term restrictions are communicated to drone operators through the Emergency Management service:

"If the flight has an U-plan, the Emergency management service will warn the pilot when a geo-fence-with-immediate-effect has been created which affects the current flight." [23]

4.7.2.2 - Sub-Use Cases UC7.2: Land/Take off, Transit inside uncontrolled U-space airspace

OPTION UC7.2A: ESTABLISHED MILITARY COOPERATION WITH USSP

In this sub-Use Case, it is assumed that:

- The ATS Unit / Military control unit systems and the CISP/USSP systems are connected;
- Coordination procedures are defined between operation centres[16];
- Communication facilities are established between Tactical Controller/Air Traffic Controller and the USSP.

	Airspace Class	Flight Rules MIL a/c	Potential airspace restrictions	Air mission control/ safety	Drone activities	U-space services	Dynamic NDZ
U-space Airspace Restricted ACCESS	F, G	Visual flight ≥170/330ft* or Operational flight <170/330ft* Flight conditions VMC	R, P, D areas NDZ	TAC C2: Broadcast control/ Pilot : see and avoid	VLOS/ BVLOS	Common information services Geo-awareness UAS flight authorisation Network identification Traffic information [weather information conformance monitoring]	Requested by military
Nominal actions	■ To transit and operate over the village, helicopter and aircraft pilots fly under VFR OAT (Operational Air Traffic) or GAT (General Air Traffic) flight above 170ft/330ft (*depending on national regulations) or under operational flight below; ■ Below the minimum control altitude (as MRVA : Minimum Radar Vectoring Altitude) of the ATS Unit / Military control unit, the Tactical Controller (TAC C2) or Air Traffic Controller (ATCO) provides broadcast control or advisory service. Tactical information is passed to enable the helicopter and aircraft pilots to accomplish the assigned task; ■ The ATS Unit / Military control unit, when possible, provides adequate warnings about hazards; ■ The connectivity, coordination procedures and interoperable communication between the ATS Unit / Military control unit and the USSP/CISP could enhance operational mission efficiency and achieve higher levels of safety; ■ Military authorities could request defined dynamic U-space airspace restrictions (FIG 71) to conduct their operations in a safe and efficient manner, notably by implementing specific transit corridors. (See UC 1) ‣ Dynamic airspace reconfiguration means temporary modification of the U-space airspace in order to accommodate short-term changes from airspace users, by adjusting the geographical limits of this U-space airspace;						

	▸ ATS Unit / Military control unit can request to temporarily limit the area within the designated U-space airspace (1 in Figure 83) where drone operations can take place in order to accommodate the request; ▸ ATS Unit / Military control unit ensures that the relevant U-space service providers and, where applicable, common information service providers, are notified (1 in Figure 83) in a timely and effective manner of the activation, deactivation and temporary limitations of the designated U-space airspace. USSP adapt Geo-awareness service (2 in Figure 83) to the airspace configuration; ▸ A dynamic reconfiguration should be a temporary limitation of the designated U-space airspace, in the form of altitude block, corridor, portion of airspace; ▸ An USSP "functionality" to ground all UAS when needed by the military should be defined ■ The **network identification service (3 in Figure 83)** allows for the TAC C2/ATCO to have full situational awareness of the complete drone activities: traffic information **(5 in Figure 83)** on drone could be provided to the helicopter and aircraft pilots; ■ The correlation between drone tracks and their **flight authorisations (3 in Figure 83)** allows the TAC C2/ATCO to extrapolate the future flight path of drone traffic; ■ The USSP **traffic information service (4 in Figure 83)** provided to Drone Operators contains information on any other conspicuous air traffic that may be in proximity with the position or intended route of their drones. This information includes information on manned aircraft shared by relevant Air Traffic Service Units.

TABLE 36: UC7.2A - CONTEXT OF OPERATION

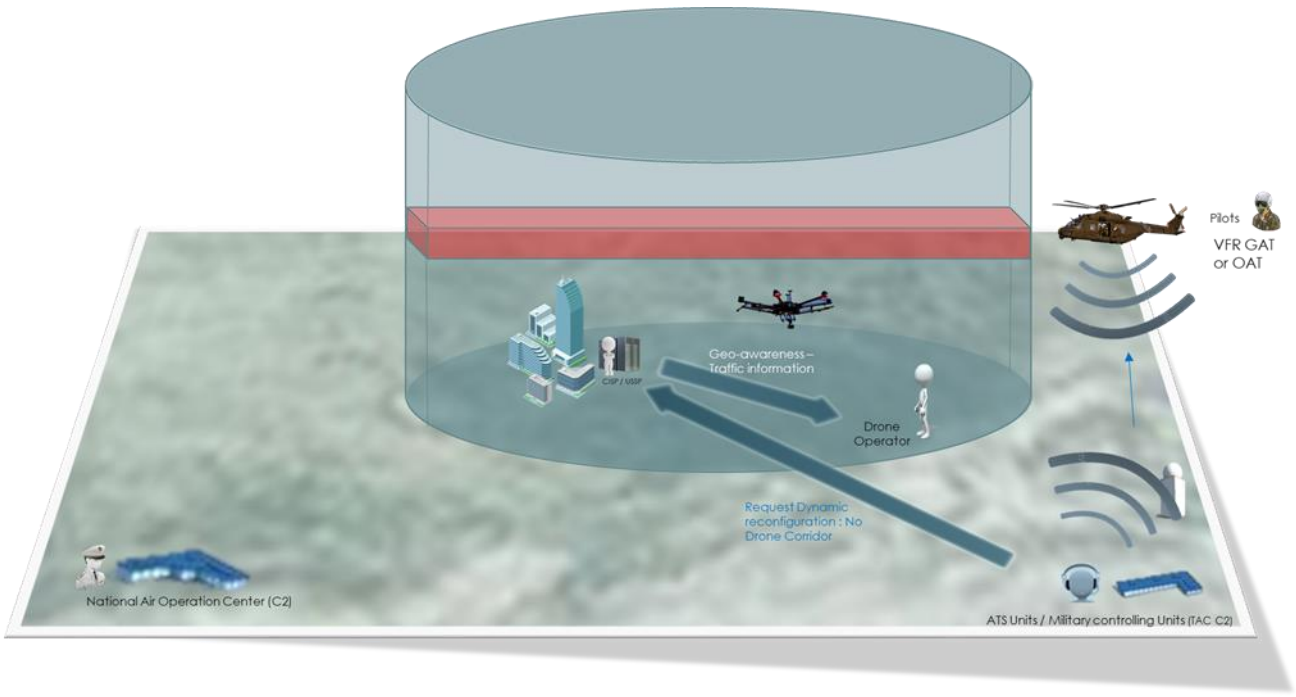

FIGURE 82: DYNAMIC AIRSPACE RECONFIGURATION PROCESS

The following diagram illustrates this nominal flow of actions and the interactions between the different actors of the use case.

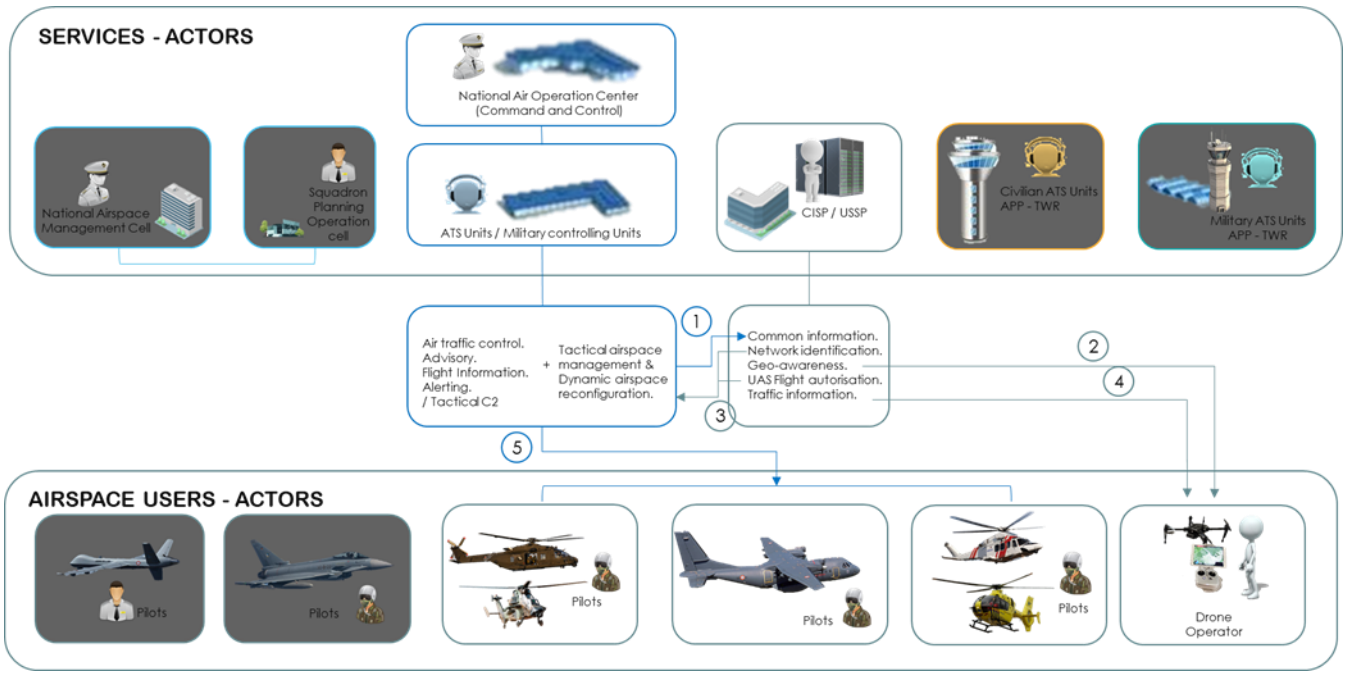

FIGURE 83: UC7 – AIR DROP AND LANDING INSIDE UNCONTROLLED U-SPACE AIRSPACE

OPTION UC7.2B: MILITARY COOPERATION WITH USSP NOT ESTABLISHED

In this sub-Use Case, it is assumed that:

- The ATS Unit / Military control unit systems and the CISP/USSP systems are not connected;
- Coordination procedures are not defined between operation centres;
- Communication facilities are not established between Tactical Controller (TAC C2)/Air Traffic Controller (ATCO) and the USSP.

	Airspace Class	Flight Rules MIL a/c	Potential airspace restrictions	Air mission control/ safety	Drone activities	U-space services	Dynamic NDZ
U-space Airspace Restricted ACCESS	F, G	Visual flight ≥170/330ft* or Operational flight <170/330ft* Flight conditions VMC	R, P, D areas NDZ	TAC C2-ATCO: Broadcast control-Advisory service / Pilot : see and avoid	VLOS/ BVLOS	None	None
Nominal actions	■ To transit and operate over the village, helicopter and aircraft pilots fly under VFR OAT (Operational Air Traffic) or GAT (General Air Traffic)flight above 170ft/330ft (*depending on national regulations) or under operational flight below; ■ Below the minimum control altitude as MRVA : Minimum Radar Vectoring Altitude) of the ATS Unit / Military control unit, the Tactical Controller (TAC C2) or Air Traffic Controller (ATCO) provides broadcast control or advisory service. Tactical information is passed to enable the helicopter and aircraft pilots to accomplish the assigned task;						

	■ The ATS Unit / Military control unit, when possible, provides adequate warnings about hazards and carries out coordination with the managers of areas (civilian and military) interfering with the transit flight path; ■ Operational actors have no awareness of drone activities and U-space services available in this uncontrolled restricted access drone geographical zone. The mitigation actions relies only on specific military systems to detect the drones that are aiming to avoid the concerned areas; ■ Unplanned or conscious entry of aircraft in the uncontrolled, restricted access drone geographical zone is a risk, which the military should assess before entering those areas. To mitigate such a risk, it is important to receive information on potential activities in the considered area (e.g. through the military surveillance systems); ■ (optional) The military TAC C2 (cf. RAP Use Case in 4.2 -) provides information on drone traffic if military sensors cover this area (limited SA).

TABLE 37: UC7.2B - CONTEXT OF OPERATION

Note: The U-space regulation IR 2021/664 [12] highlights the need to know the position of manned aircraft in the U-space concerned:

"In order to allow unmanned aircraft to safely operate alongside manned aircraft in U-space airspace, rules providing for effective signalling of the presence of manned aircraft by means of surveillance technologies are necessary. (…) The traffic information service shall include information about manned aircraft and UAS traffic shared by other U-space service providers and relevant air traffic service units. The traffic information service shall provide information about other known air traffic and shall:

(a) include the position, time of report as well as speed, heading or direction and emergency status of aircraft, when known;

(b) be updated at a frequency that the competent authority has determined.

The Strategic Research and Innovation Agenda (SRIA) highlights that: *"Research is required to understand how different modes of separation provision enable interoperable ATM and U-space services to co-exist, considering the diversity of aircraft performance characteristics and detect-and-avoid capabilities"* and *"Different solutions for separation management for all types of vehicles in all types of airspace (including airborne detect and avoid (DAA) as well as ground-based and hybrid solutions) should also be considered."* [26]

4.7.2.3 - Sub-Use Cases UC7.3: Land/take off from controlled U-space airspace

OPTION UC7.3A: ESTABLISHED MILITARY COOPERATION WITH USSP, AIRSPACE UNDER CIVILIAN ATC

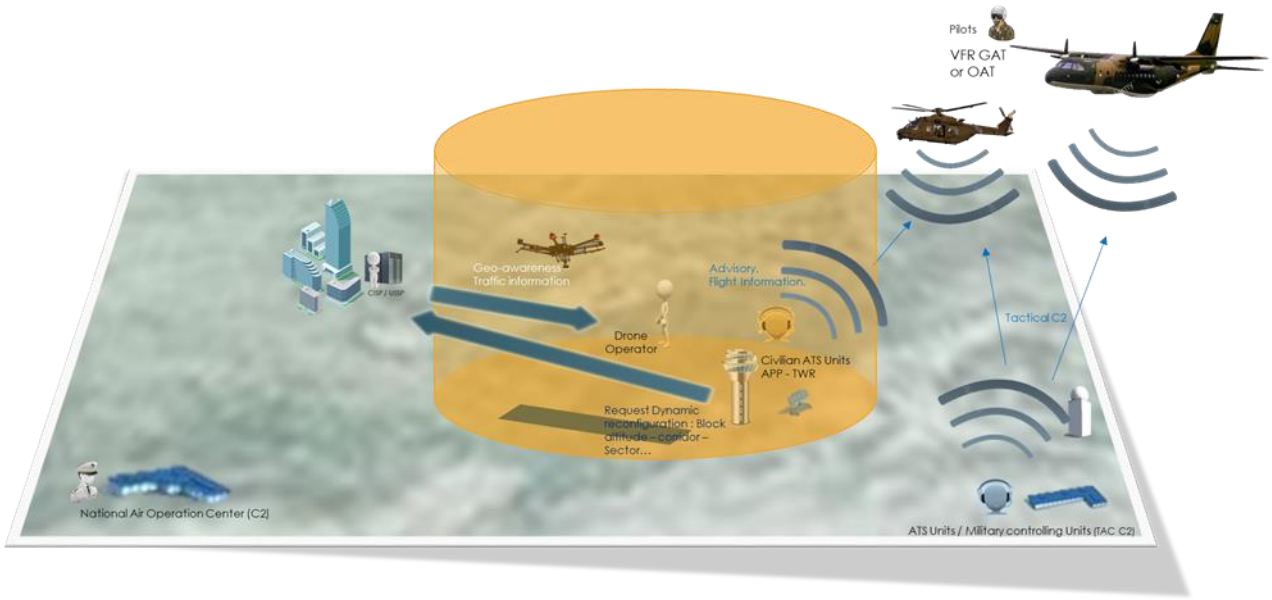

FIGURE 84: CIVILIAN CONTROLLED AIRSPACE

In addition to existing coordination between the CRC and the ATSP, in this sub-Use Case, it is assumed that:

- The civilian ATS unit systems and the CISP/USSP systems are connected;
- Coordination procedures are defined between operation centres[16];
- Communication facilities are established between Tactical Controllers and the USSP.

	Airspace Class	Flight Rules MIL a/c	Potential airspace restrictions	Air mission control/ safety	Drone activities	U-space services	ATSP
U-space Airspace Restricted ACCESS	A, B, C, D, E	Visual flight ≥170/330ft* or Operational flight <170/330ft* Flight conditions VMC	R, P, D areas NDZ	TAC C2: Broadcast Control/ ATC	VLOS BVLOS	Common information services Geo-awareness UAS flight authorisation Network identification Traffic information [weather information conformance monitoring]	Traffic information Dynamic airspace reconfiguration
Nominal actions	■ To take off inbound the village or to land from it, the helicopter and aircraft pilots fly under VFR OAT (Operational Air Traffic) or GAT (General Air Traffic) flight above 170ft/330ft (*depending on national regulations) or under operational flight below;						

	■ The civilian ATS Units could request defined dynamic U-space airspace restrictions to ensure that MEDEVAC operations are conducted in a safe and efficient manner (see UC1). ▸ Dynamic airspace reconfiguration means temporary modification of the U-space airspace in order to accommodate short-term requests from airspace users, by adjusting the geographical limits of this U-space airspace; ▸ The civilian ATCO (APP) can request to temporarily limit the area (1 in Figure 85) within the designated U-space airspace where drone operations can take place in order to accommodate the request; ▸ The civilian ATS unit (APP) ensures that the relevant U-space service providers and, where applicable, common information service providers, are notified (1 in Figure 85) in a timely and effective manner of the activation, deactivation and temporary limitations of the designated U-space airspace. USSP adapt Geo-awareness service (2 in Figure 85) to the airspace configuration; ▸ A dynamic reconfiguration should be a temporary limitation of the designated U-space airspace, in the form of altitude block, corridor, portion of airspace; ▸ An USSP "functionality" to ground all UAS when needed by the military should be defined. ■ Inside controlled airspace, the civilian ATCO provides traffic information **(4 in Figure 80)** on manned and unmanned [shared by USSP **(3 in Figure 80)**] activities to the helicopter and aircraft pilots. He facilitates the trajectory desired by the helicopter and aircraft pilots. Traffic information provided to Drone Operators through the USSP **Traffic information service (5 in Figure 80)**

TABLE 38: UC7.3A – CONTEXT OF OPERATION

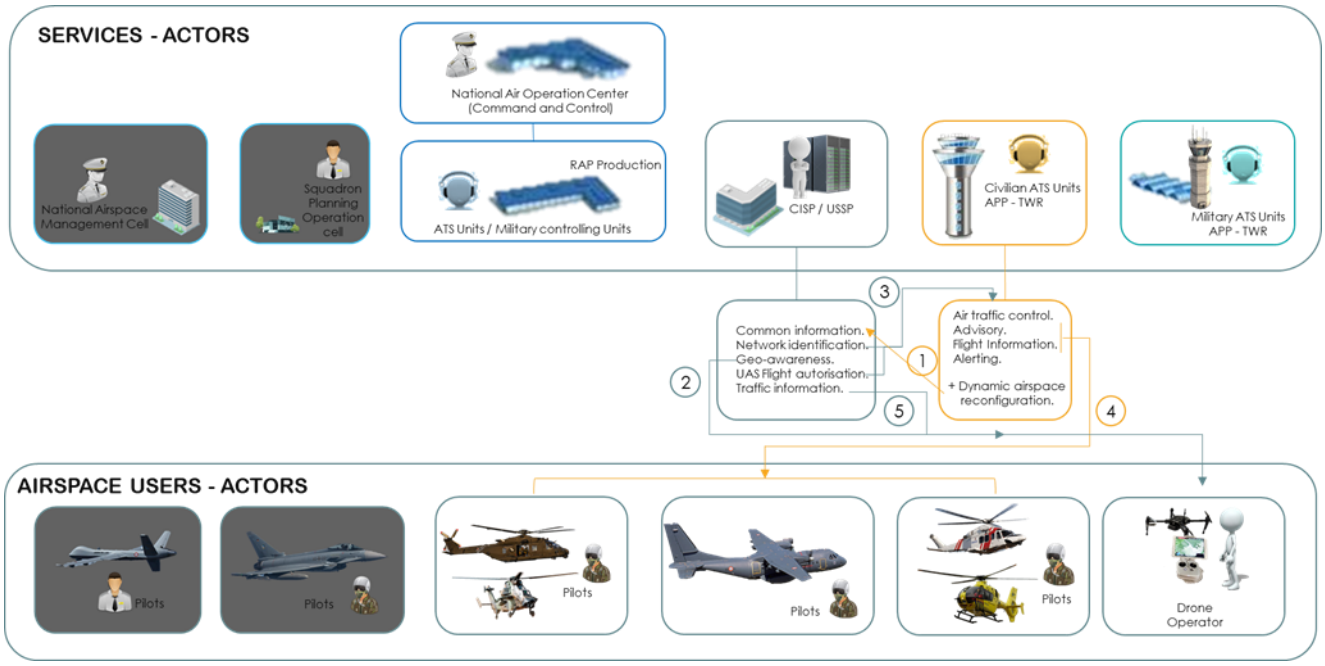

FIGURE 85: UC7 – MEDEVAC INSIDE CIVILIAN CONTROLLED U-SPACE AIRSPACE

OPTION UC7.3B: ESTABLISHED MILITARY COOPERATION WITH USSP AIRSPACE UNDER MILITARY ATC

In this sub-Use Case, the Member State has defined a military CTR as part of the U-space airspace. So, in line with the requirements of the EASA U-space Regulation, the systems connectivity methods between provider(s) of the Common Information Services, the USSP and the military Air Traffic Service Provider (CTR) is established through interoperable communication protocols.

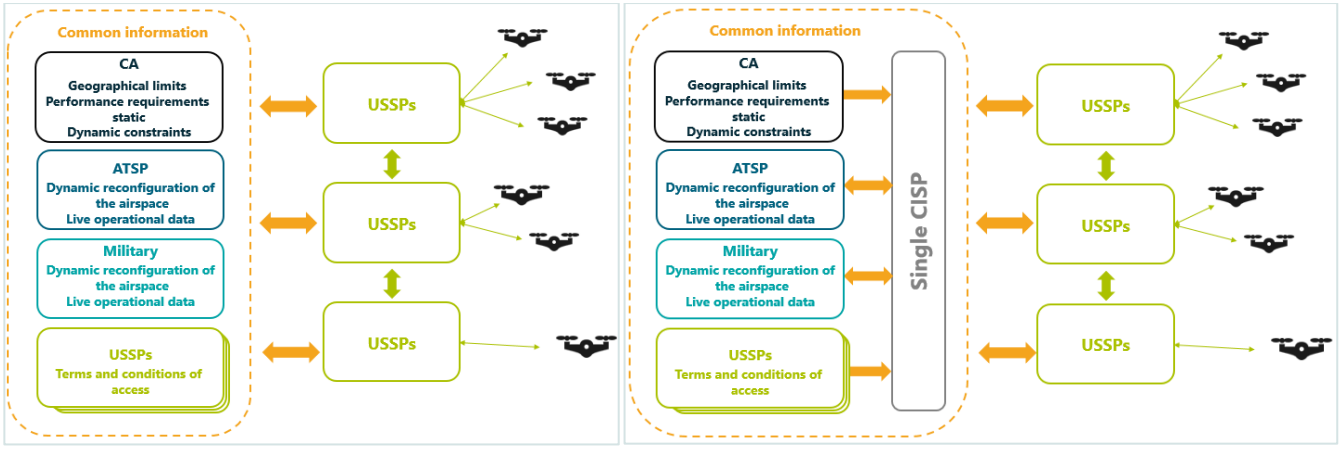

FIGURE 86: POSSIBLE INFORMATION EXCHANGE MODELS BETWEEN A MILITARY ATSU AND USSPS

In this portion of airspace, the relevant military Air Traffic Service Units (ATSUs) have to continuously share information on air assets with the USSP, in particular regarding manned aircraft.

The traffic information about manned aircraft provided by the USSP to the Drone Operator has to be shared by the relevant ATSUs.

The military ATSUs has to apply dynamic reconfiguration of the U-space airspace in order to make sure that manned aircraft and the drone remain segregated, as expected by the U-space Regulation.

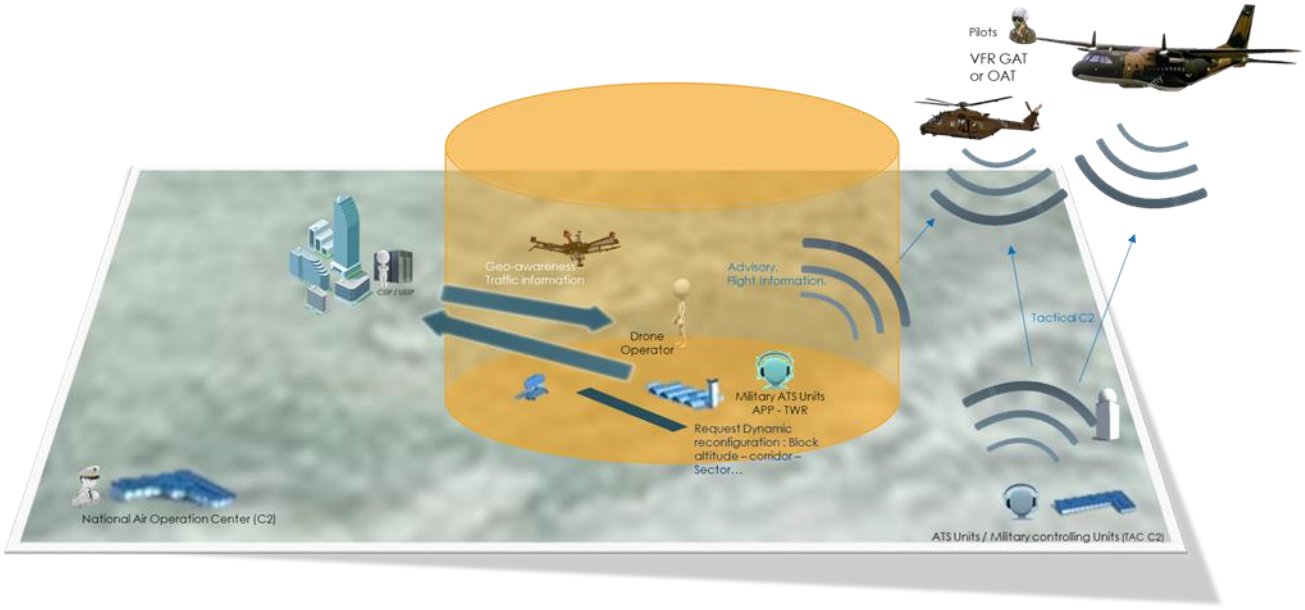

FIGURE 87: MILITARY CONTROLLED AIRSPACE

U-space Airspace	Airspace Class	Flight Rules MIL a/c	Potential airspace restrictions	Air mission control/ safety	Drone activities	U-space services	ATSP
Restricted ACCESS	A, B, C, D, E	Visual flight ≥170/330ft* or Operational flight <170/330ft*	R, P, D areas NDZ	TAC C2: Broadcast or close advisory control/ ATC	VLOS/ BVLOS	Common information services Geo-awareness	Traffic information/ Dynamic airspace reconfiguration

		Flight conditions VMC				UAS flight authorisation Network identification Traffic information [weather information conformance monitoring]	
Nominal actions	■ To take off inbound the village or to land from it , the helicopter and aircraft pilots fly under VFR OAT (Operational Air Traffic) or GAT (General Air Traffic) flight above 170ft/330ft (*depending on national regulations) or under operational flight below; ■ The ATS Unit / Military control unit manages coordination with the military ATCO (APP); ■ The military ATS Unit (APP) provides advisory service, ■ Inside controlled airspace, the military ATCO (APP) should be able to request defined dynamic U-space airspace restrictions to ensure that MEDEVAC operations are conducted in a safe and efficient manner (see UC1); ▸ Dynamic airspace reconfiguration means temporary modification of the U-space airspace in order to accommodate short-term requests from airspace users, by adjusting the geographical limits of this U-space airspace; ▸ The Military ATCO (APP) temporarily limits(1 in Figure 88) the area within the designated U-space airspace where drone operations can take place in order to accommodate the request; ▸ The military ATS unit (APP) ensures that the relevant U-space service providers and, where applicable, common information service providers, are notified (1 in Figure 88) in a timely and effective manner of the activation, deactivation and temporary limitations of the designated U-space airspace. USSP adapt Geo-awareness service (2 in Figure 88) to the airspace configuration; ▸ A dynamic reconfiguration should be a temporary limitation of the designated U-space airspace, in the form of altitude block, corridor, portion of airspace; ▸ An USSP "functionality" to ground all UAS when needed by the military should be defined. ■ Inside controlled airspace, the military ATCO provides traffic information **(4 in Figure 88)** on manned and unmanned [shared by USSP **(3 in Figure 88)**] activities to the helicopter and aircraft pilots and facilitates the trajectory desired by the helicopter and aircraft pilots; ■ The Drone Operator is alerted to the proximity with the military helicopter and aircraft through the **Traffic information service (5 in Figure 88)**.						

TABLE 39: UC 6.3B - CONTEXT OF OPERATION

The following diagram illustrates this nominal flow of actions and the interactions between the different actors of the use case.

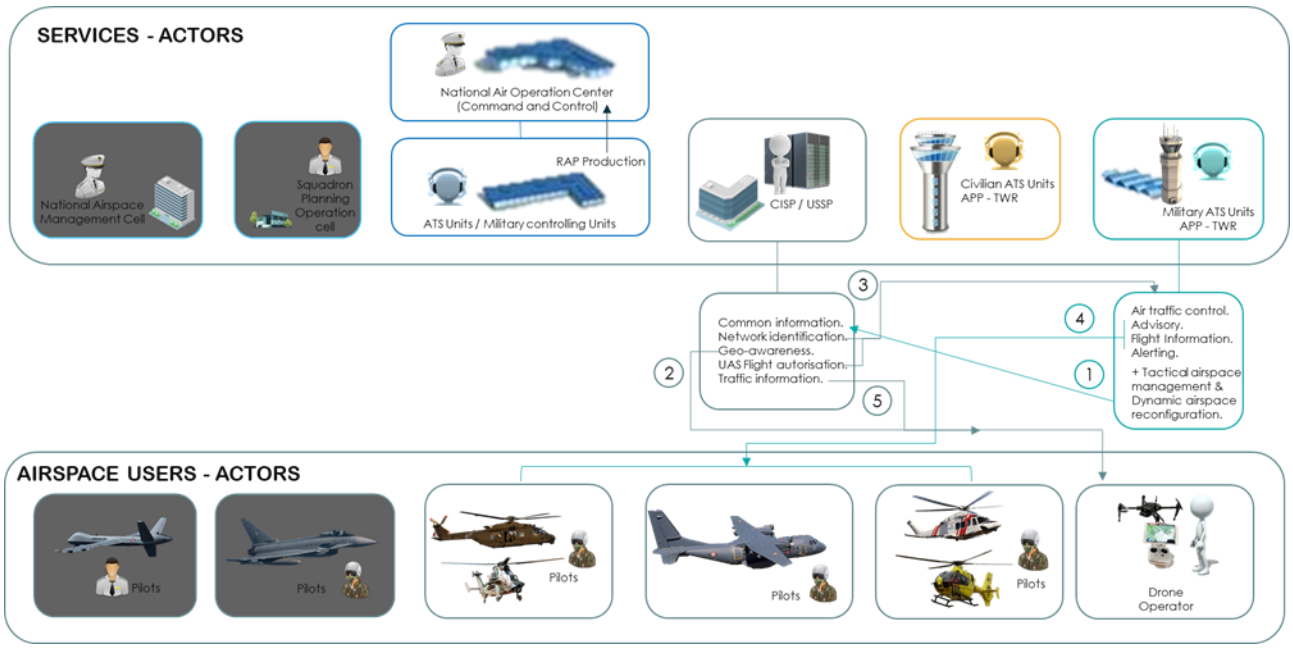

FIGURE 88: UC7 – MEDEVAC INSIDE MILITARY CONTROLLED U-SPACE AIRSPACE

5 - GAPS IN U-SPACE DEFINITION

5.1 - U-space organisation

Military and civilian aviation stakeholders have long identified the need for a common framework allowing their respective activities to safely and efficiently use the same portions of airspace. The civil-military cooperation extends from R&D to operations and is developed according to a set of shared principles including interoperability, information-sharing, collaborative decision-making and performance equivalence.

The U-space environment under implementation sits on similar principles and the research work conducted by SESAR is shaping the future relationship between USSPs and civilian ATSPs.

However, there is currently a limited understanding of how the military will interact with U-space at organisational and operational levels. This relation could be implemented through the two above channels, with the civilian ATSPs acting as a go-between, or via a direct interface between the military and U-space. The former approach will likely result in less operational efficiency, while the latter requires more investment from the military.

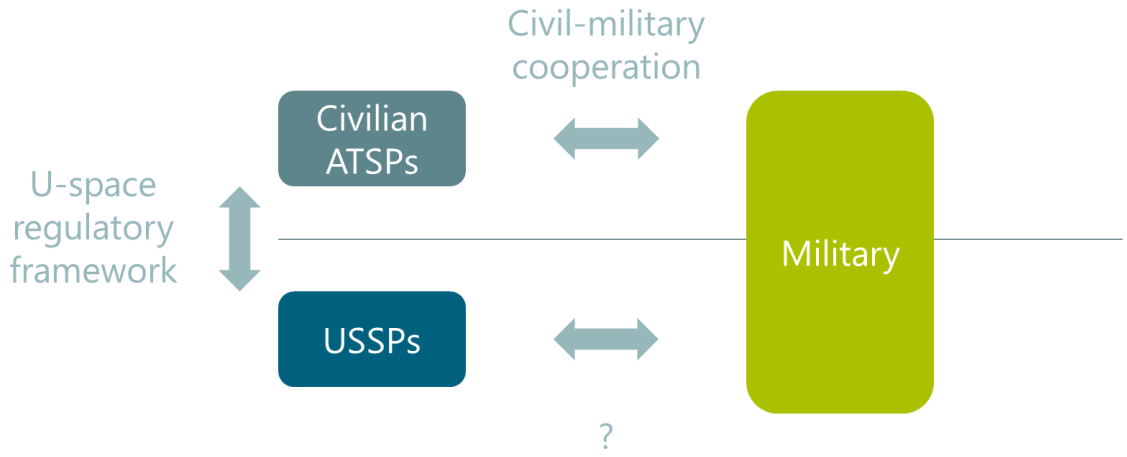

FIGURE 89: FUTURE RELATIONSHIPS IN A U-SPACE CONTEXT

As an example, the way the drone operators will become aware of the location of drone geographical zones defined by Member States (cf. 2.1.6.1 -), including those defined by the military, remains to be agreed. While static information published by the national AIS will be communicated through the Geo-awareness U-space service, there is currently no clear process for the communication of short-term changes decided on short notice.

5.2 - U-space regulation

Currently, the U-space Regulation mandates U-space services in designated portions of the airspace, while CORUS-XUAM defines airspace volumes covering the entire very low level (VLL) airspace, with a minimum set of U-space services associated to each of these volumes. Consequently, portions of the VLL airspace will remain devoid of any U-space service and airspace users will have to rely on e-conspicuity and/or the see-and-avoid principle to prevent collisions. Alternatively, implementing U-space, or U-space-like, services in these portions of VLL airspace would provide an additional layer of safety, but this possibility has only been briefly discussed at this stage.

The U-space Regulation also requires controlled air traffic and drone traffic to remain segregated. It describes dynamic airspace reconfiguration as the tool available to ATSPs to ensure that both types of traffic are effectively segregated. However, no such tool is defined for uncontrolled airspace, which is largely the case of VLL airspace, and the military do not have a means to request restrictions of U-space airspace in VLL. However, before U-space is deployed, an airspace risk assessment will need to be performed. As a consequence, there is a very small chance that U-space airspace will be created in critical military airspaces.

There is nonetheless a need to develop processes for the management of VLL airspace at strategic (fixed structure), pre-tactical (planned changes) and tactical levels (activation/deactivation of planned changes and unplanned changes), similar to ASM/FUA processes, if segregation is considered as required in uncontrolled airspace too. The counterpart organisations (USSPs, CIS providers) to the military in such an initiative are however unknown to this date.

Lastly, the Acceptable Means of Compliance (AMC) and Guidance Material (GM) associated to the U-space Regulation clearly recognise the impact of U-space on military (and State) aircraft operations and the role of military authorities as partners in the decision-making process of the coordination mechanism (as per Article 18(f) of Regulation (EU) 2021/664).

However, the AMC/GM do not introduce new processes, procedures or systems to address the specificities of military operations, other than those defined in the U-space regulation:

- Military authorities should be involved in the designation process of U-space airspaces, to cover the safety and security aspects, from the initial 'airspace risk assessment' until the U-space is implemented and monitored;
- In case the militaries require portions of the U-space to be adjusted or possibly deactivated to conduct their operations, the relevant air traffic control units should apply the dynamic reconfiguration of the U-space airspace at short notice;
- E-conspicuity remains the mechanism via which USSPs are made aware of manned aviation traffic that is not provided with an air traffic control service. The AMC/GM recommend three alternative means for transmissions of minimum position information by operators of manned aircraft:
  - Certified ADS-B out (either transmitting on 1090 MHz frequency or through UAT if it is deployed in Member States);
  - Systems transmitting on SRD 860 frequency band;
  - Systems transmitting via standardised mobile telecommunication network services coordinated for aerial use in Europe.
- A number of standards are identified for the exchange of data between CISP/USSPs and external stakeholders, meaning it will be more difficult for CISP/USSPs to accommodate external stakeholders that use different communication protocols (e.g. SWIM Yellow Profile) or data formats (e.g. JSON or ASTERIX for traffic information).

In addition, the current Regulation only covers initial U-space services. It is important to recognise that U3 and U4 envisage a great increase in automation and autonomy, which will create additional challenges and issues for other airspace users. These issues will likely be more significant than the provisions already covered by regulations. For example, SORA is relevant for small numbers of drones, but would be overwhelmed by hundreds.

5.3 - Mitigations to operational issues

As illustrated through the Use Cases presented in section 4 - , the implementation of U-space, as it is understood through the information currently available, will result in a number of operational risks for which mitigation means have to be proposed.

Drone operators are currently aware of airspace restrictions through the aeronautical information published by the national AIS. This is only relevant for static restrictions and **Drone operators are not aware of planned or unplanned changes** to the fixed airspace structure, except in Member States where initial UTM services are implemented. If the military opt to use U-space services, military will be able to communicate to USSPs their airspace restriction and to request dynamic airspace restrictions via the **Geo-awareness service**.

There is currently no requirement for drones to be equipped with an electronic conspicuity means outside of U-space airspace, creating a gap for the **elaboration of a Recognised Air Picture**. If the military opt to use U-space services, the **Network information service** will address this issue. Otherwise, ADS-B out, SRD 860 and mobile telephony networks, as recently proposed by EASA's iConspicuity concept, could be options to consider.

Unless the military implement specific systems, Air Surveillance Operators (ASO) have no means to **correlate detected drone tracks with an identification** and a planned flight path. They are also unaware of any airspace restriction in U-space airspaces, making the detection of infringements difficult. If the military opt to use U-space services, the **Network information service** will address this issue. The **UAS flight authorisation service** can also be used to partially address the issue. Alternatively, a U-space actor to be identified could convert all UAS flight authorisations (in an automated process) into ICAO Flight Plans to be shared in an efficient way with the military and therefore increasing situational awareness and contributing to enhanced flight safety.

Whether unplanned or conscious, the entry of a military aircraft into an uncontrolled drone geographical zone creates a **risk of collision with drones**. To mitigate such a risk, it is important to receive information on potential activities in the considered area (e.g. through the military surveillance systems). If the military opt to use U-space services, they will be able to inform the USSPs about military air traffic (provided the missions allows it) and the USSPs will be able to segregate drone traffic from military traffic through the **Traffic information service**.

As part of the possible use of U-space services by the military, additional military data could be supplied directly to the CIS, and this would need to be defined and standardised. Moreover, the CIS would have to be able to supply information that may be of particular interest to the military. Consequently, the military could consider investigating the potential of the CIS to meet their specific needs. For example, the military could be interested in a service providing them a full overview of the drone operations to support their operations and create situational awareness.

Lastly, there is no requirement for drones to be equipped with a collaborative detect and avoid system. Therefore, the prevention of collisions, for SORA-approved flights, only rests on the ability of the manned aircraft pilot to detect drones. If drones are not equipped with a conspicuity means, the only mitigation is the application of the see-and-avoid principle. Only the manned aircraft pilot can apply this principle if the drone is operating in BVLOS.

6 - CONCLUSIONS OF D1

The ongoing development of U-space is providing a better understanding on how drones will operate in the future U-space environment, which will impact all other airspace users notably in the lowest layers of the airspace.

The European Defence Agency has initiated a study to evaluate and assess U-space impacts from a military perspective, and to support their involvement with all other aviation stakeholders. The present document is the first step of this study.

From this D1 deliverable, one can retain the following conclusions:

- **The military are a key actor,** with specific requirements which shall be taken into account;
- Drone operations create **safety and security challenges**;
- The current U-space regulatory framework **leaves a number of questions open** on how U-space Service Providers and Common Information Service providers will interact with other aviation actors;
- U-space is organised according to services, which are provided in a **specific airspace structure**;
- U-space services, in themselves, have **no detrimental effect on key military missions;**
- U-space can provide **limited safety benefits to the military,** as U-space initial services provide Drone operators a better awareness of their operational environment;
- The full extent of potential **benefits to the military is achieved under the condition** they fully use U-space services, and if they share information with other actors through the Common Information Service;
- Military **involvement in the on-going U-space work is required to limit potential negative impacts** on State operations, including public service.

Based on the above results, this D1 proposes a number of recommendations, mostly to the military but which are also relevant for civilian actors:

- The military **may wish to monitor the progress of U-space implementation** and whether the gaps and issues identified through this D1 are satisfactorily addressed;
- Aviation stakeholders involved in the definition of U-space **shall engage more significantly with the military** to better understand their objectives and constraints, and consider them in U-space;
- The military **may wish to consider defining permanent no drone zones** around the areas they want to protect and share them with their national Aeronautical Information Service;
- Even in the current absence of identified U-space key actors, U-space Service Providers and Common Information Service providers, the military **are recommended to start defining their requirements for a shared management** of the very low level airspace at national level;

7 - ANNEXES

7.1 - Appendix 1: Abbreviations

Abbreviation	Definition
24/7	24 hours, 7 days in a week
ACC	Area Control Centre
AF	Automated Flight
AIM	Aeronautical Information Management
AIRAC	Aeronautical Information Regulation and Control
AIS	Aeronautical Information Service
AMC (regulatory context)	Acceptable Means of Compliance
AMC (operational context)	Airspace Management Cell
AMC (operational context)	Air Mission Control
ANS	Air Navigation Services
ANSP	Air Navigation Service Provider
APP	Approach
ARA	Aispace Risk Assessment
ARC	Air Risk Class
ASM	Airspace Management
ASO	Air Surveillance Operator
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATM	Air Traffic Management
ATS	Air Traffic Services
ATSP	Air Traffic Service Provider
ATSU	Air Traffic Service Unit
AU	Airspace User
BVLOS	Beyond Visual Line of Sight
C-UAS	Counter-UAS

C2	Command and Control
CAA	Civil Aviation Authority
CAOC	Combined Air Operation Centre
CBA	Cost-Benefit Analysis
CIS	Common Information Service
CISP	Common Information Service Provider
CNS	Communication, Navigation and Surveillance
CONOPS	Concept of Operations
CORUS	Concept of Operations for EuROpean UTM Systems
CRC	Control and Reporting Centre
CSAR	Combat Search and Rescue
CTR	Control Traffic Region
DAA	Detect and Avoid
DDS	Drone Detection Systems
DFS	Deutsche Flugsicherung
DOC	Document
DR	Delegated Regulation
DSA	Drone Service Application
DSNA	Direction des Services de la Navigation Aérienne
DSS	Drones Detection Systems
EASA	European Union Aviation Safety Agency
EC	European Commission
EDZ	Exclusive Drone Zone
E-SRM	Expanded Safety Reference Material
EU	European Union
EUROCONTROL	European Organisation for the Safety of Air Navigation
EVLOS	Extended Visual Line of Sight operation
FIS	Flight Information Service
FL	Flight Level
FPV	First-person View

FUA	Flexible Use of Airspace
GAMZ	Geodetic Altitude Mandatory Zone
GAT	General Air Traffic
GM	Guidance Material
GNSS	Global Navigation Satellite System
GRC	Ground Risk Class
HEMS	Helicopter Emergency Medical Service
IAS	Indicated Airspeed
ICAO	International Civil Aviation Organisation
IFR	Instrumental Flight Rules
IOP	Interoperability
IR	Implementing Regulation
ISR	Intelligence, Surveillance, and Reconnaissance
JAPCC	Joint Air Power Competence Centre
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
JPR	Joint Personnel Recovery
LDZ	Limited Drone Zone
MALE RPAS	Medium Altitude Long Endurance Remotely Piloted Aircraft System
MEDEVAC	Medical Evacuation
MRVA	Minimum Radar Vectoring Altitude
MS	Member State
NAA	National Aviation Authority
NAOC	National Air Operation Centre
NATO	North Atlantic Treaty Organization
NDZ	No Drone Zone
NM	Network Manager
NOTAM	Notice to Airmen
OAT	Operational Air Traffic
OSO	Operational Safety Objectives
PANSA	Polish Air Navigation Services Agency

PR	Personnel Recovery
Q1	Quarter 1
QRA	Quick Reaction Alert
QRA(I)	Quick Reaction Alert Interceptor
RAP	Recognised Air Picture
RCC	Rescue Coordination Centre
SAIL	Specific Assurance and Integrity Levels
SAR	Search and Rescue
SDSP	The Supplemental Data Service Provider
SESAR JU	Single European Sky ATM Research Joint Undertaking
SMC	SAR Mission Coordinator
SORA	Specific Operations Risk Assessment
TAC	Tactical Controller
TC	Type Certificate
TWR	Tower
UA	Unmanned aircraft
UAM	Urban Air Mobility
UAS	Unmanned aircraft system
USSP	U-space Service Provider
UTM	UAS Traffic Management
VFR	Visual Flight Rules
VLD	Very-Large scale Demonstration
VLL	Very Low-Level
VLOS	Visual Line of Sight operation
VMC	Visual Meteorological Conditions

TABLE 40: ABBREVIATIONS

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7.3 - Appendix 3: General ATM Overview

7.3.1 - Terminology

Terms	Description
Air Traffic Control (ATC) Service	Means a service provided for the purpose of: (a) preventing collisions: — between aircraft; — in the manoeuvring area between aircraft and obstructions; (b) expediting and maintaining an orderly flow of air traffic; [6]
Air Traffic Service (ATS) Provider	Provide Air Traffic Control services in controlled airspace; [3]
Aeronautical Information Service (AIS)	A service established within the defined area of coverage responsible for the provision of aeronautical information and data necessary for the safety, regularity, and efficiency of air navigation [6]
Air Navigation Services (ANS)	Air traffic services; communication, navigation and surveillance services; meteorological services for air navigation; and aeronautical information services; [6]
Airspace management (ASM)	A planning function with the primary objective of maximising the utilisation of available airspace by dynamic time-sharing and, at times, the segregation of airspace among various categories of airspace users on the basis of short-term needs; [6]
Air Traffic Management (ATM)	The aggregation of the airborne and ground-based functions (air traffic services, airspace management and air traffic flow management) required to ensure the safe and efficient movement of aircraft during all phases of operations; [6]
Air Traffic Services (ATS)	The various flight information services, alerting services, air traffic advisory services and ATC services (area, approach and aerodrome control services); [6]
Airspace User (AU)	Operators of aircraft operated as general air traffic; [6]
CE marking	CE marking indicates that a product has been assessed by the manufacturer and deemed to meet EU safety, health and environmental protection requirements. It is required for products manufactured anywhere in the world that are then marketed in the EU. [50]
Communication Services	Aeronautical fixed and mobile services to enable ground-to-ground, air-to-ground and air-to-air communications for ATC purposes; [6]
Controlled Airspace	An airspace of defined dimensions within which air traffic control service is provided in accordance with the airspace classification. Control airspaces covers ATS airspace Classes A, B, C, D and E; [9]
Flight Information Service (FIS)	A service provided for the purpose of giving advice and information useful for the safe and efficient conduct of flights; [6]
Flight level	A surface of constant atmospheric pressure which is related to a specific pressure datum, 1 013.2 hectopascals (hPa), and is separated from other such surfaces by specific pressure intervals. [2]

Flexible Use of Airspace (FUA)	An airspace management concept applied in the European Civil Aviation Conference area on the basis of the 'Airspace management handbook for the application of the concept of the flexible use of airspace' issued by EUROCONTROL; [6]
Manufacturer	Any natural or legal person who manufactures a product or has a product designed or manufactured, and markets that product under their name or trademark; [6]
Payload	Instrument, mechanism, equipment, part, apparatus, appurtenance, or accessory, including communications equipment, that is installed in or attached to the aircraft and is not used or intended to be used in operating or controlling an aircraft in flight, and is not part of an airframe, engine, or propeller; [9]
Prohibited area	An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is prohibited [2]
Restricted area	An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is restricted in accordance with certain specific conditions. [2]
Traffic Information	Information issued by an air traffic services unit to alert a pilot to other known or observed air traffic which may be in proximity to the position or intended route of flight and to help the pilot avoid a collision; [2]
Uncontrolled Airspace	The opposite of controlled airspace. Uncontrolled airspace covers ATS airspace Classes F and G.

TABLE 41 : ATM GENERAL TERMINOLOGY

7.3.2 - Rules of the air

Flight Rules	Description	Documentation
Visual Flight Rules (VFR)	Using the VFR flight rules, the pilot must be able to operate the aircraft with visual reference to the ground, and by visually avoiding obstructions and other aircraft. Minimum level: • 1000ft/300m above the highest obstacle within a radius of 600 m from the aircraft over the congested areas of cities, towns or settlements or over an open-air assembly of persons; • 500ft/150m above the ground or water. Unless authorized by the appropriate ATS authority, VFR flights shall not be operated: • above FL 200; • at transonic and supersonic speed.	ICAO Annex 2, Chapter 4 SERA 5001-5010 [2], [19], [29]
Instrument Flight Rules (IFR)	Aircraft shall be equipped with suitable instruments and with navigation equipment appropriate to the route flown. For the IFR, the limits are usually defined by the state in which the aircraft is being flown. Minimum level:	ICAO Annex 2, Chapter 5 SERA 5015-5025 [2], [19], [29]

	All IFR flights shall be flown except for take-off, landing or except by permission from the appropriate authority: • At a level which is not below the minimum flight altitude established by the local regulations (published on charts); • At a level which is a least 600m (2000ft) above the highest obstacle located within 8km of the estimated position of the aircraft, in mountainous areas, when no minimum flight altitude has been established; • At a level which is a least 300m (1000ft) above the highest obstacle located within 8km of the estimated position of the aircraft, elsewhere than the two first items, when no minimum flight altitude has been established.	

TABLE 42: FLIGHT RULES

7.3.3 - Airspace classes

ATS Airspace shall by classified and designated in accordance with the following rules [3]:

Airspace Class	Type of Flight	Separation Provided	Services Provided	Speed limit	Radio Com.	ATC clearance
A	IFR only	All aircraft	ATC services	Not applicable	Continues, two ways	Required
B	IFR	All aircraft	ATC services	Not applicable	Continues, two ways	Required
	VFR	All aircraft	ATC services	Not applicable	Continues, two ways	Required
C	IFR	IFR from IFR IFR from VFR	ATC services	Not applicable	Continues, two ways	Required
	VFR	VFR from IFR	ATC service for separation from IFR, VFR/IFR traffic information (and traffic avoidance advice on request)	250KT IAS below 10000ft/FL100 AMSL	Continues, two ways	Required
D	IFR	IFR from IFR	ATC service, traffic information about VFR flights (and traffic avoidance advice on request)	250KT IAS below 10000ft/FL100 AMSL	Continues, two ways	Required

	VFR	Nil	IFR/VFR and VFR/VFR traffic information (and traffic avoidance advice on request)	250KT IAS below 10000ft/FL100 AMSL	Continues, two ways	Required
E	IFR	IFR from IFR	Air traffic control service and, as far as practical, traffic information about VFR flights	250KT IAS below 10000ft/FL100 AMSL	Continues, two ways	Required
	VFR	Nil	Traffic Information as far as practical	250KT IAS below 10000ft/FL100 AMSL	Not required	Not required
F	IFR	IFR from IFR as far as practical	Air traffic advisory service, flight information service	250KT IAS below 10000ft/FL100 AMSL	Continues, two ways	Not required
	VFR	Nil	Flight Information service	250KT IAS below 10000ft/FL100 AMSL	Not required	Not required
G	IFR	Nil	Flight Information service	250KT IAS below 10000ft/FL100 AMSL	Continues, two ways	Not required
	VFR	Nil	Flight Information service	250KT IAS below 10000ft/FL100 AMSL	Not required	Not required

TABLE 43: ATS AIRSPACE CLASSES
[3]

7.4 - Appendix 4: SESAR JU U-space vision

7.4.1 - SESAR 2020 Wave 2 UAM and U-space research and demonstration projects

The table below provides an overview on the SESAR JU projects addressing UAM, U-space & ATM and Advanced services in SESAR 2020 Wave 2.

Project	Type	Name and overview
Metropolis 2	ER	**A unified approach to airspace design and separation management for U-space** The main objective of this project is to develop a unified approach to airspace rules, flight planning and separation management approaches and to demonstrate these principles in a real-world validation exercise.
CORUS XUAM	VLD	**Concept of Operations for euRopean U-space Services - eXtension for Urban Air Mobility** The main objective is to demonstrate how U-space services and solutions could support integrated Urban Air Mobility (UAM) flight operations, allowing eVTOLs/UAS and other airspace users (unmanned and manned) to operate safely, securely, sustainably and efficiently in a controlled and fully integrated airspace, without undue impact on operations currently managed by ATM.
SAFIR-MED	VLD	**Safe and Flexible Integration of Advanced U-space Services focusing on Medical Air Mobility** The SAFIR-Med objective is to demonstrate integrated Drone Traffic Management for a broad range of drone operations. The project's vision is to achieve safe, sustainable, socially accepted and socially beneficial urban air mobility.
GOF 2.0	VLD	**Gulf of Finland 2.0 Integrated Urban Airspace VLD** The objective of this project is to demonstrate safely, securely, and sustainably operational validity of serving combined UAS, eVTOL and manned operations in a unified, dense urban airspace using current ATM and U-space services and systems.
AMU-LED	VLD	**Air Mobility Urban – Large Experimentation Demonstrations** The project proposes to design and deliver a detailed concept of operations and definition of urban air missions followed by simulations and a large real flight demonstration campaign to verify and validate the concepts. The project has allowed UAM stakeholders to specify various use cases applicable to logistics and urban transport of passengers, to design or integrate UAM environment, to test the drone ground and airborne platforms and finally, to assess safety, security, sustainability and public acceptance.
TINDAIR	VLD	**Tactical Instrumental Deconfliction And in flight Resolution** TINDAiR VLD is meant to demonstrate the safe integration of UAM as additional airspace user. The results of the VLD will help to refine the

		safety, performance, standardisation and regulatory requirements to enable UAM.
U-space4UAM	VLD	**U-space for UAM** The project's overall mission is to prepare the safe introduction of UAM, including flying taxis and drones operating, at low and very low levels in suburban and urban areas.
PJ34 AURA	IR	**ATM / U-space Interface** The global objective of AURA was to lay the foundations for the integration of new entrants in current and future air traffic environment, developing the required concept of operations and validating U-space services information exchanges with ATM systems. Secondly, it defined a novel Collaborative ATM-U-space Concept of Operations (ConOps) for drones in a fully collaborative environment with ATM.
USEPE	ER	**U-space Separation in Europe** USEPE researched separation methods in highly demanding environments such as cities. This research has been accompanied by a concept of operations that was implemented and simulated for its validation. USEPE also researched on the use of machine learning algorithms to automate the safe separation and deconfliction of drones and provide the U-space separation management system with artificial intelligence.
BUBBLES	ER	**Defining the BUilding Basic BLocks for a U-space SEparation Management Service** BUBBLES is a project targeting the formulation and validation of a concept of a U-space advanced (U3) 'separation management service'. It will develop algorithms to compute the collision risk of drones (taking into account all the involved risk sources), allowing to define separation minima and methods so that a safety level stated in terms of overall probability of collision can be defined and maintained.
DACUS	ER	**Demand and Capacity Optimisation in U-space** DACUS aims at the development of a service-oriented Demand and Capacity Balancing (DCB) process for drone traffic management. This overall objective responds to an operational and technical need in European drone operations for a tangible solution integrating the functionalities of the SESAR U-space services for Drone Traffic Management (DTM) to produce timely, efficient and safe decisions.
ICARUS	ER	**Integrating UAS Detection Technologies with the Aviation and Airport Security Systems** The ICARUS project proposes an innovative solution to the challenge of the Common Altitude Reference inside VLL airspaces with the definition of a new U-space service and its validation in a real operational environment.

FIGURE 90: SESAR 2020 WAVE2 U-SPACE PROJECTS
[25]

7.4.2 - SESAR 3 UAM and U-space research and demonstration projects

The table below provides an overview on the SESAR JU projects addressing UAM, U-space & ATM and Advanced services in SESAR 3:

Project	Type	Name and overview
AI4HyDrop	ER	**An AI-based Holistic Dynamic Framework for a safe Drone's Operations in restricted and urban areas** Drones are already used in an array of sectors, from agriculture, construction and surveillance to film-making, healthcare and emergency services. Given the scale and complexity of drone operations that are expected in the coming years, a holistic approach needs to be taken to managing the airspace. The project will develop a framework that incorporates various AI-based tools and associated information flows to enable future drone operations at scale. The proposed framework will represent a digital step change in ATM, using AI as a mean to move to more automated U-space services.
ImAFUSA	ER	**Impact and capacity Assessment Framework for U-space Societal Acceptance** Citizens' confidence and acceptance are critical to the further development of the drone services market in Europe, especially urban air mobility (UAM). The project will develop an impact and capacity assessment framework for U-space societal acceptance to assist local authorities, other U-space stakeholders and users with the implementation of socially acceptable and beneficial urban air mobility in cities. The framework and its tools will address matters which influence public opinion, such as the environment (e.g. noise, visual pollution and air quality), and safety and socio-economics (e.g. affordability, accessibility, economic development, public space use and connectivity).
MUSE	ER	**Measuring U-Space Social and Environmental Impact** The project will develop a set of key performance indicators, methods and tools for the comprehensive and rigorous assessment of the impact of urban air mobility (UAM) operations on the quality of life in European cities, with particular focus on drone-generated noise and visual pollution. The project will develop a new toolset capable of generating accurate drone 4D trajectories in urban areas, modelling UAM's noise and visual footprints, high-resolution dynamic population mapping and calculation of population exposure indicators segmented by type of day and time of the day, citizens' sociodemographic profile, type of activity being performed and other relevant variables.
EUREKA	IR	**European Key solutions for vertiports and UAM** Air taxis are an exciting development in air mobility, but to get off the ground, these vehicles rely on infrastructure like vertiports and accompanying air traffic management procedures. The project will develop the complete arrival, departure and turnaround process for vertiports. The proposed solutions will take into account collaborative traffic management, how to deal with emergencies and

		disruptions and network flow and capacity management. The project will provide recommendations for regulation/standardisation and any information that will accelerate and harmonise the development of UAM, VTOL operations and vertiports across Europe.
OperA	Fast track	**Operation Anywhere** Urban air mobility (UAM) has the potential to revolutionise last-mile transportation. To pave the way and accelerate market uptake, the project will validate complex UAM operations (piloted air taxi and unmanned cargo) in real-life air traffic control conditions, including contingency and non-nominal situations. It will specifically address air/ground integration and the critical transition from piloted towards automated flights, making use of several key autonomy-enabling technologies. In addition, it will ensure environmental sustainability compared to the next-best transport alternative, and enhance it, by optimising flight routing for minimum noise footprint and aircraft energy utilisation.
ENSURE	Fast track	**ATM-U-space Interface and Airspace Reconfiguration Service** Ensuring an interoperable and effective interface between unmanned and conventional traffic and air traffic control is critical for the delivery of the future Digital European Sky. This project aims to refine and complete the definition of a common interface and services for U-space and ATM. The project will develop a standardized data model, architecture and an operational methodology. The project will also develop a dynamic airspace configuration service to help ATC actors in charge of airspace reconfigurations to maintain traffic segregation and to avoid proximity between manned and unmanned aircraft within the designated U-space airspace.
SPATIO	Fast track	**U-Space Separation Management** Keeping aircraft safely separated is one of, if not the core function of air traffic management today. As larger numbers of unmanned aerial systems (UAS) take to the skies, separation management becomes more important to avoid mid-air collisions. The project will address separation between unmanned air vehicles, in particular, strategic and tactical conflict resolution services and the relationship between separation and capacity in U-space airspace.
SAFIR-Ready	Fast track	The project aims to develop new U-space advanced services together with a central command and control centre (C2C), as well as an automated ground integration (Drone Cargo Port - DCP) to facilitate automated time-critical drone-based services for medical and non-medical use cases. Specifically, research will focus on a dynamic capacity management system (U3), detect and avoid algorithms (U3) and machine to machine communication and decision making (U4). The project will extend use cases to non-medical critical missions, such as shore to ship for the transport of materials and the inspection of railway and electric grids in case of unforeseen issues with the infrastructure (e.g. tree fallen on high tension cable).

BURDI	Digital sky demonstrator	**Belgium-Netherlands U-space Reference Design Implementation** The BURDI project aims to: • implement a U-space airspace concept able to manage various, dense and complex UAS operations in controlled, uncontrolled and UAM environment • make this implementation a reference to develop best practices, standardisation, harmonisation and/or interoperability requirements fostering operational deployment of U-space airspaces in Europe • ensure that solutions to be deployed are economically sustainable and socially acceptable/supported for the benefit of the general public BURDI project is implemented around cities of Antwerp, Liège and Brussels where the proximity of international Airports, an active maritime Port and the proximity of the border with Netherlands are considered as a relevant factors of development for UAS operations in multiple domains like delivery of goods, inspections, support to medical as well as security operations
U-ELCOME	Digital sky demonstrator	**U-space European COMmon dEpLoyment** U-ELCOME is a 3-year project started in June 2022 that will be performing a serie of tests and demonstrations in various operational environments across 15 locations in Spain, Italy and France. Its goal is to further the scalable market uptake of U-space services. The demonstrations will address the interface with the ATM system to ensure safe and fair access to airspace for all airspace users, built around real-life use cases for both business and civil authority use, such as medicine and goods delivery, inspection flights and aerial missions in urban and sub-urban environments in both controlled and uncontrolled airspace. U-ELCOME uses a scalable U-space architecture enabling information exchange and coordination among U-space Service Providers (USSPs) and the Common Information Service Provider (CISP), as well as between USSPs, CISP and ATM using interoperable standards. This allows for automated drone traffic management and situational awareness among all U-space stakeholders. The objectives of U-ELCOME project are to develop, test, and demonstrate early U1 and U2 U-space solutions up to TRL8: • U-space U1 — foundation services: including e-registration, e-identification and geo-awareness. • U-space U2 — initial services: including tactical geo-fencing, emergency management, strategic deconfliction, weather information services, tracking, flight planning management, monitoring, traffic information, drone aeronautical information management and procedural interface with ATC.

ÉALÚ-AER	Digital sky demonstrator	**Enhanced Automation for U-Space/ATM integration** ÉALÚ-AERA aims to demonstrate U-space architecture operations and the integration with ATM, leveraging drone traffic management technology solutions. These solutions include an UAS platform, a backhaul network, communications and surveillance equipment, and advanced three-dimensional phased array radar. The project builds on previous research and seeks to enable higher automation for future U-space services, beyond those defined in IR (EU) 2021/664. The project will focus on five use cases of urban air mobility, many of them involving BVLOS operations, that capture the operational requirements, vehicle dynamics, and technology demonstrations associated with the projected near-term UAM services market, such as food and product deliveries, emergency response, agriculture uses, and even personal transportation like air taxi services. The partners involved aim to integrate the U-space system into the Future Mobility Campus Ireland's (FMCI) vertiport operations site and associated facilities.

FIGURE 91: CURRENT SESAR 3 U-SPACE AND UAM PROJECTS

7.5 - Appendix 5: Military Terminology

Acronym / Term	Definition	Source
Air Policing mission	Any aircraft flying inside or approaching airspace that are unidentified, either through loss or intentional omission of communication with Air Traffic Control creates an unsafe environment, which could lead to an air incident. Air Policing missions ensure the integrity, safety and security of the airspace.	[54]
Airspace Management Cell (AMC)	A joint civil-military cell responsible for the day-to-day management and temporary allocation of national or sub-regional airspace under the jurisdiction of one or more ECAC state(s).	[48]
Combat Search and Rescue (CSAR)	Search and rescue operations in or near a combat zone. Missions range from recovering military survivor(s) by a single unit penetrating hostile territory without any support to a CSAR task force where the operations may involve a variety of forces including Command and Control (C2), Close Air Support (CAS), Suppression of Enemy Air Defence (SEAD), Intelligence, Airborne Early Warning (AEW), Medical Evacuation (MEDEVAC) and Special Operational Forces (SOF).	
Command and Control (C2)	Plan, direct, task, coordinate, supervise and support air operations of allocated assets in peace, crisis and conflict. Air command and control systems and centers enable nations to seamlessly manage all types of air operations over their territory, and beyond, integrating air traffic control (ATC), surveillance, air mission control, airspace management and force management functions.	[53]
General Air Traffic (GAT)	All movements of civil aircraft, as well as all movements of State aircraft (including military, customs and police aircraft) when these movements are carried out in conformity with the procedures of the ICAO.	[6]
Interoperability (IOP)	A set of functional, technical and operational properties required of the systems and constituents of the EATMN and of the procedures for its operation, in order to enable its safe, seamless and efficient operation. Interoperability is achieved by making the systems and constituents compliant with the essential requirements.	[6]
MALE drone	Medium-Altitude Long Endurance military drone.	
MEDEVAC	Medical evacuation.	
Military control agency	Air control centers enable to manage all types of air operations inside a dedicated airspace, integrating air traffic control (ATC), surveillance, air mission control, airspace management functions (CRC, Deployable CRC, mil APP, AEW/AWACS.	[53]
Network Manager (NM)	The Network Manager manages ATM network functions (airspace design, flow management) as well as scarce resources, e.g. transponder code allocations, radio frequencies.	[47]
Operational Air Traffic (OAT)	All Flights which do not comply with the provisions stated for GAT and for which rules and procedures have been specified by appropriate national authorities.	[32]
Operational Centre	In the context of this study, 'operational centre' is a generic term meaning any centre in an organisation where operational control of	

	drones and manned aircraft, services, procedures and communication facilities are provided to external users (e.g. Control & Reporting Centre (CRC), Air Traffic Service Unit (ATSU) centre, U-space Service Provider (USSP) operations centre).	
Quick Reaction Alert Interceptor or Intercept (QRA(I))	Aircraft stands ready at dedicated air bases to launch upon the Air C2 Centers orders to investigate unclear or potentially unsafe situations and to visually identify unknown aircrafts.	
Recognised Air Picture (RAP)	Composite of sea, land and air surveillance picture. Surveillance: Detects, tracks and identifies to the greatest extent possible all aerial objects approaching or operating within European airspace.	
Search and Rescue (SAR)	Search and rescue (SAR) service is provided to the survivors of aircraft accidents as well as aircraft in distress (and their occupants) regardless of their nationality.	[55]
Weapon Controller	Military controller providing air mission control services according to STANAG 3993 / AAP 49.	
Western Standard procedures	Procedures based on NATO STANAGs, Allied Tactical Procedures (ATP), Tactics and Techniques and Procedures (TTPs).	

7.6 - Appendix 6: Joint Air Operations

Armed Forces (air, land and navy forces) are responsible to plan, direct, task, coordinate, supervise and support air operations of allocated assets in peace, crisis and conflict times.

Air Command and Control systems and centres enable nations and NATO nations to seamlessly manage all types of air operations over their territory, and beyond, integrating Air Traffic Control (ATC), surveillance, air mission control, airspace management and force management functions.

In European airspace, peace-time air operations could be depicted as following:

7.6.1 - Air Policing missions

The air forces are permanently tasked to execute Air Policing missions. This involves 24/7 presence of fighter aircraft and helicopters which are ready to react quickly to airspace violations, to protect populations, High Value Events or strategic, operational and tactical Centres of Gravity.

Air Policing requires the Air Surveillance and Control System (ASACS), the Air Command and Control (Air C2) structure and Quick Reaction Alert (Interceptor) (QRA(I)) aircraft and crews.

7.6.1.1 - Recognised Air Picture (RAP)

Air Forces have to detect, track and identify, to the greatest extent possible, **all aerial objects** approaching or operating within European airspace to set the Recognized Air Pictures (RAP), composed of sea, land and air surveillance picture, so that violations can be recognised, and appropriate action taken.

7.6.1.2 - Quick Reaction Alert Intercept (QRA)

QRA(I) aircraft are in standby mode ready at dedicated air bases to investigate unclear or potentially unsafe situations and to visually identify unknown aircraft. They are operated by the Air C2 Centres.

Interventions may be operated in both controlled and uncontrolled airspace with unpredicted trajectories. Armed forces' effectiveness and freedom of actions will have to be guaranteed.

7.6.2 - Public service missions

The Armed Forces regularly provide public service missions to help people in difficulty or in danger, such as natural disasters or medical evacuations. Forces support or contribute to:

- Search and Rescue (SAR);
- MEDical EVACuation (MEDEVAC);
- Fire fighting;
- Natural disasters relief;
- Police or customs operations;
- Maritime patrol operations.

These operations are carried out by different types of assets (helicopters, transport aircraft, UAS) in controlled or uncontrolled airspace, segregated or not, supported by Air Mission Controller (TAC C2) in C2 centres.

7.6.3 - Training missions

The delivery of air power is defined in broad, fundamental and enduring air missions to achieve strategic, operational and tactical level objectives: counter-air, attack, air mobility, and contribution to intelligence, surveillance and reconnaissance. These operations are not unique to the air component and other components do perform them or similar activities to varying degrees.

In peacetime, forces must train to execute all spectrum of operations:

7.6.3.1 - Counter Air

- Offensive Counter-Air;
- Defensive Counter-Air.

Air-to-Air operations carried out by fighters within segregated areas (TSA[21], TRA[22], R[23], D[24], P[25], Temporary R and P) or inside uncontrolled airspace (class G).

7.6.3.2 - Attack

- Strategic Attack;
- Counter-surface force operations;
  - Air power contribution to counter-land operations;
    - Air Interdiction.
    - Close Air Support.
  - Air power contribution to counter-maritime operations;
    - Antisurface Warfare.
    - Antisubmarine Warfare.

Air to surface operations carried out by fighter bombers or Omni role fighters, attack helicopters, RPAS[26] within segregated areas (TSA, TRA, R, D, P, Temporary R and P) or inside uncontrolled airspace (class G).

7.6.3.3 - Air mobility

- Air transport (Airlift);
  - Air land delivery;
  - Airdrop;
- Support operations carried out by transport aircraft or helicopters within segregated areas or inside uncontrolled airspace (class G);
  - Air-to-Air Refuelling.
- Support operations carried out by tanker or multirole transport tanker aircraft or within segregated areas or en-route.

7.6.3.4 - Contribution to Joint Intelligence, Surveillance and Reconnaissance

Air and space based ISR-assets (manned or unmanned) operate within segregated areas or en-route/on station under Air Traffic Control or not (due regard) or inside uncontrolled airspace (classes F/G).

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[21] *Temporary Segregated Area*

[22] *Temporary Restricted Area*

[23] *Restricted area*

[24] *Danger area*

[25] *Prohibited area*

[26] *Remotely Piloted Aircraft Systems*

7.6.3.5 - Support to Joint Personnel Recovery (JPR)

The JPR missions range from recovering a survivor by a single unit penetrating hostile territory without any support to a JPR task force where the operations may involve a variety of forces including for example C2, CAS[27], SEAD[28], Intelligence, AEW[29], MEDEVAC[30] and SOF[31].

A significant number of assets (helicopters, fighters, RPAS) could participate to the JPR operation. They operate within segregated areas or inside uncontrolled airspace (classes F/G).

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[27] *Close Air Support*

[28] *Suppression of Enemy Air Defense*

[29] *Airborne Early Warning*

[30] *Medical Evacuation*

[31] *Special Operation Forces*