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MILITARY AND U-SPACE: GUIDELINES

FINAL REPORT – INCLUDING D1/D2/D3 MATERIALS

23 September 2024

EUROPEAN DEFENCE AGENCY

Document information

GENERAL INFORMATION

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ABSTRACT

The Final Report of the 'Military and U-space: Guidelines' study contains the recommendations to military and civilian aviation stakeholders, as well as to U-space actors, regarding the development of U-space and its impact on military missions and objectives. These recommendations are supported by a qualitative assessment of this impact on typical military missions in peacetime and by a cost-benefit analysis, both of which are provided as appendices to the present Final Report.

The study answers two main questions: can the military ignore U-space, considering the challenges that U-space development poses, but also the opportunities that it opens to the military? And how could they mitigate the expected risks related to safety, security airspace complexity and management, and interoperability?

As U-space is an on-going development, the conclusions and recommendations presented in this Final Report are periodically reviewed and updated, to take account of progresses in regulation, operations and technology.

EXECUTIVE SUMMARY

The executive summary of this Final Report is the executive summary of the D3 deliverable of this 'Military and U-space: Guidelines' study, on page 9.

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MILITARY AND U-SPACE: GUIDELINES

D3 – GUIDELINES

19 September 2024

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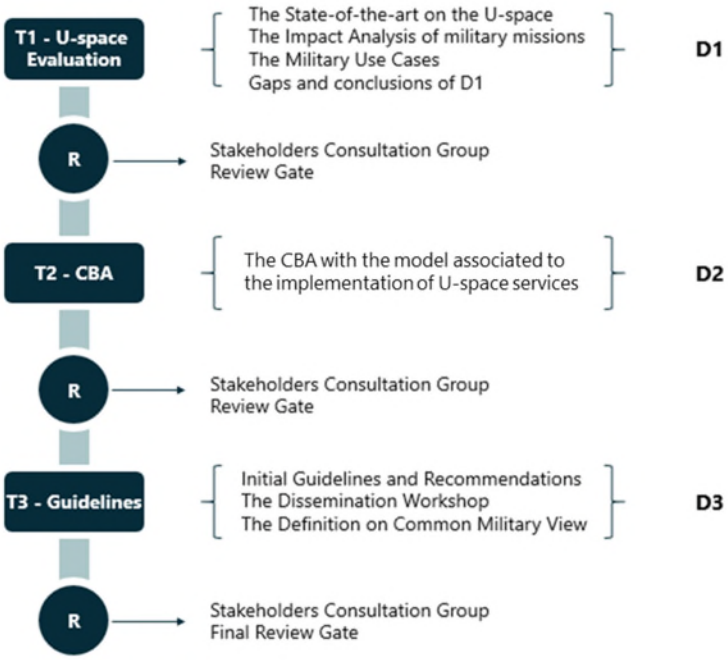
1 - EXECUTIVE SUMMARY

1.1 - Overview of the "Military and U-space: guidelines" study

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 the current stage of U-space implementation, including Military involvement. The Impact Analysis assesses the impact of typical 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 U-space, and the description of this impact and a formal description of how the services are operated through Use Cases. The final Use Cases can 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. Two implementation scenarios are 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, process reviews, staff related costs and others. 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 Position, representing the position of the EDA and its Member States, on the development of U-space. The initial guidelines and recommendations developed for Military Stakeholders are based on the results of T1 and T2. A Dissemination Workshop was organised on 09 November 2021 to communicate the initial conclusions of this D3 to EDA's Member States and to gather the Stakeholder's feedback for the final D3 version. The agreed Common Military Position on the impact of the U-space development on the military composes this D3 deliverable, which includes the outcome from the Dissemination Workshop.

1.2 - Developing guidelines for including military objectives into U-space

The Military and U-space guidelines are the cornerstone of the first European Common Military Position on the U-space development and its impact on the military. Even though in the recent years there have seen tremendous amount of work focused on U-space development and its operation, these activities target almost exclusively the civilian sector. Undoubtedly, as military share the same airspace with civilians, any military requirements should be taken into account from the earliest possible stage to ensure efficient and smooth coexistence between military and civil operators.

1.3 - Outcome of D1 and D2

The initial guidelines and recommendations with regard to U-space are based on outcomes from previous deliverables. D1 – U-space evaluation identified the set of U-space services that can affect Military missions and to which extended. D2 – CBA monetised the costs and potential benefits associated to each of these services. The initial guidelines including study conclusions and recommendations are developed before the Dissemination Workshop and shared with its attendees for the discussion. They are then being discussed and updated at a Dissemination Workshop in collaboration with both military and civilian stakeholders and experts. Once the recommendations and guidelines are finalised, the Common Military Position on the impact of the U-space development, which is the main conclusion of this deliverable, is developed. The guidelines consolidate a proposed Common Military Position, which represents the EDA and its Member States position on the U-space development.

1.3.1 - Outcome from D1

The D1 -U-space Evaluation deliverable (further refer to Appendix C: D1 – U-space evaluation) assesses the impact of U-space services on military missions and operations. This report is a living document and it is regularly updated with the new U-space developments and implementation.

The U-space evaluation analysed planned, under implementation or implemented U-space services and assessed their potential benefits and/or negative impact for military missions and operations. The evaluation of the U-space regulatory framework and other research activities summarises the current U-space direction. It is worth noting, that current initiatives are based on civilian perspective of U-space definition and operations even though the civil-military coordination and cooperation will be crucial in maintaining safe sky with efficient operations.

Further, the impact assessment defines how the future U-space services effect the military objectives and missions. The main outcome of this assessment is that the 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. In a U-space environment, it is considered that a number of military missions run in very low-level altitude could be made safer by the implementation of the geo-awareness and UAS flight authorisation U-space services, compared to a non-U-space airspace where drones would operate.

The Military Use-Cases cover typical military activities and detail how the mandatory and most beneficial U-space services will affect military missions and operations. Identified gaps as limited information how the military will interface with the U-space and mitigation issues are compiled at the end of the study.

1.3.2 - Outcome from D2

In order to gain an initial understanding of the costs implied for the military, this CBA (in Appendix D: D2 – Cost-Benefit Analysis) distinguishes between investment in ATM systems and data exchanges, aircraft equipment, process reviews, staff related costs and studies. While the precise implementation requirements for U-space are yet to be defined and the investment needs per member states require further study, this CBA establishes a framework for costing the deployment and proposes a number of assumptions that enable the calculation of monetary values.

The outcome of the CBA is negative, yielding a net present value ranging from € -400k to € -850k in standard euros for implementation scenario 1 (minimal military collaboration), from € -2.52 million to € -5.84 million in

standard euros for U-space implementation scenario 2 (full military collaboration), and from € -4.10 million to € -50.69 million for U-space implementation scenario 3 (full military collaboration, with conspicuity). For the purpose of this CBA, it was assumed that the implementation of U-space will be concluded by 2028, leading to an annual capital expenditure under scenarios 2 and 3 of € 2.52 million to € 40.24 million between 2024 and 2028, depending on the scenario and Member State's size. The resulting costs for individual Member States can vary significantly and are not shown in detail in this analysis.

Report D2 also provides a high-level overview of funding mechanisms at the European level, aimed at the development of technological and defence capabilities, civil-military collaboration, and the implementation of ATM capabilities.

1.4 - Proposed common military position on U-space development

Using the results from D1 and D2 reports, an initial set of recommendations and a proposal for a Common Military Position (CMP) on U-space development have been developed by considering the impact on their missions and objectives in case the military would ignore the on-going development of U-space.

These recommendations suggest a number of operational, regulatory, organisational and technical solutions that could help the military to mitigate this impact. However, as U-space is still a work in progress, the present study is not yet able to identify, nor recommend a solution over another.

These initial recommendations and the proposed CMP were presented to a wide range of military and civilian stakeholders in a dissemination workshop that took place on 9 November 2021. This workshop allowed collecting feedback and comments from the participating entities and led to a number of additional recommendations and considerations in the CMP. These updated elements are provided in the conclusions of the present D3.

2 - INTRODUCTION

The European Defence Agency (EDA) has initiated the "Military and U-space: guidelines" study in January 2021 to assess military impacts and cost benefits of large-scale drone operations. Understanding normal/nominal operations in a U-space "eco-system" is a prerequisite for the military to collaborate in U-space concept development.

The present report presents the conclusions and recommendations of this study, which build on the work done in previous deliverables (D1 – U-space evaluation and D2 – Cost-Benefit analysis, both updated in September 2024 and annexed to this report) and from the outcome of a dissemination workshop held on 09/10/2021. Notably, this study proposes a Common Military Position on the development of U-space that represent the position of EDA Member States. It has been developed with a view of promoting it to other aviation stakeholders but also to the military and of auctioning on the recommendations of the study.

2.1 - U-space development

U-space is essentially a civilian development that will provide an "ecosystem" facilitating a Safe and Secure integration of drones in the airspace. The regulatory framework supporting the implementation of U-space is coming closer to completion and introduces significant changes to the way air traffic is currently managed by defining new types of airspace and new actors in charge of delivering services to airspace users in these areas.

It is recognised that U-space is a new structure, which will impact both GAT and OAT flights, e.g. in terms of aeronautical information and services. Because drone operators are sharing the same airspace with other airspace users, especially with the military and particularly at very low levels, it is thus important that military authorities participate to governance structures that rule operations within the airspace.

At a technical level, the military are operating modern systems to support their operations. Keeping the highest possible level of interoperability with ATM, and potentially with UTM, systems should be a priority of U-space implementation. However, long-term military investment cycles and priorities may not be compatible with UTM technical requirements. EDA recognises that the military rather had an observer role in the R&D phase of U-space and this induces a risk of U-space not fully addressing military requirements or retaining solutions that are not compatible with the military objectives or operations.

The "Military and U-space: guidelines" study is thus a key step in better understanding the impact of U-space on the military, on identifying the means to minimise this impact and in developing a shared military position on the on-going and future development of U-space.

2.1.1 - U-space at a glance

U-space is a set of new services relying on a high level of digitalisation and automation of functions and specific procedures designed to support safe, efficient and secure access to airspace for large numbers of drones. As such, U-space is an enabling framework designed to facilitate any kind of routine mission, in all classes of airspace and all types of environment - even the most congested - while addressing an appropriate interface with manned aviation and air traffic control.

U-space facilitates any kind of operations[1] for both, private and public drone users[2] *"in all operating environments[3], and in all types of airspace (in particular but not limited to very low level airspace[4])"* ([3]) by *"enabling framework to support routine drone operations, as well as a clear and effective interface to manned aviation, ATM/ANS service providers and authorities."* ([3]).

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[1] Including visual line of sight (VLOS) and beyond visual line of sight (BVLOS) operations

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

[3] Urban, suburban, rural, regardless the density of population

[4] Very low level airspace refers to the airspace below 500ft

The definition of U-space has been initiated by SESAR which proposed a definition of the new services brought by U-space as well as a concept of operations applicable to European airspace. Based on this work and through cooperation with aviation stakeholders, EASA has defined the regulatory framework that now allows considering the implementation of U-space.

2.1.2 - Current state of U-space development

U-space implementation is only starting and some key elements of the supporting regulation are still under development (e.g. certification requirements for service providers in U-space). However, a significant milestone has been achieved in April 2021 with the adoption of IR (EU) 2021/664 and entry into force in January 2023 shortly after the publication of the associated AMC/GM, which define the rules and procedures for the safe operations of UAS in the U-space airspace, for the safe integration of UAS into the aviation system and for the provision of U-space services.

The centrepiece of this regulation is the concept of U-space airspace where drones can only operate if they use mandatory U-space services ensuring to support safe, secure and efficient access to this airspace for a large number of drones and delivered by a U-space Service Provider (USSP). In this airspace, drones should be segregated from manned aircraft, which have themselves to be made conspicuous to allow for safe separation. Several Member States (e.g. Spain, Belgium, Sweden) are actively implementing U-space, starting with the designation of the national civilian Air Navigation Service Provider (ANSP) as single Common Information Service Provider (CISP), in charge of collecting and distributing the elementary data required by USSPs to build the U-space services they need to provide to drone operators. In some instances, the ANSP is also designated as a USSP itself, either with a full commercial capability or with a restriction of their U-space services to State-operated drones.

2.1.3 - The need for guidelines to the military

The European Commission has published its European Drone Strategy 2.0 on 29/11/2022, which sets out the vision of the Commission for a mature and thriving drone eco-system in 2030. 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 identified to further build the drone service market and strengthen the drone civil, security and defence industry capabilities and synergies, a number of them stand out as particularly relevant for the military, whether in terms of operations, financing or development of capabilities.

Considering also the risk that military objectives are not properly addressed in the development of U-space and the on-going implementation of the first U-space airspaces, military authorities need to be in the loop of any modification to their operating environment. EDA has thus launched the present study to assess the impact of U-space on military missions and objectives and to develop a Common Military Position on the development of U-space that can be promoted to civilian aviation stakeholders but also to the military.

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.

2.2 - On this study

The military and U-space guidelines study aims to establish and promote the Common Military Position on the U-space development and its impact on military. Hence it opens crucial discussion on civil-military collaboration on U-space. This four years framework contract is composed of the following Specific Contracts (SC):

- SC1 represents the first phase of the study that is followed by the three main deliverables

- U-space evaluation including the military U-space Use Cases;
- Financial costs calculation for the military from the U-space implementation; and
- Military guidelines and recommendations for further U-space involvement and engagement with the civilian stakeholders.

The main aim of the SC1 is to propose a military position on on-going and further U-space developments, including operational and costs impacts and to consult them with the involved parties.

- SC2 aims to monitor U-space activities in the coming three years. It will be used to inform EDA and the SCG about the progress of the U-space development and its effect on the Common Military Position.
- SC3 investigates in detail the applicability of two U-space mechanisms to military operations, the electronic conspicuity of manned aircraft and the dynamic reconfiguration of U-space airspace, and develop proposals for the military to adapt to, and potentially benefit from these mechanisms, in particular for uncontrolled traffic.
- SC4 investigates possible roles for the military in the future U-space environment, where they would actively contribute to the day-to-day planning and management of manned aircraft and drone operations in U-space airspaces. This would be achieved by receiving, and possibly providing, information from U-space actors (e.g., CISP, USSPs, etc.).

The **STAKEHOLDERS CONSULTATION GROUP (SCG)** brings together the experts from different touched groups including e.g. EASA, EUROCONTROL, SJU, NATO, to impress their vision on the U-space airspace taking into account required military involvement.

The **DISSEMINATION WORKSHOP** conducted in November 2021 played a key role in communicating the initial conclusions of D3 and in gathering feedback from stakeholders to produce the final version of D3. It engaged all involved stakeholders in the work. The Dissemination Workshop also acted as a forum to collect and discuss the stakeholders' views which is one of the key points.

2.3 - Document structure

This report is composed of the 7 main sections:

SECTION 1 – EXECUTIVE SUMMARY that brings condense and clear outline of the D3 Military and U-space Guidelines deliverable.

SECTION 2 – INTRODUCTION is intended to provide a detailed presentation of the report, its objectives and the undertaken approach.

SECTION 3 – CAN THE MILITARY IGNORE U-SPACE? Based on outcomes of our previous deliverables, this section demonstrates if and how should military prepare and possibly be involved in the U-space definition and operations.

SECTION 4 – HOW COULD THE MILITARY MITIGATE THE IMPACTS OF U-SPACE? is an initial draft of the constraints and actions to be undertaken by the military to minimise the U-space impact on their operations.

SECTION 5 – PROPOSED RECOMMENDATIONS chapter contains recommendations resulting from the actions proposed in the previous chapter. The recommendations lead to the proposition of a common military position regarding the development of U-space.

SECTION 6 – POSSIBLE NEXT STEPS FOR THE PRESENT STUDY describes the plan of this study over the following next 3 years.

SECTIONS 7 TO 10 – ANNEXES section includes the final D1 U-space evaluation and D2 Cost-Benefit Analysis deliverables that are the cornerstones of the D3 deliverable.

3 - CAN THE MILITARY IGNORE U-SPACE?

This chapter 3 contains a high-level description of the challenges that the development of U-space poses to the military, but also highlights some opportunities that are currently open to them. It is understood that U-space will affect military missions and operations by enabling new entrants to develop their operations, and possibly to a much wider extent than current airspace users. Therefore, this chapter aims at providing elements on the extent of this impact and whether the military need to adapt for this future environment.

3.1 - A brand new future aviation environment

A significant change to aviation environment is currently being shaped by the adoption of the European U-space regulation, as well as the work carried out by SESAR on possible concepts of operations for drones and cooperation between civilian ATM and UTM.

This new environment presents a number of risks to the military and the associated mitigation means are currently under definition. A difficulty in this process is a lack of identified USSP/CISP and of actual U-space operations, which means military lack counterparts to discuss their specific issues. This can however be considered as an opportunity for the military to promote their views among the working groups and fora in charge of developing and implementing U-space.

3.1.1 - Stakeholders and their roles

Even if the main actors of the ATM remain present in U-space due to the interaction with manned aviation, new actors are recognised. The key new actors are presented here and a more detailed description is available in Appendix C.2.1.

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.
U-space Service Provider (USSP)	Any legal person certified as U-space service providers providing or intending to provide U-space services.
Common Information Service Provider (CISP)	The CISP[5] provides the common information services in respect of all or some of the U-space airspaces under their responsibility. This provider ensures that all the necessary information for the functioning of U-space can be granted to relevant authorities, air traffic service providers, U-space service providers and UAS operators on a non-discriminatory basis, including the same data quality, latency and protection levels.

TABLE 1: NEW U-SPACE ACTORS AND THEIR ROLE

Current ATM actors are also impacted by the development of U-space and will see their roles and responsibilities expanded to address this new environment.

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[5] Alternatively, IR 2021/664 foresees that common information services can be provided as a distributed system, without a centralised CISP (cf. §4.3.2.3 of Appendix C: D1 – U-space evaluation). However, this is not the approach adopted by those MS that are actively implementing U-space at the time of writing.

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 U-space regulation are mandatory, etc.)
Civil Aviation Authority (CAA)	Is in charge of, in particular: ■ Transposing U-space and drone regulations into national or local law and supervising its application; ■ Providing a certificate to USSP and CISP and the related oversight process; ■ Establishing, maintaining and making publicly available a registration system for certified U-space service providers.
(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.
ANSP Air Navigation Service Provider (civil, military)	In controlled airspace: the 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 for the provision of ANS as for the other IFR flights. If the certified drone does 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: the ATS provider remains responsible for the provision of Flight Information Service to the operators of manned aircraft.

TABLE 2: CURRENT ATM ACTORS IMPACTED BY U-SPACE

3.1.2 - Airspace structure

The U-space regulation promulgated by the European Commission creates a new type of airspace, U-space airspace, that is an UAS geographical zone designated by Member States, where UAS operations[6] are only allowed to take place with the support of U-space services. U-space airspace can be defined in either controlled or uncontrolled airspace. The key principle to ensure the safety of flights within U-space airspace is the segregation of manned and unmanned flights.

Depending on the case, segregation can be ensured in two ways:

- Within **controlled U-space airspace**, 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.
- Within **uncontrolled U-space airspace**, USSPs use a combination of the UAS flight authorisation, geo-awareness services and traffic information to allow safe operations of drones. Manned aircraft are expected to be electronically conspicuous to USSPs.

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[6] *UAS operations considered in IR 2021/664 are related to the "specific" category and, if they present a certain level of risk, to the "open" category. Drones operations under the "certified" category are considered as IFR and thus subject to the provisions applicable to this type of operations.*

3.1.3 - Risks for the military

Although the U-space services defined in IR (EU) 2021/664 provide a certain level of protection, the military can operate within the whole airspace and the future airspace structure thus creates an underlying risk for military aircraft flying in uncontrolled U-space airspace if the segregation mechanism does not cover all cases.

European regulation 2021/664 expects manned aircraft to be electronically conspicuous in U-space airspace, effectively signalling their presence by means of surveillance technologies. However, the military are excluded from this regulation and their missions may require them to **not** be conspicuous or otherwise detected by other airspace users or civilian controlling units.

Therefore, segregation via U-space services is insufficient to ensure the safety of military flights operating in uncontrolled U-space airspace and needs to be complemented by other mechanisms, e.g. coordination between military controlling units and USSPs, detection and avoidance of drones by military aircraft or detection and avoidance of military aircraft by drones.

3.1.4 - Opportunities

The development of U-space services presents an opportunity for the military, who may use these services to improve the efficiency of their missions.

As illustrated by D1 in Appendix C, if the military receive the civilian drone identifications and positions 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.

Similarly, the military could improve the safety of their drones participating in Public Service Missions in U-space airspace by providing the identification and the position of military drones to USSPs through the network identification service (if the mission allows it).

Lastly, as demonstrated in SC3, the military could improve the safety of their operations in uncontrolled U-space airspace with cost-effective solutions to manage the airspace in cooperation with USSPs and applying operational processes inspired by Flexible Use of Airspace (FUA).

3.2 - What we don't know yet

3.2.1 - Regulation and implementation at State level

In parallel with the preparation and adoption of U-space regulation, States have started preparations at their level for the implementation of U-space airspace. Although the AMC/GM for regulation IR (EU) 2021/664 have been published last 2022 and the IR (EU) 2021/664 became applicable on 26 January 2023, their effort is still limited by the following significant gap:

- The key U-space actors, USSPs and CISPs, do not exist yet and limited coordination can take place with them during this preparation phase;

Therefore, practical implementation of U-space airspaces and services is currently limited and further work is needed before the military can expect to know clearly how they will be able to interact with other stakeholders in the future U-space environment.

3.2.2 - Are ANSPs ready?

Although several European ANSPs have already implemented UTM solutions, they provide only limited services compared to U-space and will need significant evolutions to meet the requirements of the U-space regulation. In addition, the future coordination between ATM and UTM is also under definition, notably with SESAR investigating whether this coordination can be supported by SWIM services.

As ANSPs, the military will likely require to be able to interact with USSPs. 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

ANSPs will also have to adapt their processes for the publication of aeronautical information, to take into account the UAS geographical zone and U-space airspaces as they are defined. Because the military are associated to this process, they will be impacted by the implementation of U-space and, more largely, the development of drone operations.

3.2.3 - Technology changes

Many questions regarding the technology enabling U-space remain open at the moment, some of which having potentially a significant impact on the way that military will be able to adapt to U-space. Without clarification to these questions, the military will not be able to define appropriate solutions to operational challenges. The challenge of retaining sovereignty over U-space technology is also a key question to consider.

- DAA capabilities of drones: will drones operating in U-space have the ability to detect (either by themselves or with the support of external services) and avoid military aircraft? Will this capability have equivalent safety performance for all types of military aircraft, from helicopters to fighters?
- Communication means available to USSPs: how will USSPs be able to communicate with other stakeholders? Will their communications means have a sufficient level of security to envisage interfacing with military systems?
- Level of automation in USSPs: what will be the role of humans in the provision of U-space service? Will military controllers or pilots have access to a counterpart in USSPs to solve operational issues or coordinate operations?

3.2.4 - Costs for Airspace Users, including the military

As of today, it remains very difficult to estimate the costs of adapting to U-space, as illustrated in D2 (cf. Appendix D), due to the uncertainties mentioned in previous sections, but also to the unknown timeline for U-space implementation in the different States, the number of U-space airspaces that will be defined, the density of drone flights in these airspaces, etc.

Without more detailed information on these open points, it is currently not possible to develop an accurate view of the costs that the military in a given Member State would incur to adapt to or cooperate with U-space. It is similarly not possible to estimate the benefits that the military could achieve by using U-space services and thus how they could balance their investments.

4 - HOW COULD THE MILITARY MITIGATE THE IMPACTS OF U-SPACE?

This chapter aims at summarising the main challenges the military could face with U-space and potential mitigations they could implement to minimise the risks related to:

- Complexity of the airspace structure preventing State aircraft to get access to the airspace,
- Safety issues due to the increasing number of airspace users flying in the same portion of airspace,
- Interoperability as civil and military systems are more and more digitalised and interconnected,
- Security aspects such as cyber robustness and air policing missions, which shall continue H24.

4.1 - Operations and training

4.1.1 - State aircraft operations, and national security and defence

The right to access all airspace, within the limits of the operational needs, is a crucial requirement to enable the military, customs and police[7] to perform the security, defence and law enforcement operations mandated by their States and by international agreements. It is a fundamental requirement for States to be able to train and operate State aircraft when they want and where it is needed while having due regard for the safety of navigation of civil aviation[8].

In pursuit of their tasks, operators of State aircraft should, where practicable, respect international, regional and State civil aviation legislation and aim for compliance. However, it is recognised that the nature of the defence and security tasks can create unique situations that need special handling and considerations.

4.1.1.1 - State aircraft main constraints

Operational constraints. External and internal threats set operational imperatives that State aircraft operations should be prepared for and able to conduct efficiently. These demands give rise to unique situations that need special handling and consideration, linking operational constraints to the Air Traffic Management (ATM) domain. For example, activities such as Search And Rescue (SAR), air policing/patrol, aerial firefighting and special air operations demand utmost priority for the safety of the public for which they serve. Noting that ATM delays or denied access to relevant pieces of airspace should be minimised for military aircraft during these types of missions.

Technical Constraints. Equipage of State aircraft is predominantly focused on the output and nature of the task that the aircraft is expected to perform. Therefore, it is not always possible to fit, because of limited space in the airframe or conflict with mission-essential systems, ATM, Communication, Navigation, Surveillance (CNS) or UTM equipment on board.

Financial constraints. Aging fleets and constraints on defence budget spending, can hinder the implementation of new equipment on State aircraft to satisfy global developments in new ATM programmes.

4.1.1.2 - Planning process

In operations, the planning of military flights may be known late, at least with respect to the level of airspace requirements (timing, size and level). Major exercises are planned months in advance even if airspace requirements are known approximately between 2 months and only a few hours (or days) beforehand. On the contrary, the routine training flights following the day-to-day FUA process (EU Reg No 2150/2004) usually get finalised between five and one day before the day of the training.

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[7] This report focuses on military aircraft and other State aircraft will not be considered further. However, most issues discussed here are relevant for customs and police aircraft.

[8] ICAO Convention Article 3-d)

For training flights and exercises, the final execution is mainly based on the aircraft and pilot availability and weather situation. A re-scheduling may be required, when possible.

4.1.1.3 - Circumstances when State aircraft could be fully compliant or partially compliant with international civil aviation rules and procedures.

State aircraft operators usually operate three main types of missions: real operations, training/exercises, test or routine flights. The real operation is a "live" mission where the State aircraft are engaged in an operation against an assessed real threat (suspected unlawful interference, sinking ship/aircraft, intruder, pollution…). In this case the State authority (military, relevant ministries, coast guard…) expects the assets to deploy all their capabilities and skills to achieve a specific objective, using certain specific procedures. During an operation, aircraft request priority to perform their mission, even if it has an impact on civilian air traffic capacity and efficiency.

Based on the use cases explained in D1, the paragraphs below present some non-exhaustive examples where State aircraft may be compliant with U-space requirements.

- **Counter air missions** including quick reaction alert, air policing/patrol and interceptions of suspect hijacked aircraft could offer partial compliance. Furthermore, the aircraft could require short-notice penetration of airspace, heavily congested by civil air traffic, and expeditious handling.
- **Aeromedical Evacuation.** Aircraft providing aeromedical evacuation would usually be fully compliant. Nevertheless, in real-time operation, certain medical situations may require slower rates of climb and/or descent than might otherwise be expected from the type of aircraft.
- **Search and Rescue.** Whether operated by civil or military, SAR flights have to be given high priority and handled as expeditiously as possible. Although SAR activities are normally performed at lower altitudes, aircraft are sometimes used at medium altitudes as airborne relay units or on-scene SAR mission coordinator. SAR flights could therefore offer partial compliance, as long as the contribution to the actual SAR mission remains uncompromised.
- **Large-scale exercises** require large-scale exercise scenarios and large volumes of airspace and, if carried out within controlled airspace, extra capacity for the ACCs concerned. Such exercises therefore require appropriate planning and coordination, to enable timely reservation and promulgation of suitable airspace reservation for the activity. Large scale exercises often require segregation of large segments of airspace and for this reason all efforts should be made to closely monitor airspace usage in order to release segregated airspace to public use as quickly as feasible.

4.1.2 - Due regard as a solution?

"Due regard" is a phase of flight wherein an aircraft commander of a State-operated aircraft assumes responsibility to separate his/her aircraft from all other aircraft.

Flight operations in accordance with the options of "due regard" require the authorised State aircraft commander to:

- Separate his/her aircraft from all other air traffic; **and**
- Assure that an appropriate monitoring agency assumes responsibility for search and rescue actions; **and**
- Operate under at least one of the following conditions :
  - In visual meteorological conditions (VMC); **or**
  - Within radar surveillance and radio communications of a surface radar facility; **or**
  - Be equipped with airborne radar that is sufficient to provide separation between his/her aircraft and any other aircraft he/she may be controlling and other aircraft; **or**
  - Operate within uncontrolled airspace.
- A common understanding between the pilot and controller regarding the intent of the pilot and the status of the flight should be achieved before the aircraft leaves ATC frequency.

The above conditions provide for a level of safety equivalent to that normally given by International Civil Aviation Organization (ICAO) ATC agencies and fulfils Member States obligations under Article 3 of the Chicago

Convention of 1944 (Reference (d)), which stipulates that there must be "due regard for the safety of navigation of civil aircraft" when flight is not being conducted under ICAO flight procedures.

In a UAS context, inside U-space airspace within uncontrolled airspace, surveillance capability and efficient coordination are fundamental. Therefore, the conditions to operate with "Due Regard" seem difficult to meet due to the lack of:

- Drones and other airspace users being equipped with technologies such as ADS-B (used as a UAS surveillance system) or Drone Tracking Transponders, Detect And Avoid systems or ;
- Military primary surveillance capability to safely integrate State aircraft in a non-segregated environment.

4.1.3 - Civil/military cooperation and collaboration

Interactions between unmanned civilian activities and manned military activities in very low-level airspace, require[9] civilian and military **to develop coordination** at all levels to ensure the compatibility (segregation-based) of their activities. Such a collaboration has been re-affirmed at the 13th ICAO Air Navigation Conference[10] and at the 40th ICAO General Assembly.

The underlying principles of existing civil-military cooperation and collaboration provide a blueprint for the future U-space environment. These principles should be extended to shape the future relationship between the military and U-space actors (i.e. USSPs and CISPs).

4.1.3.1 - Managing the airspace

As airspace is a scarce resource, there is a need to take a balanced approach and improve airspace management in the most harmonized way possible. This requires communication, cooperation, coordination and trust, as recognised by the AMC/GM for the U-space regulation:

GM1 Article 1(1) Subject matter and scope

"(a) Although military and State aircraft operations are in principle excluded from the scope of Regulation (EU) 2018/11392 and its implementing and delegated acts, the safety of such operations is paramount when conducted in airspace that is subject to EU aviation safety regulations. In this context, the safe separation between military and State aircraft also in the U-space airspace is always expected during all stages of flight.

(b) It is recalled that when defining UAS geographical zones in accordance with Article 15 of Regulation (EU) 2019/9473, Member States should also consider other aspects than safety, such as security aspects. Indeed, a Member State could designate a U-space airspace in critical areas for security and/or defence reasons, including military and State aircraft operations.

(c) In this context, military and State aircraft authorities are partners in the decision-making process of the coordination mechanism (as per Article 18(f) of Regulation (EU) 2021/6644) for the designation of U-space to cover the safety and security aspects in a U-space airspace, from the initial 'airspace risk assessment' until the U-space is implemented and monitored.

(d) The involvement of military authorities in relation to U-space is considered key to guaranteeing the level of safety and security in the U-space airspace from both a ground and an air risk perspective."

The establishment of joint civil/military coordination entities for U-space organisation and management is essential to the realization of current and future CNS/ATM initiatives. Meeting future unmanned and air traffic requirements for increased safety, security, capacity, efficiency, environmental sustainability, and sovereignty

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[9] *In accordance with Article 3 and Annex 11 of the Chicago Convention and European Regulations, ICAO document 4444 and ICAO document 10088 (Manual on Civil-Military cooperation in Air Traffic Management, 1st edition 2020)*

[10] *AN-Conf/13-WP/311 Report*

depends on effective civil/military coordination. In order to extend FUA to lower airspace and to establish effective coordination of civil and military activities), basic prerequisites should be considered by States:

- The establishment of a specific national, high-level civil (UTM)/military coordination body.
- The extension of the current processes and procedures at civil-military Airspace Management Cell (AMC) level to U-space.
- The establishment of communication, negotiation and priority rules and procedures for civil (UTM)/military coordination.
- The establishment and publication of procedures for activities which require airspace reservation or restriction. Airspace reservations or restrictions should be applied only for limited periods of time and based on actual use.
- The development of framework agreements between civil (UTM) and military authorities to facilitate coordination.
- The definition of a low level airspace management concept based on the FUA principle that airspace should not be designated as purely unmanned, civil or military, but rather as a continuum in which all user requirements are accommodated to the greatest possible extent.

4.1.3.2 - Interoperability

U-space provides a framework and core capabilities of a "typical" UTM system to the European Member States that are considering the implementation of a UTM system. Any such UTM system should be able to **interact** with the civilian/military air traffic management (ATM) ([1]). **In the short term**, this could increase the Air Defence systems to **integrate new data**, which is of nature to improve the Recognised Air Picture.

The introduction and management of unmanned traffic as well as the development of associated U-space infrastructure should not negatively affect the safety or efficiency of the existing civil-military ATM and Air Defence systems.

For the purposes of this report, in the immediate/near term U-space is considered as a separate system with an interface to ATM, while in the long-term integration and potential convergence with ATM / Air Defence could be a solution. However, to achieve complete integration, significant standardisation issues will have to be addressed.

In terms of interoperability among civil and military systems related to U-space, it is suggested to consider three levels:

- Level 1: Low interoperability

  A Military Operations Cell has a direct link to a USSP/CISP. Such communications exist today with civilian ATS units and could be extended to USSPs/CISPs.
- Level 2: Medium interoperability

  More substantive data sharing may also be used, such as ANSP/Military radar data or to support tactical airspace management between a civilian or military controller position with the relevant USSP/CISP.
- Level 3: High interoperability

  This could be achieved through the combined implementation of several mechanisms, such as
  - Dynamic airspace reconfiguration between :
    - civilian/military **control service position** and relevant USSP/CISP inside controlled airspace.
    - civilian/military **information service position** and relevant USSP/CISP inside uncontrolled airspace.
  - Tracking data (Cooperative UAS picture) shared by USSP, (Safety and RAP benefits)
  - Sharing ANSP/Military radar data.

4.2 - Regulations and Standardisation

The European Member States through their civil-military aviation authorities and service providers should use and/ or reinforce their respective civil/military bodies that coordinate and collaborate to identify the regulation and standardisation need together based on the operational and technical interoperability requirements of all stakeholders.

In example, as they are doing for the current airspace, both the civil and military authorities should agree on a common policy for civil/military UTM-ATM coordination and cooperation, including airspace design development, airspace access requirements, long and medium term planning, standardisation of procedures, regulation and deployment of new procedures, which should define the Collaborative (or Informative to U-space) Decision Making responsibilities of the following functions:

- Regulator
- ANSPs
- CISPs, USSPs
- Airspace managers
- Airspace users

Today, numerous principles in the current ATM system are applicable to UTM services, such as:

- Oversight of the service provision, either UTM or ATM, is the responsibility of the regulator.
- Existing policies for aircraft prioritisation, such as aircraft emergencies and support to public safety operations, should be applicable, and practices unique to UTM should be compatible with such policies.
- Access to the airspace should remain equitable provided that each aircraft is capable of complying with the appropriate conditions, regulations, equipage/performance requirements and processes defined for the specific airspace in which UTM operations are proposed.
- To meet their security and safety oversight obligations, States should have unrestricted, on-demand access to UAS operators, remote pilots and the position, velocity, planned trajectory and performance capabilities of each UA being managed by the UTM system.

Some challenges must be addressed to enable safe UAS operations within the UTM and ATM systems.

- Positional references. Common altitude, navigation and temporal references for manned and unmanned operations are needed. Gaps in the use of reference points and equipment providing different levels of accuracy and performance in the measurement of altitude, navigation or time introduce safety concerns which must be resolved. Determining the extent to which traditional aviation standards can be used remains a work in progress. Traditional standards which address the provision of such references should be utilised whenever possible.
- Interface between UTM and ATM. There is a need to develop procedures and adequate tools to ensure the sharing of information, the interoperability of the two systems, and to identify roles, responsibilities and limitations.
- Responsibilities and procedural development, must be addressed to ensure compatibility between manned and unmanned operations.
- Further research is required to support the development of the interoperable standards and protocols for the elements of UTM and ATM data exchange.

4.3 - Organisation/structure

The military airspace management structure implemented for the FUA process could be extended to include additional U-space prerogatives and different civilian stakeholders (CISP, USSPs). This would result in a FUA process for low-level airspace that would be carried out at national or regional level.

U-space/military cooperation would allow to define static and dynamic U-space airspace restrictions to enable air operations in a safe and efficient manner. The low level airspace management could use the same three coordination levels as FUA and should be considered at all levels of the administrations for all phases:

- Strategic level (airspace design, coordination and airspace management procedures, operational rules in order to define responsibilities);
- Pre-tactical level (day-to-day (rhythm has to be defined) management and temporary allocation of airspace through national or sub-regional Airspace Management Cell);
- Tactical level (real time activation, deactivation or real-time reallocation of the airspace).

The main difficulty related to the application of Airspace Management outside controlled airspace is the way of informing in real time the users and/or the USSPs about the current airspace status. It remains a State decision to implement the most effective method of promulgation and notification based on its particular requirements. However U-space airspace inside "Manned Uncontrolled airspace" becomes an "Unmanned Controlled airspace" with the services provided by USSPs to drone operators.

At this stage of European regulation definition, considering that the Dynamic Airspace Reconfiguration applies to operations in U-space airspace established within controlled airspace **only**, and Military organisations do not have to comply with the U-space regulation with regard to e-conspicuity, a specific coordination process between military and USSP inside U-space uncontrolled airspace has to be developed.

4.4 - Systems interoperability

Interoperability among civil and military systems is a must, notably because a dynamic and efficient exchange of data is participating to reach the best level of security. The European Regulations, which apply to the civilian systems are indirectly impacting the military interfaces. For security and State reasons, the military authorities must reserve the right to control the sharing of information on military flights with civil entities.

The evolution of the UTM architecture should meet the demands of the UAS community while ensuring a high level of safety for all airspace users (manned and unmanned) and third parties on the ground by enabling the timely introduction of the appropriate traffic density management capability to accommodate planned operations. Such an architecture would likely be predicated on the interaction and integration of these operations through information exchanges, avoiding direct communication with civil-military ATS units, except when specifically required.

Operational and technical interoperability (procedural and system approaches) should be combined whenever possible. Where technical interoperability, relying on the ability to exchange information between equipment or systems, cannot be achieved, the application of operational interoperability based on the use of common procedures can be a potential mitigation option to ensure the required safety level and allow for an accommodation of military aircraft in airspace where mixed operations are supported.

4.4.1 - Communication systems

The current trends for inter-system communication in Europe is to migrate to Internet Protocol (IP) networking and to rely on SWIM (System Wide Information Management). This includes communications with future U-space actors, as exemplified by the work done by SESAR.

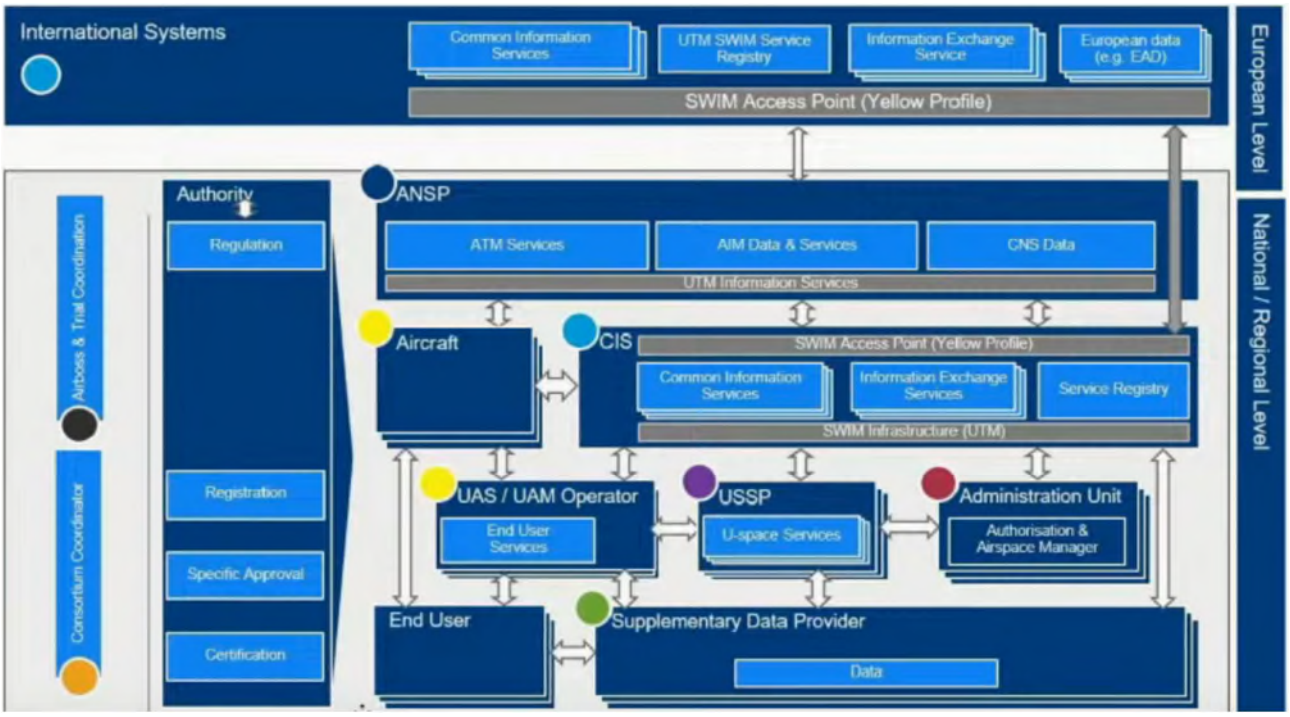

FIGURE 1: INTEGRATED AIRSPACE ARCHITECTURE (BY GOF 2.0 SESAR PROJECT)

We can thus expect that supporting more advanced services, will require military (ATM and Air Defence) participation in the wider SWIM and its supporting infrastructure. Military use of SWIM will largely depend on adequate security provisions.

Longer term requirements may imply overall compliance of military systems with current versions of applicable aeronautical information and flight data standards, adherence to data quality requirements and communication protocols (profiles). That requires suitable interfacing solutions to cover civil/military interoperability at the level of technical infrastructure, taking into account the notion of security.

To ensure operational coordination, especially in emergency situations, civil and military ATC units and USSP, as well as Air Defence units, should be connected by direct voice circuits. To improve safety as well as efficiency, voice should be complemented by inter-centre electronic notification, coordination and transfer messages. In case existing standards would not apply to the technical solutions used to support this coordination, new standards will have to be defined.

4.4.2 - Surveillance systems

USSP rely on extensive cooperative surveillance coverage to detect cooperative UAS. The provision of such data to Air Defence units could increase the situational awareness, and safety and security of all stakeholders by enabling an additional layer of surveillance and capability to ascertain the lateral, and vertical, movement of drones when primary surveillance (PSR) coverage is not able to detect such movements.

4.4.3 - UTM/ATM/Air Defence Systems

For safety and security reasons, UTM, civil and military ATM systems and Air Defence systems (consisting of Flight Data Processing System, surveillance data processing systems) could be connected in such a way that flight data, aeronautical information, meteorological information, surveillance data, airspace management data, etc. can be mutually exchanged to achieve a high level of common situational awareness, while taking security issues into account.

4.4.4 - AIM systems

In terms of data modelling, the information that is relevant for all stakeholders needs to be fully harmonised. Existing international standards applicable to aviation (e.g. AIXM) could be used.

States are encouraged to integrate civil (manned and unmanned) and military Aeronautical Information Service (AIS) or at least ensure there is close cooperation in the provision of this service.

4.4.5 - Operational Interoperability

Operational interoperability, in this context, is achieved by the application of common operational standards and procedures in conjunction with close civil/military coordination, using standardised terminologies. ICAO standards should be applied whenever possible.

Considering that the current U-space approach is focused on a highly automated and digitalised environment, this would require additional communication means between civil and military ATC units and USSPs, as well as with Air Defence units. To ensure efficient operational coordination and to improve safety, the connectivity between interoperable systems should transmit formatted messages.

The high degree of automation envisaged for USSP operations also raises Human Factors issues. Indeed, it may not be possible to replicate in a U-space context the existing working methods and procedures for civil-military cooperation in ATM, because military controllers will not necessarily have human counterparts in USSPs.

4.5 - Finances

4.5.1 - Costs and benefits

To facilitate the costing of the U-space deployment, the implementation measures were broken down into different cost categories.

Consistent with the use cases presented in this report, generalised assumptions were made in relation to the mission requirements and required investments. These and other assumptions are presented in Appendix D.

This compares to safety benefits and some limited operational benefits which could not be quantified. There are no financial benefits expected to derive from the implementation of U-space for the military.

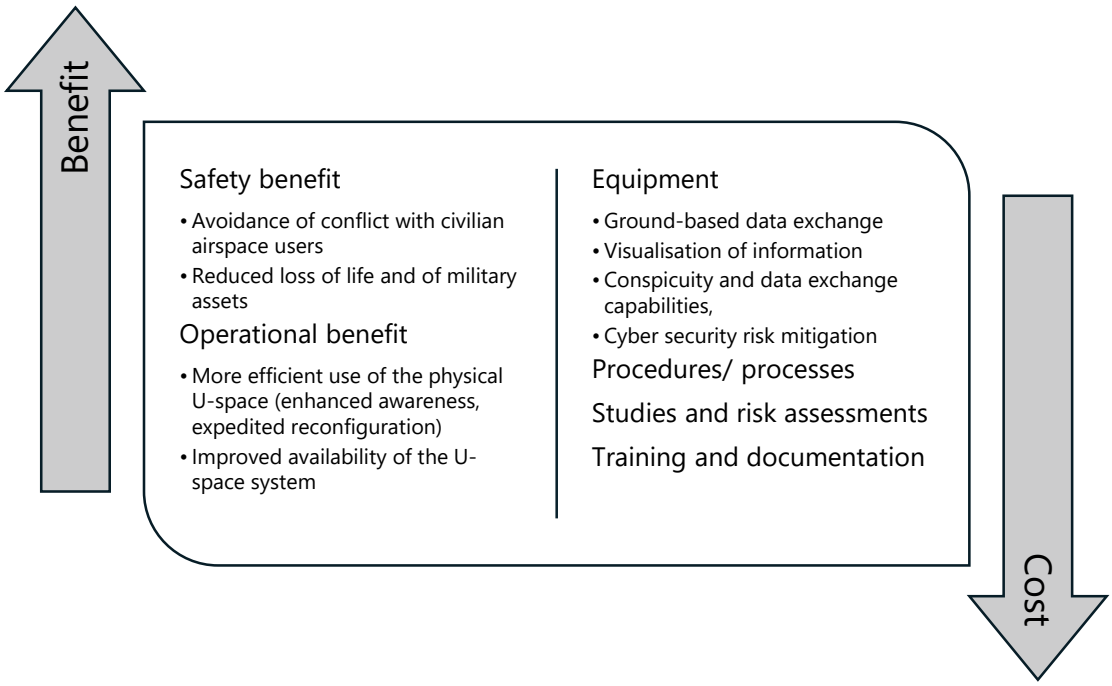

FIGURE 2: CBA COST-BENEFIT DRIVERS

4.5.1.1 - Scenarios

The CBA compares two U-space deployment scenarios against a baseline: the **baseline scenario** corresponds to the current arrangements related to drone operations and U-space, meaning that no implementations and investments are required from the military, whatsoever. There are no costs and benefits for the military that derive from the baseline scenario.

Under this scenario, the responsibility of segregating drone traffic from military air traffic and preventing drone/military aircraft collisions would fall on the drone operators and USSPs.

The **implementation scenarios** correspond to the requirements of regulation IR (EU) 2021/664, which mandates the deployment of at least the following 5 services in U-space airspaces:

- Common Information Service, an enabler for the provision of other U-space services;
- Network identification service;
- Geo-awareness service;
- UAS flight authorisation service;
- Traffic information service.

This CBA distinguishes between implementation scenarios 1 and 2, whereby:

- scenario 1 assumes that the military offers only a minimum degree of collaboration in the implementation of U-space,
- scenario 2 assumes that the military does collaborate in the same way as civilian ANSPs, through the exchange of data and the implementation of the Dynamic Airspace Reconfiguration process for airspace management[11].

The CBA can therefore be understood as an envelope of potential outcomes within which the costs and benefits of U-space deployment are likely to be. The scenarios are explained in detail in appendix D.

4.5.1.2 - Outcome

The outcome of the CBA is negative, yielding a net present value ranging from € -400k to € -850k for standard euros and from € -355k to € -743k in estimated 2023 euros for implementation scenario 1 (minimal military collaboration) and from € -1.95 million to € -4.82 million in standard euros for U-space implementation scenario 2 (full military collaboration).

4.5.1.3 - Capital expenditure

The capital expenditure phase for military investments related to U-space is assumed to extend from 2024 to 2028, whereby the costs in the first year correspond to studies and process re-design, followed in the subsequent years by training and documentation, as well as substantial investment in IT (for scenario 2).

Depending on the size of the Member State, the capital expenditure in 2024 is € 300k to € 550k (scenario 1), € 600k to € 850k (scenario 2), respectively, followed by € 25k to € 75k (scenario 1) and € 480k to € 1.25 million (scenario 2) annually from 2025 to 2028.

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[11] *A variation of this implementation scenario 2, limited to a flexible use of U-space airspace in uncontrolled airspace in the strategic, pre-tactical and tactical phases, is described in the SC3 Final Report.*

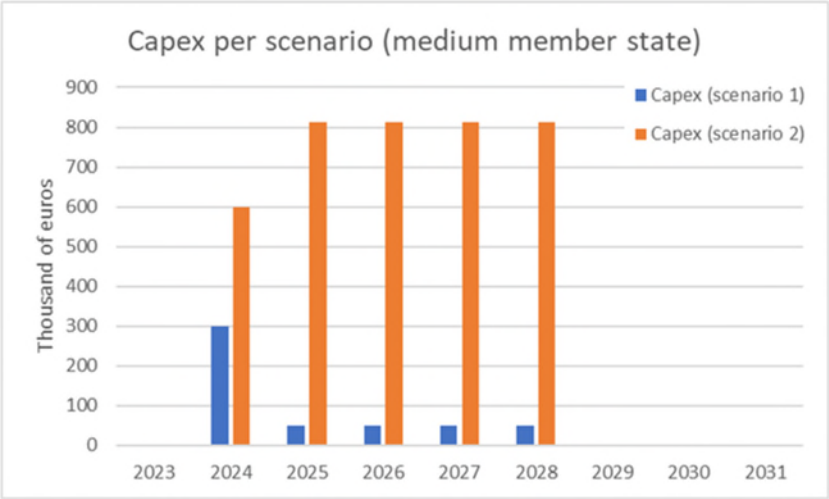

FIGURE 3: CAPEX BY SCENARIO FOR MEDIUM-SIZED MEMBER STATE

4.5.1.3.1 - Capital expenditure breakdown for scenario 1

A more detailed breakdown of the expenditure categories for scenario 1 shows that in the case where the militaries only commit to a minimal level of collaboration, the biggest single cost item would be to conduct initial studies to fully understand the ramifications of U-space implementation at national level (€ 250k for a small- or medium-sized member state, € 500k for a large-sized member state). This is necessary to ensure all safety critical and security related risks can be identified and mitigated. Furthermore, the processes involving the strategic and pre-tactical airspace management need to be revised and adjusted (€ 50k), followed by minor updates in the training syllabus and manuals for affected staff (€ 100k for a small-sized member state, € 200k for medium-sized, € 300k for large-sized).

The discounted capital expenditure for this scenario is € -354k to € -741k depending on the size of the Member State.

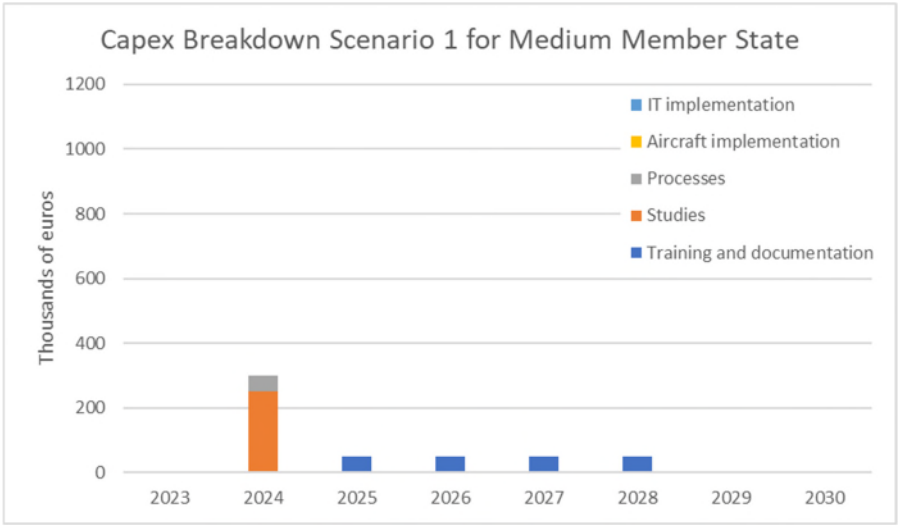

FIGURE 4: CAPEX BREAKDOWN IN SCENARIO 1 FOR MEDIUM-SIZED MEMBER-STATE

4.5.1.3.2 - Capital expenditure breakdown for scenario 2

For scenario 2, the costs for initial studies are assumed to be identical as in scenario 1 (€ 250k for a small- or medium-sized member state, € 500k for a large-sized member state); however, the efforts and costs related to the re-design of processes is bigger (€ 350k), given that the scope of U-space implementation in the collaborative scenario includes tactical activities.

Still, the main part of the implementation costs is incurred in the context of implementing data exchange (€ 1.72 million for a small-sized member state, € 2.95 million for medium-sized, € 4.59 million for large-sized). Training and documentation related activities are expected to continue throughout, generating a relatively small cost of € 200k for a small-sized member state, € 300k for medium-sized and € 400k for large-sized.

The discounted capital expenditure for this scenario is € -2.07 million to € -4.73 million depending on the size of the Member State.

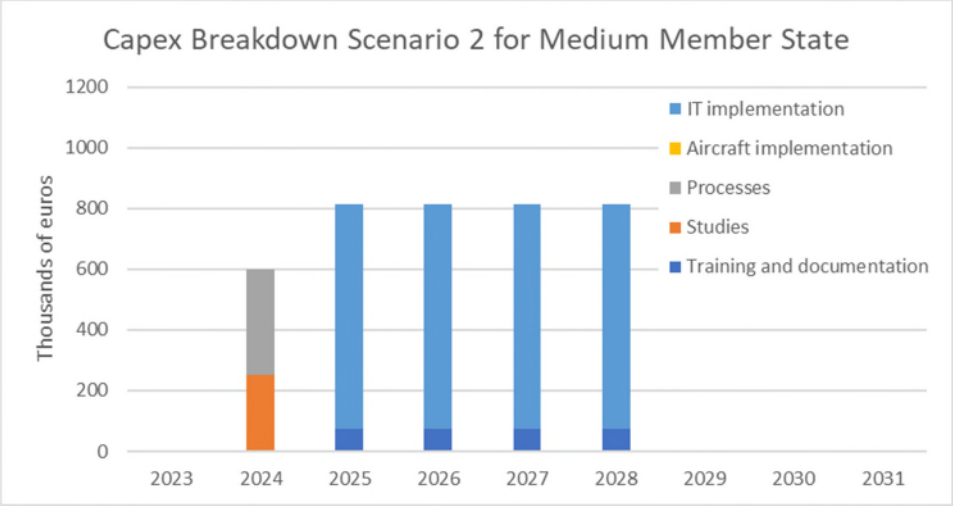

FIGURE 5: CAPEX BREAKDOWN IN SCENARIO 2 FOR MEDIUM-SIZED MEMBER STATE

4.5.1.4 - Operating expenditure and ongoing costs

No operating expenditure costs are expected since no scenario includes additional staffs, offices space, data subscriptions or licenses purchases

With regard to scenario 2 , cost savings associated to safety gains during U-space operation are reflected as other ongoing costs (cost reduction). These correspond to the avoided loss of life and hull loss or damage to helicopters from being involved in drone accidents, as well as the related administrative efforts from such accidents. The cost reduction impact is very low (approximately €19,000) when estimated as an annual average due to the low probability of an incident (for further detail on the estimated savings see annex D).

4.5.1.5 - Depreciation

In order to better understand the economic costs of the investment over time, a simplified depreciation schedule has been developed, assuming that the depreciation period is:

- IT and ATS unit related assets: 7 years
- Training and documentation: 1 year
- Studies, training, documentation: not applicable (costs are not capitalised)

These assumptions may of course vary between individual investment items and between member states. In discussion with the project stakeholders, the applicable capitalisation and depreciation policies and assumptions should be clarified and refined.

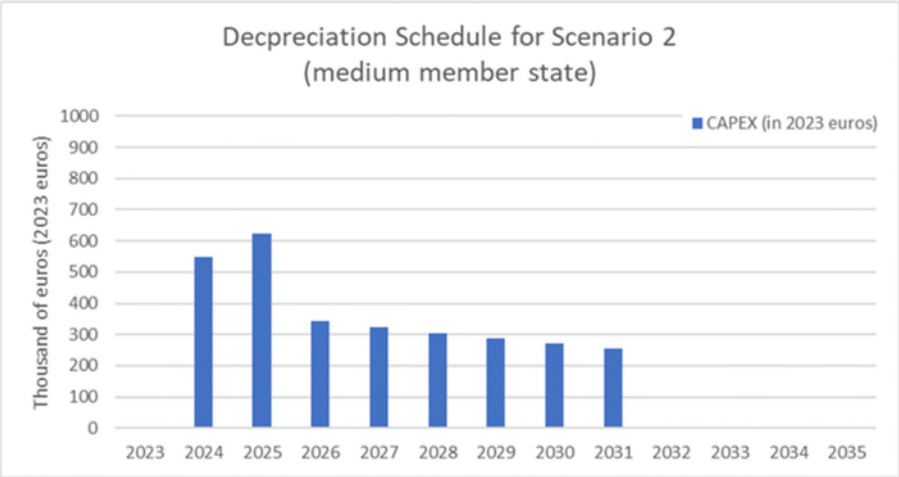

FIGURE 6: CAPEX DEPRECIATION SCHEDULE FOR MEDIUM-SIZED MEMBER STATE

4.5.1.6 - Sensitivity analysis

Given the conceptual nature of this CBA and significant uncertainties about the required capital expenditure and available funding mechanisms, no sensitivity analysis was conducted at this stage of the study.

4.5.2 - Funding options

A number of funding options from European institutions and related to research and technology deployment were identified. Other funding options that may exist at the member states level, NATO and other organisations could not be identified or are considered outside of the scope of this study.

4.5.2.1 - EDA portal 'IdentiFunding'

Under the name 'IdentiFunding', EDA launched in 2019 an online tool that allows defence stakeholders to quickly identify existing EU funding schemes available for their defence-related projects[12]. IdentiFunding covers more than 20 funding opportunities currently open for defence-related projects, including the European Defence Fund (EDF – see next section), Structural Funds, COSME, LIFE, Erasmus+. Since July 2019, the European Investment Bank (EIB) has joined EDA's IdentiFunding by adding its "Project loans". Available opportunities for funding encompass grants, loans and equity.

The aim of the IdentiFunding tool is to save budget, time and human resources usually required for defence stakeholders in order to identify whether their project and entities qualify for potential EU support.

Different EU funding opportunities are available for Ministries of Defence and Armed Forces; European defence industry including Small and Medium-sized Enterprises (SMEs - up to 250 employees) and Mid-Caps (250-3000 employees), large companies and EU PRIMEs; and Defence-related Research & Technology organisations, universities and other institutes.

The scope of the investment and projects that can be funded includes:

- R&T/D (up to systems – from Technology Readiness Level 1 to 9);
- Equipment & Infrastructure (e.g. asset purchase, acquisition, procurement, manufacturing);
- Training and Learning;
- Working Capital and Financial Capacity

[12] *Information from European Defence Agency, IdentiFunding Fact Sheet (www.eda.europa.eu)*

FIGURE 7: DEFENCE FUNDING OPTIONS (EXTRACT)

Given the fact that the requirements for U-space are not yet fully defined, research, technology and development conducted by armed forces, industry or Research & Technology organisations and other will require further funding in the near future. Additional funding will be needed for asset purchase, acquisition, procurement and manufacturing of assets and infrastructures and training. Both, research and development, and deployment related investment is potentially in the scope of the available funding schemes.

It needs to be noted that at the time of preparation of this report the portal was unavailable and under review. A revised version of the portal is expected to become available in the near future, pending its update to the new EU budget 2021-2027.

Below, several funding options that can be relevant in the context U-space related investment are presented. More detailed and up-to-date information is expected to be included in the revised IdentiFunding tool.

4.5.2.2 - European Defence Fund (EDF)

This funding mechanism has been available since 2018 through DG MOVE under the funding window of the European Defence Industrial Development Program (EDIDP). It was intended to facilitate the cooperative development of product technologies for agreed defence capabilities and priorities. Funding is available to consortia of public and private entities in the form of grants and public procurement opportunities.

In the context of the implementation of U-space, this program could be used by militaries to study, design and test U-space related solutions together with the industry and develop these towards maturity.

4.5.2.3 - Structural Reform Support Program (CEF)

This funding mechanism has been available since 2014 through CINEA under the CEF Transport Single European Sky ATM Research window (SESAR). It is intended to fund ATM related studies and (cooperative) works as well as pilot activities conducted by the Single European Sky member states.

If calls were to be launched under this mechanism, applications would need to be submitted by member states or entities in agreement with a member state.

4.5.2.4 - European Structural and Investment Funds (ESIF) – Cohesion Funds

ESIF funds (European Regional Development Fund (ERDF), European Territorial Cooperation Goal (ETC), European Social Fund (ESF), Cohesion Fund) have been available to public-private bodies, ministries of defence, universities, private enterprise and other since 2014, with the funds aimed at facilitating objectives such as technical innovation, transborder cooperation, employment, creation of skills and sustainability. The intended scope of the programs under ESIF specifically refers to dual-use applications and seems therefore relevant in the content of U-space related military investment.

Funding is provided in forms of grants, loans and equity up to €50 Million (for the ERDF and ETC).

4.5.2.5 - European Defence Agency ad-hoc funding

EDA funding is available on a continuous basis under the Category A and B funding windows[13]. With the aim to support cooperative defence research and technology and capabilities, finance can be requested by enterprises, research and technology (R&T) bodies, universities and consortia.

Yearly calls for this instrument have taken place since 2017, with funding being provided by the national Ministries of Defence.

4.5.2.6 - Funding of U-space investment

As shown in this report, the implementation of U-space will require capital expenditure from the military of the member states, deriving from investment into data exchanges, ATS units and aircraft as well as modifications to processes, training and documentation. Benefits are mainly limited to safety improvements and small operational benefits. As a result, the military CBA for U-space implementation is negative and there is limited financial incentive for the military to invest.

Still, in order to maximise the benefits of U-space to all users, including civilian and commercial applications, it is critical that the military is supportive and undertakes a number of investments and procedural adjustments. It is therefore that funding mechanisms should be identified that minimise the financial impact on the military, ideally preventing the military from having to shoulder the entirety of the costs from their regular budget.

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[13] *Technology development in the EDA environment is implemented through variable project geometries. The most common format is the "Category B" project, prepared by a small number of contributing Members (cM) and open to others under an "opt in" scheme. More comprehensive and complex activities are established as "Category A" project or "Joint Investment Programmes" by all pMS, with the possibility to "opt out". Recently, a hybrid format of Cat B-like projects under a Cat A umbrella has proven very successful.*

5 - PROPOSED RECOMMENDATIONS

This chapter 5 contains recommendations resulting from the actions proposed in chapter 4. These recommendations are not limited to the military as they also could be considered as a potential way forward for other State aircraft/organisations (ANSPs, regulators, etc.). These recommendations provide the basis for a Common Military Position regarding the development of U-space, which is formulated as the main conclusion of the present study.

5.1 - Recommendations to U-space local civil and military regulators

Since aviation was born, the civilian and military authorities have always coordinated their activities in order to offer the right level of safety and flight efficiency. The new U-space environment is a paradigm change, which will increase the need to pursue a robust and efficient coordination at all levels, for example to define U-space airspaces.

Member States should agree on a harmonised policy for civil/military UTM-ATM coordination and cooperation, including airspace design development, airspace access requirements, long- and medium-term planning, standardisation of procedures, regulation and deployment of new procedures, which should define the Collaborative (or Informative to U-space) Decision Making responsibilities of the following functions:

- Regulator;
- ANSPs;
- CISPs, USSPs;
- airspace managers;
- airspace users.

5.2 - Recommendations for U-space airspace design and management

In order to ensure the compatibility of manned and unmanned activities, the establishment of a joint civil/military coordination and potentially entities for U-space organisation and management is essential:

- At national high level civil/military coordination body: USSPs should join the airspace directory to:
  - Design and establish airspace structure,
  - Develop coordination procedure and airspace procedures,
  - Develop separation standards and operational rules in order to define responsibilities between civil and military control units when accommodating interactions between civil and military flights.
- The Airspace Management cell, with additional stakeholders (CISP, USSPs) should:
  - Develop a consistent, collaborative national airspace planning process taking into consideration the needs of all airspace users and national security, defence and law enforcement requirements.
- Established communication, negotiation and priority rules and procedures for civil (UTM)/military coordination.

5.3 - Recommendations to U-space operational civil and military stakeholders

The complexity of the European airspace structure at low and very-low level, combined with the increasing number and type of air assets operating in these critical layer of the airspace, is a safety challenge that States are successfully facing daily. It is recognised that the new entrants shall not compromise nor degrade the level of safety achieved so far.

In this context the aeronautical information of air activities should be exchanged in a more dynamic and real-time way. This is the reason why implementing a resilient and interoperable system able to communicate drones positions should be used by all U-space stakeholders, including the other GAT/OAT VFR flights, which shall be kept informed on these activities as well. Such a system should consider military specificities such as confidentiality.

To improve the safety of military flights in U-space airspaces designated in uncontrolled airspace, the most sensible and affordable approach would be to request CISPs/USSPs to also use Mode S for electronic conspicuity where this is applicable and to rely on other mechanisms, such as strategic and tactical airspace management processes supported by information sharing, that use as much as possible the principles of the Flexible Use of Airspace process.

5.4 - Recommendations on interoperability of civil and military systems

Keeping interoperability among civil and military systems to the maximum extent possible is crucial. Globally, this should gradually increase with more performance-based Standards. What is more, dual use and/ or re-use of military systems are ways for military authorities to meet interoperability while reducing the costs.

Civil and military stakeholders together conceptualising tomorrow's system from the outset, including U-space technical requirements, would ensure that interoperability increases, and that a safer and more efficient air navigation system is achieved.

5.5 - Recommendations to military authorities

The military need to coordinate their needs and requirements, with local Civil Aviation Authorities (CAAs) aiming at promoting them at EU-level, to ensure they are duly considered in U-space development.

In this context, the recommendations to the military will depend on each State position and specificity, which could differ from one State to another.

Noting that cross-border operations are a key aspect of military missions, the maximum level of harmonisation in U-space implementation should be an objective. In case such a harmonisation is not possible, a dynamic aeronautical information should be used to give the right information to the flight crews.

5.6 - Proposed Common Military Position

The key military objectives with regard to U-space have been stated by EDA in a 2019 white paper titled "U-Space, Drones and Military Low-Level Flights". These objectives are reminded below:

1. To maintain the level of **Safety** for Military (low-level) operations, to preserve operational effectiveness and to protect Search and Rescue operations.
2. To guarantee the **Security** of (Military) infrastructures, assets and operations.
3. To quantify the **financial impacts** of U-space implementation on the Military and to secure the necessary funding to maintain safety, guarantee security and ensure interoperability

Considering the military high-level strategy in the context of Single European Sky, and considering the above-key objectives, as well as the results and recommendations of the present study, a Common Military Position should be endorsed by the EDA participating Member States and promoted toward all civilian aviation stakeholders, organisations, bodies and European Institutions engaged in the development of U-space.

The following proposed common military position to the EDA is of nature to better face U-space implementation:

1. Member States should **agree on a harmonised policy for civil/military UTM-ATM coordination and cooperation**, including airspace design, airspace access requirements, long- and medium-term planning, standardisation of procedures, regulation and deployment of new procedures. This policy should consider the responsibilities of all stakeholders: regulators, ANSPs, CISPs, USSPs, airspace managers and airspace users.
2. The operational, technical and financial impacts of U-space on military objectives and missions shall be minimised but, **the military authorities should envisage implementing technical solutions** to ensure interoperability with the civil aviation in order to keep both safety and security at the highest level possible. The costs of adapting should be mitigated through appropriate funding mechanisms at EU-level, or by the implementation of off-the-shelf solutions.

3. The U-space actors (USSPs, CISPs) should **rely on existing military and civilian airspace structures and governance processes** to ensure a level of cooperation that is appropriate to ensure the safety of military operations and the security of military infrastructures and assets. As a minimum, this should include the strategic management of the airspace at national level.
4. Further cooperation shall be considered by **managing the U-space airspace in a dynamic manner thanks to data/ information sharing among military ATC and USSPs/CISPs**.
5. Achieving a high level of interoperability between civil and military systems in U-space is crucial for the safety and efficiency of the air navigation systems. Consequently, new entrants should **provide equivalent technical means of compliance to exchange data with all airspace users and operators**.
6. U-space is an on-going development, and the number of drone operations is expected to increase significantly in the next years. The military should thus **monitor the progress of U-space implementation, be systematically involved in the rulemaking process and regularly update this Common Military Position** considering new developments.

6 - APPENDIX A: TERMINOLOGY

Acronym	Definition
ACC	Area Control Centre
ADS-B	Automatic Dependant Surveillance – Broadcast
AIM	Aeronautical Information Management
AIS	Aeronautical Information Service
AIXM	Aeronautical Information Exchange Model
AMC (airspace management)	Airspace Management Cell
AMC (military operations)	Air Mission Control
AMC (regulation)	Acceptable Means of Compliance
ANS	Air Navigation Services
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Traffic Services
ATSP	Air Traffic Service Provider
CAA	Civil Aviation Authority
CAPEX	CAPital EXpenditure
CBA	Cost and Benefit Analysis
CEF	Connecting Europe Facility
CINEA	Climate, Infrastructure and Environment Executive Agency
CISP	Common Information Service Provider
CMP	Common Military Position
CNS	Communication, Navigation, Surveillance
COSME	Competitiveness of Enterprises and Small and Medium-sized Enterprises
DAA	Detect And Avoid
EASA	European Union Aviation Safety Agency
EDA	European Defence Agency
EDIDP	European Defence Industrial Development Programme

Acronym	Definition
EIB	European Investment Bank
ESIF	European Structural and Investment Funds
EU	European Union
FTE	Full-Time Employee
FUA	Flexible Use of Airspace
GAT	General Air Traffic
GM	Guidance Material
GOF 2.0	Gulf of Finland 2.0 (SESAR project)
ICAO	International Civil Aviation Organization
IFR	Instruments Flight Rules
IR	Implementing Regulation
IT	Information Technology
NATO	North Atlantic Treaty Organization
OAT	Operational Air Traffic
OPEX	OPErational EXpenditure
PADR	Preparatory Action on Defence Research
R&D	Research and Development
RAP	Recognised Air Picture
SAR	Search And Rescue
SC	Specific Contract
SCG	Stakeholder Consultation Group
SESAR	Single European Sky ATM Research
SJU	SESAR Joint Undertaking
SWIM	System-Wide Information Management
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
USSP	U-space Service Provider
UTM	UAS traffic Management
VFR	Visual Flight Rules

Acronym	Definition
VMC	Visual Meteorological Conditions

7 - APPENDIX B: REFERENCES

[1] ICAO – Unmanned Aircraft Systems Traffic, Management (UTM) – A Common Framework with Core Principles for Global Harmonization, Edition 3

[2] EDA – White paper - U-Space, Drones and Military Low Level Flights, April 2019

[3] SESAR JU – U-space Blueprint, 2017

8 - APPENDIX C: D1 – U-SPACE EVALUATION

D1 - U-Space evaluation v1.7-final

9 - APPENDIX D: D2 – COST-BENEFIT ANALYSIS

D2 - Cost-Benefit Analysis v1.5-final.d